

School of Information Systems

**The VIVID Model: Accessible IT e-learning environments
for the Vision Impaired**

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Declaration

To the best of my knowledge and belief this thesis contains no materials previously published by any other person except where due acknowledgement has been made. This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

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Date

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ABSTRACT

Sighted learners and vision impaired learners experience different problems when accessing e-learning environments. Web designers use complex visual images and interactive features which learners with vision impairment are unable to access. Learners with vision impairment must rely on assistive technologies to acquire the information they are seeking. Vision impaired learners must have conversion facilities to translate the contents of these displays into readable and accessible formats.

This research identifies problems faced by learners with vision impairment and demonstrates how e-learning environments must be modified to ensure success. The most significant problems are the lack of accessibility to teaching materials and an inability to participate in the learning experience to the same extent as sighted learners. Learning materials designed for sighted learners are often unsuited to those with vision impairment. Frequently, text provided is too small and unable to be altered; colour graphics are of little value unless accompanied by text or audio description and interactive Web sites present numerous challenges in navigation. Most courses are designed for sighted learners and learners with vision impairment struggle to maintain the required timeframe because of difficulties in reading texts and documents, completing assignments and sourcing reference materials due to their inaccessible formats and presentation.

These problems result in lower academic achievement for vision impaired learners, which in turn lead to a lack of choices in employment opportunities. Learning environments for people with vision impairment need specific consideration in design and implementation. This ensures that the learning materials meet their needs and allow maximum accessibility so that the learners can achieve the same outcomes as their sighted peers.

There is a small number of existing models to assist the design of e-learning sites for people with a disability. Kelley's holistic model (2005) and Seale's contextualised model (2006) are designed for people with disabilities in general and not specifically for those with vision impairment. Lazar's Web accessibility integration model (2004)

does not take into account the importance of social elements. Prougestaporn's WAVIP model, (2010) whilst it has generic guidelines, the model is limited in its scope.

Venable's Design Science Research method was chosen to investigate the specific problems faced by vision impaired learners enrolled in IT e-learning courses. The characteristics of approximately one hundred adult vision impaired learners were investigated using two case study environments. The data were collected by observation and semi-structured interviews. Additionally, data were collected from these same learners to identify their specific needs in a Web-based learning situation. Accessibility needs were also identified and analysed. These activities involved the Problem Diagnosis stage in the Design Science Research model. Accessibility guidelines and legal and statutory requirements from several sources were also investigated. The components needed to deliver an effective, fully accessible IT curriculum in two Web-based e-learning environments for the vision impaired was then identified.

Information was compiled from studying two learning environments for the vision impaired. Data instruments used in this phase were observations and semi-structured interviews with vision impaired learners and teachers. These activities involved the Problem Diagnosis and Theory Building stages of the Venable model. The relationships between the characteristics and needs of the learner, and the components of the learning environment for an Information and Communications and Technology (ICT) curriculum were analysed and then synthesised to build a conceptual model of an effective Web-based e-learning environment for the vision impaired.

A new theoretical model, the Vision Impaired using Virtual IT Discovery (VIVID) was then developed. This holistic framework takes into account the specific needs of vision impaired learners. It also includes a social element which vision impaired learners identified as being extremely important to the success of their learning. This activity involved both the Technology Design/Invention state and the Theory Building stage in the Venable model.

An evaluation was carried out by a focus group of eight experts in the field of accessible and e-learning course design and the model was then modified to incorporate their suggestions.

The resulting model is a high level, comprehensive conceptual model that can be applied in differing pedagogical environments relating to IT education for adult learners with vision disabilities. It provides a framework to guide education managers, instructional designers and developers who are creating accessible IT e-learning environments for the vision impaired.

Whilst this model relates only to the IT area, further research could extend its use to other curriculum areas and to those learners with multiple disabilities.

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Dedication

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CHAPTER ONE

INTRODUCTION

1.1 Background

Various forms of vision impairment affect a significant number of people, not only in Australia, but also throughout the world. These impairments range from total blindness to low vision and the causes can be congenital, as the result of an accident or because of specific acquired diseases. Many e-learning courses which are available for sighted learners are not accessible to those with visual issues.

As a result, employment figures for those with vision impairment are considerably lower than for those who are sighted. Statistics from Vision Australia (2007) demonstrate that only fourteen per cent of adults with vision impairment are engaged in the business sector as opposed to sixty three per cent of sighted adults.

The use of the Internet is an important tool in contemporary education and training. However, since by its nature it is an extremely visual medium, many of those with vision impairments are severely limited in accessibility. Inadequate or inappropriate Web sites are major issues for this group. World Wide Web Consortium (W3C) Director and inventor of the World Wide Web, Tim Berners-Lee, stated that,

“The power of the Web is in its universality. Access by everyone regardless of disability is an essential aspect.” (<http://www.w3.org/WAI/>).

The present increase of usability issues indicates that many Web page developers have little understanding of accessibility and usability design. When the World Wide Web (WWW) was in its infancy, it was not envisaged that it would evolve into the global communications phenomenon it is today. Recently, there has been a growing awareness about making information on the Web accessible to everyone, regardless of an individual's capability. Many Web page designers and Web page developers, however, are unaware of the need to ensure that their own Web sites reach the high level of accessibility that is required in our society (Sloan, 2008). Accessibility and usability are closely related, as both can improve the satisfaction, the efficiency and the effectiveness of users. Usability is aimed at providing effective and efficient navigation for the end user. Accessibility is aimed at making Web sites open to a

wider user population, providing flexibility for the needs of an individual user. The combination of usability and accessibility provides for a more enjoyable and valuable Web interaction experience (Paciello, 2000; Spool, Scanlon, Schroeder, & Snyder, 1999; UseableNet, 2001; Valdes, 2001).

Paciello (2000) indicates that people who have a vision impairment are likely to be the most significantly disadvantaged disability group when it comes to accessibility issues. This is primarily due to the graphical nature of the Web's client-server interface. As such, the inaccessibility of Web design has the potential to significantly impact specific Web-based services such as the critically important issue of e-learning (Mimmagh, 2004). This also includes other factors such as access to online banking and information access.

In recent years, the use of teaching and learning materials in e-learning formats has become an integral part of curriculum delivery in educational institutions. The inclusion of vision impaired learners in the mainstream classroom has become increasingly common practice but little consideration has been given as to whether this group's full accessibility is assured. Statistics demonstrate that a significant number of those with vision impairments do not complete the courses in which they have enrolled (ABS, 2009).

The Internet has also resulted in a number of e-learning courses becoming available to learners in remote communities, providing them with the equality of opportunity available to those in major urban centres. Whilst a number of these courses are appropriate for sighted learners, those with vision impairments have both general and individual requirements which are not currently being met.

1.2 E-learning Environment and Accessibility

There are several advantages with e-learning over attendance in a traditional classroom.

These include:

- personal physical presence in an educational institution is not required as access can be gained from any geographical location with an Internet connection

- costs are reduced, particularly those involving travel
- learners are able to study in their own time making learning flexible and
- people with disabilities other than vision impairments can enrol in e-learning courses

(Permvattana, Armstrong, & Murray, 2012).

Some vision impaired learners, however, criticise the many e-learning environments available because they fail to take advantage of the assistive equipment and applications offered by developing technologies. Totally blind learners and those with severe visual problems gain information from computer systems by using Braille and/or audio devices. Many also require screen readers which translate screen images into speech, thus allowing access to electronically produced documents.

Murray (2008) identified the following problems which face vision impaired learners enrolled in advanced IT courses:

- blind learners with mobility problems and isolated learners are physically unable to attend classes
- whiteboards and overhead screens are unable to be seen
- sighted teachers are not aware of the requirements of vision impaired learners
- screen readers are not able to access diagrams, images, pop up and drag and drop facilities and
- simulation software, together with the Linux operating system, are inaccessible.

Learners with vision impairments need to perform more steps than sighted learners when undertaking a given task. This results in the fact that designing a successful curriculum for these learners presents additional challenges. Merely ensuring that traditional lecture notes are available on line does not constitute best practice. Vision impaired learners also need to be able to communicate easily with teachers and their fellow learners so that appropriate support and feedback are readily available and their learning experience reflects best practice.

There are a huge number of Web pages accessible to the potential user and these contain information which is presented in many different ways. Today more than ever, vision impaired users are beginning to question the suitability of many Web

sites because for many of them, the sites are inaccessible and cannot be used for the intended purpose, which is information gathering.

Information Technology is an ideal subject for the vision impaired because skills in this area are core components in tertiary education courses for most disciplines. For the vision impaired IT knowledge can provide easy access to areas such as banking, shopping and retrieving information which provide a broader access to facilities and enable increased time management.

In order to compete in the employment market this group requires educational qualifications to ensure they have the same level of expertise as able-bodied people.

One of the most common problems is that e-learning IT courses are not designed specifically for vision impaired learners with regard to the particular nature of their needs in comparison to other disabilities. The guidelines for Web accessibility for the vision impaired are not designed for effective delivery of learning materials. There is also a misalignment of the use of guidelines for the development of accessible teaching and learning materials and Web accessibility standards and guidelines. Additional teaching aids specifically for vision impaired learners are necessary to ensure that the concepts being taught are easily understandable, can build on past knowledge and are accessible.

A second problem is that e-learning models are commonly designed for sighted learners and do not incorporate considerations for those with disabilities, particularly those with vision impairments. Learning outcomes commonly assume that all learners are sighted and vision impaired learners are expected to attain the same learning outcomes to succeed in the course. Whilst there are many universal accessibility models, the majority of these models are highly conceptual and are difficult, if not impossible to implement and this is not helpful when practical application is essential to ensure accessibility is achieved. What are needed are models that sit between the universal accessibility level and the physical level, translating the principles of universal accessibility into practical solutions for those with vision and other disabilities. More specific virtual and physical solutions and broader communications are required in an e-learning environment for the vision impaired if they are to succeed.

1.3 Potential Solutions

While standards and guidelines for Web pages now exist in most developed countries, there has been little active research published concerning the improvement of access for the vision impaired in advanced IT e-learning courses.

Those courses which are available should offer:

- accessible curriculum materials
- accessible methods of teaching
- accessible assessment tools
- accessible classrooms, either physical or virtual where learners and teachers can communicate seamlessly
- teachers who have a good knowledge of vision difficulties and
- teachers with the skills required to provide the tools for accessibility.

Although a number of e-learning models have been developed for learners with disabilities in general, very few of these models are conceptual and holistic. For application into an e-learning environment specifically for vision impaired learners, most of the proposed accessibility models need alterations and adaptations in order to meet the needs of that specific group. E-learning environments specifically designed for the vision impaired which meet all their needs and requirements are therefore imperative if accessibility is to be achieved.

Frequently, e-learning materials are not designed to integrate with the range of assistive technologies used by vision impaired learners. This often results in these learners acquiring incomplete or inaccurate translations, or on occasion, no accessibility at all. The scope of this research is not to evaluate Learning Content Management Systems accessibility or other specific learning tools and platforms such as Moodle and Blackboard but to build a much more holistic framework and model for education and institutions.

1.4 Research aims

The aim of this study was to investigate specific problems faced by vision impaired learners undertaking IT studies at tertiary level and to develop a more holistic approach to the design of Web-based learning environments for these learners.

1.5 Achievement of the research

This research aimed to develop a theoretical model which would assist education managers, designers and developers to produce accessible IT e-learning environments for the vision impaired. To achieve this aim, surveys, observations and interviews with vision impaired learners and teachers were conducted. The problems identified were further discussed and possible solutions which addressed direct needs were explored. Using existing e-learning model principles and the information gathered, a new model for accessible IT e-learning environments for the vision impaired was developed. This model is presented to guide those designing and developing e-learning situations for learners with acute vision problems undertaking advanced IT studies.

1.6 Structure of the thesis

Chapter one consists of a brief general introduction to the subject of this research study.

It discusses Web accessibility in IT e-learning environments and details some of the issues which affect successful teaching and learning for the vision impaired. It demonstrates that there is a definite need for improvement in this area and possible solutions are listed.

Chapter two consists of a review of contemporary research in learning and the vision impaired, accessibility for people with vision impairment, assistive technologies (AT), accessibility and the World Wide Web, the World Wide Web standards, specifications and government policies, e-learning models currently available and accessible e-learning.

Chapter three consists of a description of the research methodology chosen for this study and how it was applied. This research utilises the Design Science research model by Venable (2006), an iterative approach to designing conceptual and/or

physical artefacts to address a given problem or opportunity. It highlights the importance of a sound theoretical foundation and ensures validity via evaluation. Data collection methods included observations, interviews and questionnaires delivered to vision impaired learners and teachers.

Chapter four consists of details of two current e-learning environments, the TruVision and the Cisco Academy for the Vision Impaired. Areas investigated included course content, course delivery, entry requirements, the roles of learners and teachers, physical classroom layouts and the software and hardware employed.

Chapter five consists of a description of the ways in which the data were collected from learners and teachers involved in the two selected e-learning courses. This is followed by a description of how the data were analysed and details of the subsequent findings. The new findings were grouped into those areas which vision impaired learners identified as being essential for successful accessibility. These were then used as the foundation for a new theoretical model for the design and development of IT e-learning environments.

Chapter six consists of the presentation of a new theoretical model for the design and development of accessible e-learning environments for the vision impaired.

Chapter seven consists of an explanation of the process by which eight experts in IT and education for the vision impaired evaluated the new model. The responses were analysed and applied to the model. Following this, the revised model is presented.

Chapter eight consists of ways in which the new model can be implemented in e-learning environments for the vision impaired.

Chapter nine concludes the thesis by highlighting the contributions of the research, discussing the limitations and suggesting areas of future research.

CHAPTER TWO

LITERATURE REVIEW

An understanding of the needs of vision impaired learners is an essential component when designing an effective and accessible e-learning environment. However, there are a number of overlapping areas which also need to be investigated. These include the current state of assistive technologies where technology is changing rapidly, as are accessibility standards and regulations. Through consulting available research in these areas, and analysing the characteristics and needs of vision impaired learners, a detailed study can be presented.

The discussion of related literature is divided into seven general areas:

- learning and the vision impaired
- accessibility for people with vision impairment
- assistive technologies (AT)
- accessibility and the World Wide Web
- the World Wide Web standards and government policies
- e-learning models currently available and
- accessible e-learning.

2.1 Learning and the Vision Impaired

The use of the Internet is an integral tool for communication in the twenty first century. However, there are many people with vision impairments who need to learn specific skills in order to take advantage of this tool. Such people have previously been disadvantaged due to inaccessible learning materials or instructional media which have not been tailored to their specific needs.

Noonan (1999) states that people with general disabilities comprise a number of groups with some having multiple disabilities. The United States Access Board identified the following groups of people as requiring specific attention in regard to equal access to information technologies:

- those with hearing disabilities
- those with physical disabilities

- those with speech disabilities
- those with cognitive disabilities
- those with medical disabilities
- those individuals with combinations of any of the above and
- those with visual impairment.

The Australian Bureau of Statistics figures (2009) demonstrate that there is a significant difference between educational achievement and employment income between those with a disability and those without as illustrated in Table 2.1.

Table 2.1 Educational Achievement and Income for those with a Disability and No Disability (ABS 2009)

	Disability	No Disability
Completed Year 12	30 %	49 %
Bachelor degree or higher	13 %	20 %
Labour force participation	53 %	81 %
Unemployed	8.6 %	5.0 %
Weekly median gross income	\$255.00	\$501

The Australian Bureau of Statistics (2009) reports that four million people in Australia (18.5%) had a disability in 2009 according to the results of the Survey of Disability, Ageing and Carers (SDAC). Research undertaken by Vision Australia of people who are blind or vision impaired indicated that sixty three per cent who are of working age are unemployed (Vision Australia, 2007). This is a very significant percentage and clearly demonstrates that a major issue exists which requires addressing if this group is to participate fully in society.

Education is a vital factor in preparing learners to develop into responsible adults who can take their place in the work force. It is therefore important that those with vision impairment are able to access education as fully as possible so that they can gain useful employment and participate in society. According to The National Disability Strategy (2011): “work is essential to an individual's economic security and is important to achieving social inclusion. Employment contributes to physical and mental health, personal wellbeing and a sense of identity. Income from employment increases financial independence and raises living standards. The economic independence employment brings is also important as it helps people with disabilities to exercise more choice in their lives, aids them to live independently and facilitates their inclusion in the community. These are all issues covered in the United Nations Convention on the Rights of Persons with Disabilities.” Article 27 of the United Nations Conventions also recognises: “the right of persons with disabilities to work, on an equal basis with others; this includes the right to the opportunity to gain a living by work freely chosen or accepted in a labour market and work environment that is open, inclusive and accessible to persons with disabilities.” (ABS, 2009)

There are two hundred and eighty five million people with visual impairment worldwide, of whom thirty nine million are blind and two hundred and forty six million have low vision (World Health Organization, 2011). In addition, the Australian Disability Clearinghouse on Education and Training (ADCET) estimated that there are about three hundred thousand vision impaired in Australia (2012).

The World Health Organization (WHO) (2003b) predicts that with the population growth expected within the next twenty five years, the number of vision impaired people will double. It is this group which is in need of support, particularly in the areas of education, social networking, economic management and vocational training. For the vision impaired, successful and accessible training is essential if they are to lead a normal and fulfilling life.

For all learners, vision is the primary sense required for successful learning and development (Kelly, Sanspre & Davidson, 2000). One of the main difficulties caused by visual impairment is the problem of access to information and with the developing use of technology this difficulty is increasing (Permvattana, et al., 2012).

Without vision, learners and instructors use speech to a much greater extent and a virtual classroom is needed to supplement the physical classroom and laboratory setting (Murray & Armstrong, 2009).

Current e-learning models are commonly designed for sighted learners and do not incorporate considerations for those with visual impairment. Learning outcomes commonly assume that all learners are sighted. This results in vision impaired learners being required to attain the same learning outcomes in order to succeed in the course. Without unique educational accessible supports programs, trained staff and accessible services, many vision impaired learners cannot succeed and large numbers do not complete the course (American Foundation for the Blind, 2013a).

More specific models are required in an e-learning environment if the vision impaired are to gain equitable access to educational opportunities. This must also take into account the needs and characteristics of this group.

2.2 Accessibility for People with Vision Impairment

People with vision impairment range from those who have never had any visual function to those who had normal vision for some years before becoming gradually, suddenly or partially blind. In addition, there are also people with vision impairments affecting part of the visual field as well as many who have a vision impairment combined with one or more disabilities.

Eye specialists have determined that an individual with perfect vision should be able to read an eye chart comfortably from a distance of six metres. In countries based on the metric system, this is described as 6/6. Non metric countries, such as the United States of America, refer to this distance as twenty feet and thus refer to perfect sight as being 20/20.

A person who has a visual acuity of 6/60 is considered to be legally blind. This figure means person with a severe vision disability may only be able to see this at 6 metres while an able bodied person would be able to see at 60 metres. Although legally blind people may still have limited vision, their ability to use a computer screen is severely restricted (Chilson, 2002; Reidmiller, 2003; Stein, 2002).

Medical conditions resulting in visual impairment may affect the following capabilities (SCC, 2000; Special Education, 2000):

- the ability to see detail
- contrast sensitivity
- colour vision and
- accommodation to changing light levels.

One or more of these conditions can seriously affect learning potential.

Ward (2004) reports that three in ten people with learning difficulties also have a visual impairment, with four in ten having a hearing impairment and some having both sight and hearing difficulties. Teachers providing information for such learners need to take into account how to present information so that it is accessible to those who have impairments. Most methods available to assist learners with visual impairments are not expensive and advanced planning can help to keep down costs.

All those with vision impairments will have different needs and will require information in different formats. Some will prefer audio information on electronic storage media. Some will need more than one standard format which may include one for reading and a second to keep for reference. Some may need short documents, such as memos, in print or Braille but they may access longer documents, such as minutes of a meeting, by an electronic means. They might also require a summary of longer documents such as course outlines.

Vision impaired learners, therefore, must rely on assistive technologies and e-learning environments are seldom designed to incorporate these. E-learning materials are not designed to integrate with the range of assistive technologies used.

A key issue for the instructional designer is to plan in advance and ask people with vision impairments what they need for accessibility purposes. This avoids the necessity of modifying accessibility later, which could result in the expenditure of large sums of money. One of the important characteristics of a design team is the ability to be proactive.

An important factor in assisting the vision impaired learner is in the aspect of presentation. Words and pictures need to be laid out in a way that is easy to see, read

and follow. Galitz (1997) states that while one font size will not suit all vision impaired learners, a fourteen point print size is the minimum size which is acceptable. According to Ardit (1997), of Lighthouse International, people with low vision find that open, sans serif fonts, such as Arial, are the best for everyday use as they are more easily readable. Ardit also recommends that a mixture of lower and upper case lettering is preferable to using all capitals. Ardit's research (1997) further concluded that those designing print documents should choose sixteen or eighteen point font size thus ensuring that the print is legible to low vision learners. Such readers might find the same font sizes useful on the World Wide Web but since Web design techniques differ from the print format this is not always possible.

Web designers should use the relative units of measurement supported by the Cascading Style Sheets (CSS), which include the em and percentage, or the verbal descriptors such as largest, larger, medium, smaller and smallest. These are referred to as relative measures because the font size shown on a computer screen is relative to each user's default setting.

The contrast between text and background is also important for many with visual impairments, as it is easier to see dark print on a white background (Ward, 2004).

The results of inaccessible learning materials or mediums of instruction can lead to the lack of opportunities for information access and knowledge. Accessibility is about removing barriers. More accessible materials benefit all participants, including those with a disability as well as those without.

2.3 Assistive Technologies

A formal legal definition of Assistive Technology (AT) was first published in the United States of America in legislation passed in 1998 entitled the Technology-Related Assistance for Individuals with Disabilities Act.

AT refers to a broad range of enabling strategies, technologies and devices that allow individuals with special needs to work around their areas of challenge. Appropriately selected AT helps people with disabilities to gain or access information or to perform a task more independently and efficiently. In an educational setting, AT can assist a learner with a disability to participate in an activity or to complete a task that would

have been difficult or impossible to do unaided. AT has now brought printed materials within reach for those unable to see.

AT can improve accessibility for various types of visual impairments. These range from the congenitally blind, who are blind from birth or soon after, through to those who lose their sight in varying degrees through accidents, disease or the effects of medication. Some of these conditions can be treated, improved or occasionally reversed but congenital blindness is usually permanent (Murray & Armstrong, 2004).

The rationale for making use of AT includes a number of significant factors which are relevant to those with vision impairment.

- AT devices provide new opportunities for improving access to information.
- AT devices can be used throughout life making accessibility to everyday tasks an easier process.
- AT devices can be user specific so that each person seeks out those which best suit his or her needs.

Technological advances have changed daily life for many people, but they have proven particularly valuable to people who are blind or vision impaired. Until only recently, the world of print information was extremely difficult for people with little or no sight to access.

A number of AT devices and software has been developed to assist people with the various forms of visual impairment. These technologies consist of devices and systems which have been designed to overcome, or diminish, the difficulties faced by users when interacting with computers and associated technology. They include a broad range of enabling devices and strategies which allow individuals to increase and improve their accessibility skills. Appropriately selected technologies assist people with vision impairment to access information or perform a task more independently and efficiently.

It is essential that learners feel capable of setting and achieving their own goals. These goals will vary from learner to learner. The use of an AT device to produce better outcomes encourages achievement of relevant goals for a learner with a visual impairment. As a learner improves and develops his or her own abilities through the use of AT, new goals can be set and accomplished. Positive results achieved through

the use of AT can create motivation for learners to set higher and more difficult targets.

The following AT aids are three types of equipment that people with visual impairment commonly use to enhance their everyday activities - screen readers, screen magnifiers and Braille displays Koufogiannakis (1997). The AT specifically mentioned in this research is only a sub-set of those available in the market.

Screen readers are popular with most people with visual impairments and they are commonly known as voice output technology. Screen readers recognize text and read it out using synthesized speech, allowing the user to hear what is written on the screen. The advantage of these devices is supported by Heim who also stated that: “ blind or vision impaired Web users rely on screen reader software or talking browsers to navigate the Web” (Heim, 2000).

Screen magnifiers are software based and they act to magnify the screen content thus enabling the user to read more easily.

A Braille display is a device, usually attached to a computer keyboard, which allows vision impaired users to read the contents of a screen display one text line at a time in the form of a line of Braille characters.

Any education system must develop the self-esteem of all learners. The use of AT helps to decrease frustration for learners because they are able to act independently and at their own pace. They do not have to rely on others to assist with tasks they would rather perform for themselves. Those who develop a high level of knowledge and skill in specific areas of AT will also become useful resources for other learners through sharing expertise, mentoring and assisting others (American Foundation for the Blind, 2013b). The use of technology also promotes increased interaction with others and helps to prevent social isolation. AT equipment allows a learner to access information and communicate or participate in any social setting (TheAllianceforTechnologyAccess, 2000).

Teachers must understand the needs of vision impaired learners and the barriers to learning these learners face. It is therefore essential that teachers understand the benefits which the use of AT can provide and that they have a good knowledge of the variety of the tools and devices which are available.

Ultimately, all AT devices function as problem solvers for learners with visual impairment. There are still challenges to face on a day-to-day basis even with well selected AT devices, but they do help make life more manageable for both learners and their families. AT provides opportunities for success and optimism, while allowing educators to better serve learners. AT helps to create bonds through problem solving and teamwork while reducing feelings of dependence.

AT is making a great difference to the lives of many learners with vision impairment. Teachers, in partnership with special educators and other members of the educational community, can assist in expanding the educational opportunities available to all learners by promoting and developing accessible teaching and learning materials (D'Amour, 2004; Hopkins, 2004).

One problem that vision impaired learners face in accessing AT is the price. This is because it is a niche market and thus the companies are able to set the price confident that there is little competition. A supporting statement appears in the Australian Communications Consumer Action Network (ACCAN) which recently reported that Australians, especially people with a disability, pay too much for AT (Media Access Australia, 2012). Although, recent years have seen an increase in free AT, the features are not sufficiently comprehensive for many vision impaired learners.

A second problem is that each product has unique characteristics. Braille embossers require specific configurations and cables to be connected to a computer, modem or printer. The Braille printers have to be configured for the appropriate hardware or software to perform correctly, and reading machines have to be configured to scan and read text with attached keypad.

As technology progresses, the lines between expectations for technology and accessible technology will continue to diminish. According to the Microsoft Accessible Technology Team, computers will adjust to a person rather than the person adjusting to the computer (Microsoft, 2012).

In the coming decade, all computer users will have alternative ways in which to interact with their computers. The average business computer will have built in flexibility for alternatives such as handwriting and speech recognition, thus allowing accessibility to both vision impaired and sighted users.

The most optimistic view of future technology is where the need of accessible technology and AT will no longer exist. All technology will be flexible enough to be accessed to by anyone in the way that they choose, including for teaching and learning purposes. To this end, all researchers hope that the next generation of technology will be life-changing for everyone, and in particular for people with disabilities (Moulton, Huyler, Hertz, & Levenson, 2002).

Overall, strong research and guidelines have been developed to increase online accessibility for users with disabilities. There is also a wide range of AT. However, little is known about how best to design materials which provide options for all these tools. Significantly, most online learning development is done for learners in general and accessibility considerations are later added. If online learning programs were designed primarily for accessibility, their development would be completely different. The need to consider accessibility as the main focus is growing stronger. In designing primarily for accessibility it is important to know which areas are the most important to consider.

2.4 Accessibility and the World Wide Web

According to the American Foundation for the Blind (AFB, 2004a) the World Wide Web (WWW) has become an extremely useful tool for those with vision impairments. They are now able to access the daily press on line on publication day, order goods and supplies with prior knowledge of prices before proceeding to the check-out cart and determine the contents of a DVD before making a selection. There are many other examples of areas where vision impaired people can make use of information on the Web. However, not every Web page is designed for users with vision impairment.

A study by Russell (2003) who investigated the accessibility of the Internet, showed that the partially sighted can only gain full access to Web sites if they are supported in their endeavours.

Online information provides many benefits compared with printed information. These include:

- it is easy for people with poor eyesight to increase the font size

- the text-to-speech conversion works much better for online text than print because the document can be reread and rechecked if required
- accessing information online reduces the cost involved in purchasing printed materials and
- it is more convenient for vision impaired users to retrieve information from the Internet as this can be done in their own home thus avoiding the necessity of traveling long distances.

(Guthrie, 2000; Spyridakis, 2000; Takagi & Asakawa, 2000).

The most serious accessibility problem faced by users with visual impairments is that: "...most Web pages are highly visual" (D. Brown, 2000; Nielsen, 1996a). Many Web pages have a combination of background and foreground colours which are totally inaccessible for those who are colour blind. It is quite common to see combinations of background and foreground colours that make pages virtually unreadable for the colour-blind.

One of the ways of making the Web more accessible for the vision impaired is by the use of Hyper Text Markup Language (HTML). This language can be used to change the size, colour and structure of Web pages and it can also present images in more accessible ways. The advantage of HTML is that individual users can adjust their default settings so that browsers can convert Web pages into more accessible formats (Nielsen, 1996a, 2000). Scanning long pages is problematic for a vision impaired user. In order to facilitate this, the use of proper HTML codes can improve the structure of the page. The vision impaired user can quickly skip an uninteresting section by instructing the screen reader to jump to another part of the document (Nielsen, 1996b).

Many educational institutions use the Web in order to provide information to learners enrolled in courses. Results of recent research in e-learning environments have resulted in an increase in accessibility for vision impaired learners (Murray & Armstrong, 2004). Since access to the Web has grown, Government facilities, corporations, educational institutions and commercial entities use it for publicising policies and procedures so that it has become a virtual bank of information.

Although the technologies detailed above have provided a great improvement in accessibility for vision impaired learners, there is still scope for further development. According to the Post Secondary Education for Individuals with Difficulties report published by the National Forum on Education Policy in the United States of America (2001) approximately six per cent of learners enrolled in post secondary educational institutions had a disability with the most common being a visual impairment (AccessIT; 2004). Based on these statistics, Mates (2000) states that universities and colleges need to be more aware of accessibility issues faced by vision impaired learners. Further research by Leiserson (2001) indicates that there is a definite need for vision impaired learners to be provided with technologies so that they have the same access to materials and information as sighted learners.

A further problem lies in the fact that too many Web pages have been designed without an appropriate description tag for each image. As a result, the screen readers use the alternative text description to describe the images. However, screen readers can often only find limited meaning to read out loud for vision impaired users. There is still insufficient research into the whole issue of Web page design for vision impaired users (Nielsen, 1996b).

The International Center for Disability Resources on the Internet (ICDRI) reported that many laws and policies which have been formulated recommend that Web pages be accessible to people with disabilities. These laws and policies are now at the beginning stage in dealing with electronic and Information Technology accessibility for people with disabilities. They have begun to expand their scope from just the idea that Web pages must be accessible to the idea that all electronic and Information Technology must be accessible to people with disabilities (International Center for Disability Resources On the Internet, 2004).

Increasing access to the Internet means Information Technology developers, as well as business, training and educational instructors, need to become aware of the importance of Web page design in order to accommodate this vast number of users. Many people are using the Web for purposes that were never originally intended such as inappropriate communications like scam (Lau, 1997; Nielsen, 2001).

If people with disabilities are not able to access the Web they will be left further behind than they are now. The absence of these opportunities will make a difficult

reality even worse and stop many vision impaired learners from being productive members of society (Burks, Aguilar, Pardos, Waddell, & Nahane, 2000).

As technological growth has expanded, there has been an increase in the use of technology in educational institutions. However, much less attention has been paid to widening access and certain groups of users have been left behind (Hollier, 2006).

The growth of the importance of new technologies, particularly the Internet, has resulted in a vast amount of interest in their structural design and their connection to commercial potential, but much less attention has been paid to widening access. Certain groups of users have been left behind as new technology progresses. This is often referred to as a digital divide (CenterforDemocracyandTechnology, 2001).

A study by Russell (2003) who investigated the accessible Internet, showed that the partially sighted or those with impaired motor skills, can gain full access to Websites if they are enabled and supported. Improvements have been made in the area of online accessibility, as many cases were filed in the United States of America under the Rehabilitation Act 1973 and the Americans with Disabilities Act 1990. These cases often refer to the Web Content Accessibility Guidelines to determine standard accessibility but no universal standard has yet been developed. Developments in this area are gradual but if accessibility requirements are recognised not only for public, but also for private Websites, the impact will be significant.

Making the Web more accessible for the vision-impaired user is, to a great extent, a matter of using HTML in the way that it was intended to be used – to encode meaning rather than appearance. As long as a page is coded for meaning, it is possible for alternative browsers to present that meaning in ways that are optimized for the abilities of individual users and this facilitates the use of the Web by disabled users (Nielsen, 1996a, 2000).

Online information provides many benefits compared with printed information. It is easy for people with poor eyesight to increase the font size and the text-to-speech conversion for blind users works much better for online text than print (Guthrie, 2000; Spyridakis, 2000; Takagi & Asakawa, 2000). In fact, many disabled users are empowered by computers to perform tasks that would have been difficult for them with traditional technology.

Textual pages are reasonably easy to access for the blind since the text can be fed to a screen reader. Long pages are more problematic for a blind user to scan for interesting parts than it is for a sighted user. In order to facilitate scanning it is recommended that the structure of the page is emphasized by proper HTML code, using Heading size 1- <H1> for the highest-level heading. By doing so, the vision impaired user can get an overview of the structure of a page by having the <H1> read aloud and can quickly skip an uninteresting section by instructing the screen reader to jump to another part of the document (Nielsen, 1996b).

The use of AT by teachers and learners has become more wide spread as accessibility tools are now within reasonable financial reach. The devices are now freely promoted in educational institutions and are generally included in the resources available.

2.5 The World Wide Web Standards and Government Policies

The United States of America was the first country to pass legislation requiring Federal agencies to make their Information and Communications Technology (ICT) accessible to people with disabilities. Congress amended the Rehabilitation Act of 1973 in 1998. This included Section 508, which stated that agencies must give disabled employees and members of the public access to information that is comparable to access available to those with no disability. This was designed to remove the barriers in IT and open new opportunities for people with disabilities. It also supported the development of technologies that would help achieve the requirements of the act. The law applies to all Federal agencies when they develop, procure, maintain, or use electronic devices and IT.

The United States Federal Government is an extremely large consumer in the ICT market. Section 508 effectively required many ICT manufacturers to make their products accessible, the alternative being to lose their business with the Federal Government. Section 508 resulted in a big change in the market. Most devices that were initially designed to be accessible only for the Federal Government became available to the general public (Media Access Australia, 2011c).

The Web Accessibility Initiative (WAI) took the United States Section 508 as the starting point for their publications. Australia then adopted the WAI specifications and recommendations. The following are examples of WAI international guidelines.

1.1 **Text Alternatives:** Provide text alternatives for any non-text content so that it can be changed into other forms people need, such as large print, braille, speech, symbols or simpler language.

2.2 **Enough Time:** Provide users enough time to read and use content.

(Web Accessibility Initiative, 2012)

For people with disabilities in general, and vision impairment in particular, Australian Government legislation since the 1980s has played an important role. At the Federal level in Australia, the Disability Services Act 1986 (DSA) provided the framework for the implementation of many support services. These agencies were established to provide better independent living for people with disabilities. The DSA 1986 was criticised for not ensuring compliance, but this omission was corrected in 1999 by amendments that implemented Law Reform Commission recommendations (Clear, 2000). (See Appendix A for the most significant amendments)

The Disability Discrimination Act (DDA) of 1992 complemented the DSA (1986) and, as well as recognising the rights and those with disabilities, it also focused on limiting discrimination. The DDA 1992 is similar in many ways to the US Americans with Disabilities Act (ADA) 1990, which focuses on service provision and civil rights issues (Drake, 2003; Hollier, 2006). The main objectives of the DDA 1992 (Australian Federal Government) are as follows:

“a. to eliminate, as far as possible, discrimination against persons on the ground of disability in the areas of:

- (i) work, accommodation, education, access to premises, clubs and sport
- (ii) the provision of goods, facilities, services
- (iii) existing laws and
- (iv) the administration of Commonwealth laws and programs;

- b. to ensure, as far as practicable, that persons with disabilities have the same rights to equality before the law as the rest of the community and
- c. to promote recognition and acceptance within the community of the principle that persons with disabilities have the same fundamental rights as the rest of the community.”

(Disability Discrimination Act, 1992)

The DDA 1992 focuses on ensuring equity within the community in such areas as employment and education.

Because of the period in which the DSA 1986 and the DDA 1992 were written, neither directly refers to computer technological requirements or the use of the Internet for people with disabilities. These issues have been addressed by the Human Rights and Equal Opportunity Commission (HREOC), which recommends equity in the areas that relate to Information Technology.

However, in 1994, the Australian Federal Government developed internal policies for the delivery of online information. Although the Government has no specific IT legislation to ensure that such information is provided to people with disabilities, there are internal policies that control how Government publications can be effectively presented in an accessible online format. These are outlined in the Commonwealth Disability Strategy (CDS). (See Appendix B for parts of the CDS)

The HREOC also provides a process for resolving disability related discrimination issues which operate within the framework of the DSA 1986 and the DDA 1992.

The following example highlights the difficulties faced by vision impaired people when accessing the Internet.

Australia: The Olympic Games

Although Australia has a strong commitment to accessible information technology, on June 7th 1999, Bruce Maguire sued the organising committee of the Olympic Games. Maguire is blind and his case consisted of the complaint that he had been unlawfully discriminated against in three ways, namely:

- failure to provide information for ticket purchase in Braille

- failure to provide a Braille version of the souvenir program and
- failure to provide a Web site which was accessible to people with vision impairment.

Maguire sued under the provisions of the Australian Disability Discrimination Act 1992 (DDA) and in August 1999 the HREOC ruled in his favour. Although the designers of the Web site claimed in court that it would take an enormous amount of both time and money to modify the site, the site was in fact modified in just a few days and at a cost of less than thirty thousand dollars (Slain & Rush, 2003). Maguire was awarded twenty thousand dollars in damages.

The issue of ensuring an accessible Olympic Games Web site has not yet been completely resolved. The Australian Paralympics site was tested with a Web site validation tool (BOBBY) and failed at all levels of compliance. This finding reinforces the fact that awareness of the needs of people with vision impairments continues to be a low priority.

Two policy instruments are important for the regulation of access to education. The DDA 1992 and the related Disability Standards for Education 2005 require, at least implicitly, educational materials to be delivered in accessible formats. However, a provider is required only to make a “reasonable adjustment”. An adjustment is not mandatory if it would cause “unjustifiable hardship” to the provider (Disability Standards for Education, 2005).

Although Australia currently has a variety of legislative and policy instruments which mandate and support accessibility, it remains the case that there is no single accessibility instrument or regulatory body.

The principal media access regulators in Australia are:

- the Australian Communications and Media Authority
- the Australian Human Rights Commission and
- the Department of Broadband, Communications and the Digital Economy.

In 2010, The Australian Government endorsed the Web Content Accessibility Guidelines (WCAG) version 2.0 for all Government Websites. Information about the new standard, including the full scope of the improvement, is detailed in the Web

Accessibility National Transition Strategy (NTS) 2010, published on the Department of Finance and Deregulation Website (Australian Government).

As the Australian Human Rights Commission (AHRC) 2010, states in its Advisory Notes: “Commonwealth Government departments and agencies, and other organisations where they are involved in administration of Commonwealth laws and programs, do not have the benefit of an explicit unjustifiable hardship defence under the DDA. These organisations are required to provide equal access free from unreasonable barriers.” (Media Access Australia, 2011a).

All Australian Commonwealth, State and Territory Governments have policies that require their departments and agencies to provide at least one of a number of accessibility services. These include:

- captioning all television commercials and public information videos
- providing information in a suitable accessible format, or providing an alternative format on request and
- applying the World Wide Web Consortium (W3C) WCAG 1.0 guidelines to Websites, and WCAG 2.0 guidelines by 2015.

In particular, the Web Accessibility National Transition Strategy states: “Australian Governments at all levels have endorsed WCAG 2.0, and require all Government Web sites (Federal, State and Territory) to meet the new guidelines at the minimum compliance level (Single A) by the end of 2012. In addition, the Australian Government requires all Federal Web sites to meet the medium conformance level (Double A) by the end of 2014.” (Australian Government Information Management Office, 2010). The NTS provides recommendations for improved Web services. These will assist Web page designers and developers to create more accessible and usable Web pages which will allow full participation from all people within society.

The W3C was involved in providing actual concrete specifications and guidelines to support the Australian Government’s Web accessibility policy.

The International Organization for Standardization (ISO) and The International Electrotechnical Commission (IEC)

International Organization for Standardization (ISO) is the world's largest developer and publisher of International Standards. The ISO is a network of the national standards organisations of some 164 countries as of July 2012. More than hundred of ISO's members are from developing countries. The IEC is the world's leading organization that prepares and publishes International Standards for all electrical, electronic and related technologies together known as "electrotechnology." IEC international standards cover a massive range of technologies from power generation, distribution to home appliances and also office equipment.

The Special Working Group on Accessibility (SWG-A), which was approved by the ISO/IEC Joint Technical Committee 1 (JTC 1), works on developing international standards. It focuses on three aspects: publishing a comprehensive users needs summary, itemizing the standards and policies related to accessibility, and providing guidance for standard development organisations to map a standard against user needs.

The ISO/IEC TR 29138, Information Technology which is a Technical Report prepared by the ISO/IEC JTC 1 consists of three parts, under the general title Information Technology-Accessibility considerations for people with disabilities:

- user needs summary
- standards inventory and
- guidance on user needs mapping.

(International Organization for Standardization, 2009; W3C, 2012)

The World Wide Web Consortium (W3C) Specifications and Guidelines

There are many guidelines for designing Web pages. However, very few address the issues of those with vision impairment (Paciello, 2000; Spool, et al., 1999; UseableNet, 2001; Valdes, 2001; Webable, 2001). Most of the proposed guidelines are not supported by experimental research or design and they are therefore not entirely credible (Borges & Morales, 1996).

There are many ways in which Web pages, the basis of e-learning, can be optimized for accessibility. The leader in establishing accessibility guidelines for Web page authoring is the Web Accessibility Initiative (WAI), a sub-committee of the W3C, a highly respected research group (Dunn, 2003; World Wide Web Consortium, 2004).

The WCAG 1.0 was published and became a W3C recommendation on 5 May 1999. It has since been superseded by Web Content Accessibility Guidelines WCAG 2.0 (2008).

WCAG 1.0 is organised around Web accessibility guidelines that have checkpoints which are priority 1, 2, or 3.

WCAG 2.0 is organised around four design principles of Web accessibility. Each principle shows guidelines, and each guideline provides testable success criteria at level A (Single A), AA (Double A), or AAA (Triple A). The basis for determining conformance to the WCAG 2.0 are the success criteria (Web Accessibility Initiative, 2009).

WCAG 2.0 was published as a W3C Recommendation on 11 December 2008. Goals include the development of guidelines to a point which will allow full potential of usability for people with visual impairments. According to Paciello (2000) and (Withrow, 2001) the WAI's (WAI, 2003) mission is as follows: "to support the W3C's commitment to develop the Web to its fullest potential and, by promoting a high degree of usability for people with disabilities. In bringing together organisations and research groups around the world, WAI is working on accessibility issues of the Web through five primary directions:

- technology
- guidelines
- tools
- education and
- research and development."

W3C guidelines recommend design so that Web content will be more easily accessible to users, whether they are using a desktop browser, a voice browser or a mobile phone (World Wide Web Consortium, 2004). Improved design will make information accessible more quickly. W3C does not discourage content developers

from using images and video, but rather explains how to apply multimedia content that is more accessible to a wider audience.

The importance of WCAG 2.0 in relation to multimedia content was highlighted by its adoption on 15 October 2012 as an International Organization for Standardization (ISO) standard, (ISO/IEC 40500). This endorsement provides additional avenues for people with disabilities to be better supported (W3C, 2012).

The guidelines are organised in three priority level checklists (WAI, 2003):

- **Priority 1-** A Web developer **must** satisfy these checklists, otherwise one or more groups will find it impossible to access the information.
- **Priority 2-** A Web developer **should** satisfy these checklists, otherwise one or more groups will find it difficult to access the information
- **Priority 3-** A Web developer **may** satisfy these checklists, otherwise one or more groups will find it somehow difficult to access information in the document.” (See Appendix C for further details).

The existing W3C guidelines are generally designed for people with all disabilities, not specifically for the vision impaired. Although the information provided is comprehensive, there is still a need for accessibility awareness to be raised amongst all Web page developers on how to overcome accessibility barriers in a practical way (Gibson, Sloan, Gregor, & Booth, 2001).

WAI (2003) publishes its recommendations as a series of standards and has issued three sets of guidelines:

- **Web Content Accessibility Guidelines 1.0** — These explain in detail how to make a Web site accessible for people with a variety of disabilities.
- **Authoring Tool Accessibility Guidelines 1.0** — These describe how to use current tools to support the production of accessible Web content.
- **User Agent Accessibility Guidelines 1.0** —These explain how to make accessible browsers and multimedia players and how to make assistive technologies that interface with these technologies.

Following recommendation from Section 508, the Section 508 Access Board evaluated guidelines from the W3C and WAI in order to: “include provisions which are based generally on priority one checkpoints of the WAI/WCAG 1.0, as well as other documents on Web accessibility.” More information about the difference between each international accessibility guideline is based on Nevile’s research in 2002. “The important difference between the US and Australia is about how the legal framework itself is set up. In the US, Section 508 is a set of rules that must be met for anything purchased by the Federal Government or with their money (i.e. grants to States). In Australia, the legal requirement is ‘not to discriminate against people because of their disability’. So it is more broadly applicable, and there is no absolute set of rules.”

(See Appendix D for a comparison and alignment of WACG 1.0 Guidelines and Access Board Section 508 Guidelines, Nevile, 2002 and (Thatcher, 2007).

Hudson (2002) found that Section 508 Guidelines presented an impetus to improve Web sites that required accessibility renovation. In addition, the Guidelines can further assist those requesting resources, creating policy and setting Guidelines. As the WWW develops to include more graphics, with more videos and links, Web designers must weigh the desire for appealing graphics against presenting the information that is required on the Web site in an accessible manner (Hudson, 2002).

Webdale (2004, p 14) argued in support of these moves and recommended further that:

- “government should promote a formal accreditation process for Website developers and promote a main scheme for Website developers
- Website developers should involve disabled users with a range of sensory, cognitive and mobility impairments from an early stage in the design process
- Website developers should not rely exclusively on automatic testing software
- the W3C's Web Accessibility Initiative should give serious consideration to extending the scope of its guidelines and
- developers of operating systems and browsers should take steps to ensure that accessibility options are easier to discover, understand and select.”

Research by Witt and McDermott (2004), showed that Web accessibility is a major concern within UK academic institutions. However, a lack of understanding of the requirements still remains. A worrying trend in the United States, as the result of Section 508, is that most designers and developers have decided to create a less graphical text version of their site to meet the accessibility criteria.

Most of the Web accessibility guidelines propose restrictions on the use of page layouts which can impede screen readers from interpreting the content successfully for the vision impaired user. In order to comply with the guidelines, many developers simply remove the rich and alternative media. While this can ensure compliance, it often does so at the expense of the information and content. Specific design strategies that support accessibility in the initial stages of Web projects are advantageous as this will assist in preventing important alterations at a later date.

Government, business, educational and other organisations in Australia are increasingly using the Web as a resource to provide large numbers of people with access to information and other services in a timely and cost efficient way (Alexander, 2004). In Australia, the Disability Discrimination Act 1992 makes it illegal to design and develop Web pages that are inaccessible to people with disabilities. As a result, many businesses see designing for accessibility not just as a matter of legal compliance but also as a means of extending their potential customer base.

To comply with the DDA 1992, there is a need for Web developers and designers to find tools that test Web pages for accessibility, report on problem areas and suggest possible improvements. These evaluation tools are not a substitute for user testing, but they do allow Web designers to ascertain an initial response from prospective users. There is now a growing list of tools that can be used to ensure accessibility guidelines have been met.

Web developers can use self-approval system tools or validation tools, such as BOBBY, Usable Net, W3C HTML Validator, WebAIM-The WAVE 3.0, InSight and InFocus. There is also an A-Prompt Tool Kit to show that a site is accessible. However, the developer must ensure that checks are carried out carefully as not all these tools have the same standards.

If a Web site has been designed with accessibility in mind, its developer may have the right to display a number of logos which declare that the site meets particular standards. However, users may be better served with a single ‘accessibility achieved’ type of logo. At present an institution has to decide which priority level it wishes to implement. One single standard would provide clarity for the end user. However, if accessibility is successfully embedded into an institution's Web site policy, there should be no need for badges and logos, as it will be taken for granted that the institution’s Web site is accessible to all (Witt & McDermott, 2004).

According to Witt and McDermott (2004), there is a danger that Web accessibility may be seen as a quality assurance process relying on checklists and evaluation tools which then treat accessibility as a late addition to a project. Accessibility issues must take place in academic institutions where Web developers need to consider how the Web site will be used when it is first designed.

Interface Design for Accessible Web Pages

According to Shneiderman (1998), Web page designers should start the task by identifying the type of information, objects and actions. They can present interface metaphors for information and objects accompanied by prompts for actions. Success also requires considered choices during detailed page design to show objects such as menus, search results, fonts and colours. It should also invoke actions, button press and selections from the list. These visible design elements are often the most discussed aspects of design and they are the ones most directly implemented by Web page designers (Horton, Taylor, Ignacio, & Hoft, 1996; Shneiderman, 1998).

The Web, in conjunction with assistive technology tools, now offers blind and vision impaired users the opportunity to access the Internet more fully. The recent increasing use of the Internet has seen the growth of the Web as an easy to use retrieval system. The fact that the vast majority of information now occurs in the form of primarily text-based Web documents makes it a valuable resource for all users, particularly those with visual impairments (Shumila & Richards, 1996).

Each Web document is scripted in HTML codes. Like pages in a book, Web pages can be complex combinations of printed words and graphical representations. However, these pages, unlike their paper counterparts, may contain active

Hyperlinks which, when selected, cause another pre-specified page to be displayed. These Hyperlinks can be either text, usually displayed in a different colour and underlined, or clickable images.

In addition to displaying other Web pages, clicking on these multimedia spots may display related graphic, audio, or video information (Shumila & Richards, 1996). Since most Web page design is based on Hyperlinks, users with vision impairments face many problems using the pages. One of the significant problems is that not enough information is supplied with graphics as the alternate tag.

Apart from the Hyperlink problem, another issue for users with visual impairment is that interface design is not accessible, and developers must focus on accessibility for all users. The use of HTML's Alternate (ALT) tag is an essential technique for describing graphics, particularly when the graphics contain useful information which is also included in text form for the screen reader.

Navigation Systems

In a paper book, the reader's progress is easily seen by the number of flipped pages. For online materials, a careful navigation system must be employed if the user is to keep track of the Web path. Vision impaired users find navigating extremely difficult and time consuming. One simple indicator, such as a site map, can guide vision impaired users in exploring larger sites, thus reducing frustration. Dynamic indicators that respond to where the mouse is placed by opening up a hierarchy or popping up details of information in a small window are also useful navigation tools.

Scroll bars are primary navigation tools because they provide a simple and standard mechanism. Using a page bar strategy, which is cognitively less demanding, users have a clearer sense of position in a Web site. The general problem with the navigation system of Web sites is that it is easy to get lost when trying to navigate through a large number of links which are provided on some Web sites. The solution is to create links within texts when possible and to avoid graphics used as links.

With a well designed Web navigation system, users are able to search efficiently for relevant information and make quick and effective decisions about the usefulness of the pages retrieved (Zajiceka, Powella, & Reevesb, 1997). The latest speech output technology screen reader programs and browsers enable the vision impaired user to

move easily around the screen, jump to interaction objects in the screen and read specific areas of text. However, for vision impaired users, Paciello (2000) and Zajiceka et al. (1997) recommend that care be taken not to move too fast as this action can lead to confusion and a resulting loss of place.

Overall, information about how to make Web pages more accessible for vision impaired users has only been researched in a limited way. There are many guidelines to follow and many ways that Web pages can be optimized for accessibility. Designers tend to apply standards and guidelines in the development of pages for public use, but most educational developers have yet to explore how best this can be achieved to increase accessible e-learning for the vision impaired.

The passing of legislation and the development of specifications and guidelines have only grown slowly during the last twenty five years. Since Web designers and developers rely on these to assist in ensuring accessibility, policy makers must continue to establish updated specifications and guidelines which encompass advanced technological changes. This is extremely important for those with visual impairment if they are to fully participate in modern society.

2.6 Learning Models

There have been numerous educators who have published theories and models about how people learn successfully. These range from the more formal and traditional to the open ended free and easy educational setting. The following are well-known educational theorists whose models have a particular impact on vision impaired learners:

- Benjamin S Bloom (February 21, 1913 – September 13, 1999)
- David A Kolb (1939 - to date) and
- Thomas Daniel Wilson, (1935 - to date).

Bloom's Taxonomy is a classification of learning objectives. It divides learning development into three domains.

Cognitive Learning includes skills in the areas of knowledge, comprehension and critical thinking.

Affective Learning includes skills in the areas of attitudes, emotions and feelings.

Psychomotor Learning includes skills in the areas of physical activities such as movement, coordination, manipulation, dexterity, strength and speed.

Table 2.1 shows the levels in Bloom’s model with their accompanying actions described by keywords.

Table 2.1: Bloom’s Taxonomy (1956)

Source: http://www.imteachingfrench.com/?page_id=28

Levels	Key Actions
Evaluation To make judgement about knowledge	Decide, justify, interpret, criticise, judge, rate, solve, assess and appraise
Synthesis To create new things or ideas	Create, develop, hypothesize, predict, produce, invent, modify, extend, formulate, build and compile.
Analysis To take information apart	Study, combine, separate, inspect, examine, categorise, compare, and generalise
Application To use or apply information	Solve, complete, examine, illustrate, demonstrate, employ, construct, make, try and show
Knowledge To understand information	Tell, uncover, show, list, name, recall, investigate and explain
Comprehension To find information	Compare, summarise, sample, demonstrate, discuss and reword

Kolb (1984) defined three stages of a person's development. These are:

- acquisition from birth to adolescence; the development of basic abilities and cognitive structures
- specialization acquired at school; early work and personal experiences of adulthood; the development of a specialized learning style shaped by social, educational, and organizational interaction and
- integration from mid-career through to later life; expression of a non-dominant learning style in work and personal life.

Kolb further stated that different learners require different learning styles and he defined four different learning styles through which learners move at their own pace: Diverging which is a combination of feeling and watching, Assimilating that combines watching and thinking, Converging which combines thinking and doing, and Accommodating that combines feeling and doing (see Figure 2.1).

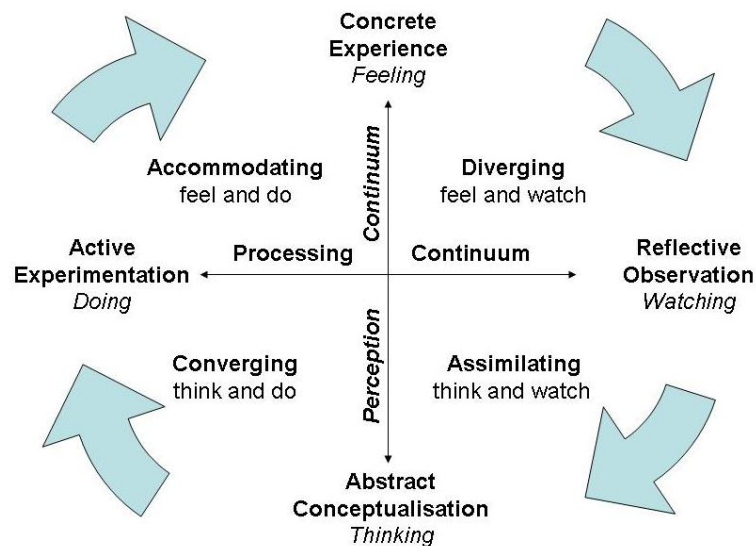


Figure 2.1: Kolb's Learning Styles Diagram

Source: <http://www.nwlink.com/~donclark/hrd/styles/kolb.html>

These four learning styles are mapped across two continuums, a Processing continuum ranging between active experimentation (doing) and reflective observation (watching), and a Perception continuum extending between concrete experience (feeling) and abstract conceptualization (thinking).

The nature of the disability held by vision impaired learners, only two learning styles from Kolb are highly applicable; these are Converging (doing and thinking) and Accommodating (doing and feeling).

Wilson developed a model of information seeking behaviour in which he proposed that there are three basic needs cognitive, physiological and affective. This model is a framework for considering a specific problem and it includes transfer of the information between the seeker and other people as well as accessing a number of information sources. Wilson's information behaviour model is presented below (see Figure 2.2).

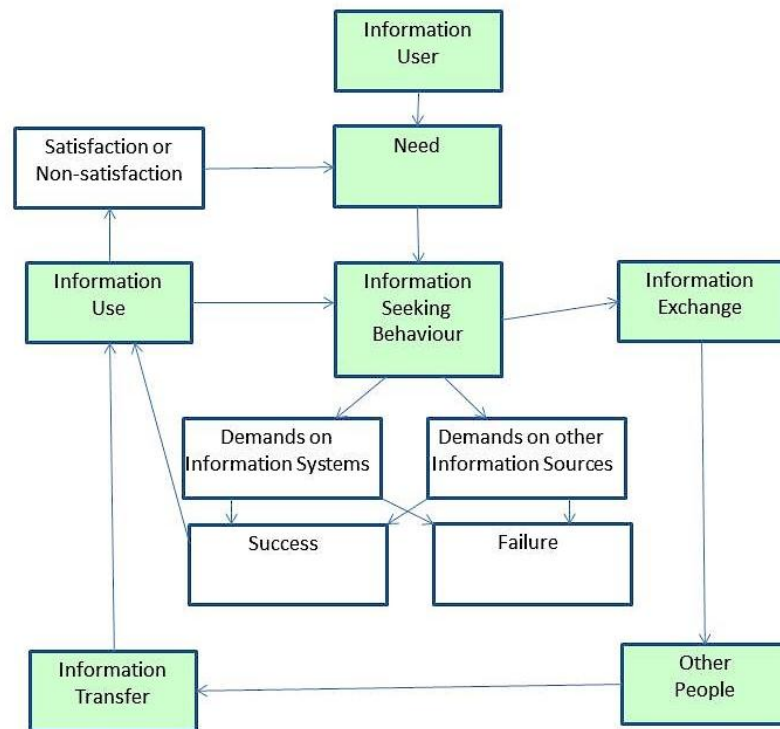


Figure 2.2 Wilson's Information Behaviour Model

Source: <http://informationr.net/tdw/publ/papers/1994FiftyYears>

The learning models developed by Bloom, Kolb and Wilson rely heavily on sensory experiences and in particular, on the sense of sight. In Bloom's Taxonomy it is difficult for vision impaired learners to observe, illustrate and demonstrate. In Kolb's model it is difficult for the vision impaired learners to observe reflectively. In Wilson's model the vision impaired learner has limited options in accessing other information sources.

A learner with vision impairment is severely limited when compared with a sighted learner. Using the environment to gather information is extremely difficult for a vision impaired learner as clues and connections can be easily missed. On occasions, concepts can be misread or completely misunderstood which can lead to a lack of confidence in the learner's ability in his or her capabilities. Families and teachers of these learners use many alternative strategies and resources to assist educational achievement, social interaction and competence in daily life tasks (AFB, 2004a).

Learning Theory and Vision Impaired E-learning Environments

Research in the area of e-learning styles for vision impaired learners is still in its infancy when compared to research in e-learning styles for sighted learners.

Although numerous researchers have provided guidelines for the improvement of accessible e-learning materials, there is no specific e-learning model or theory which takes into account the needs of the learning styles of the vision impaired. E-learning models are commonly designed for sighted learners and do not incorporate considerations for learners with vision disabilities. Learning outcomes commonly assume that all learners are sighted and vision impaired learners are expected to attain the same learning outcomes in order to succeed in the course.

There are a number of issues which need consideration when designing an e-learning model.

- Learners and teachers with vision impairment use speech to a much greater extent in order to analyse and clarify understanding.
- A virtual classroom is needed to supplement the physical classroom. This results in less traveling and reduced cost for the learner who may study at home. For the course provider a virtual classroom is not only cost effective but it also enables learners to access a broader range of services and materials.
- Vision impaired learners must rely on assistive technology and e-learning models are seldom designed to incorporate assistive technologies and the e-learning materials are not designed to integrate with the range of assistive technology available.
- E-learning models generally do not include social elements, and vision impaired learners need confidence building through sharing of knowledge and skills. It is therefore important that any model includes many means of communication on issues including technological, learning matters, accessibility and general items. Learners with a vision impairment readily share their knowledge so that in many cases the group achieves the learning outcomes, not just the individual.

- A learning model designed specifically for vision impaired learners based on sound educational principles and practices is still lacking in research literature.

Modern Mainstream Learning Content Management Systems

There are some popular mainstream LCMS available in the market. Modular Object-Oriented Dynamic Learning Environment (Moodle) and Blackboard are widely used within Australian institutions.

Moodle is a free source e-learning software platform, also known as a Learning Management System, or a Virtual Learning Environment (VLE). Moodle is a software package for producing Internet-based courses and Web sites. It is a global development project designed to support a social constructionist framework of education.

Moodle is provided freely as Open Source software and it is copyrighted, but the users have considerable freedom as they are allowed to copy, use, modify and provide the source to others.

Moodle was originally developed by Martin Dougiamas from Perth, Western Australia, to assist educators in creating online courses with a focus on interaction and collaborative construction of content. It is in continual evolution. The first version of Moodle was released on 20 August 2002. As of October 2012, there were 70,793 registered users, serving 63,204,814 providers in more than 6.7 million programs and with more than 1.2 million teachers (Moodle, 2013).

Accessibility awareness was raised by the Moodle community but the organisation itself is not yet providing clear information on how to make course materials accessible.

The accessibility of the Blackboard Learning platform is an important part of design and development at the organisation. It is committed to providing adequate documentation, tutorials and references for those seeking to access Blackboard courses, and this includes modifications for people with disabilities. These modifications can be accessed by students, faculty members, instructional designers and administrators.

2.7 Accessible E-learning

During the 1990s, the use of the Internet and confidence in Information Technology increased enormously (Atwater, 2003). It is estimated that between 8%-12% of learners in American higher institutions have disabilities that require special attention. The last twenty five years have seen colleges and universities develop some resources and facilities that accommodate the needs of these learners. The Americans with Disabilities Act of 1990 has played a critical role in encouraging educational institutions to make their campuses physically accessible and to employ trained personnel to work with disabled learners.

However, the growth of the Internet since the 1990s, has led to demands that higher education provide learners with what is known as assistive technology, or technology that is information and media oriented. Higher education experts note that while American colleges and universities have assertively improved courses and campus communication with Web sites, they have paid little attention to making the technology accessible to learners with disabilities (Roach, 2002).

Accessible e-learning features have lot in common with creating accessible Web sites, but the nature of learning is more than studying materials such as reading text or watching videos (Fisseler & Schaten, 2010).

There has been a significant amount of work committed to making online learning accessible to people with a range of disabilities, including those who have visual impairments (Dunn, 2003). One of the most prominently discussed approaches to accessible e-learning is Universal Design (UD). This involves designing instructional materials and learning activities such as delivery methods, physical spaces, information resources, assistive technology, personal interactions and assessments so they are usable by all learners without the need for adaptation or specialised design (Burgstahler 2007). The principles of UD, as suggested by Burgstahler, are listed below.

- **Equitable Use:** the design is useful and marketable to people with diverse abilities.
- **Flexibility in Use:** the design accommodates a wide range of individual preferences and abilities.

- **Simple and Intuitive:** the use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.
- **Perceptible Information:** the design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
- **Tolerance for Error:** the design minimizes hazards and the adverse consequences of accidental or unintended actions.
- **Low Physical Effort:** the design can be used efficiently, comfortably and with a minimum of fatigue.
- **Size and Space for Approach and Use:** appropriate size and space is provided for approach, reach, manipulation and use regardless of the user's body size, posture, or mobility.

He also points out that although specific accommodations may be needed for learners with disabilities, applying Universal Design concepts in course planning ensures access to the content is maximized for most learners and the need for particular adjustments will be diminished.

A number of e-learning models have been presented for learners with disabilities. However, very few of these models are conceptual and holistic. For application in an e-learning environment specifically for vision impaired learners, most of the proposed accessibility models need modification or refining in order to have value. There are very few holistic e-learning models that relate to accessibility and disabled learners. This view is supported by other researchers. Seale (2006) states there are very few original models and theories published in the literature to illustrate or build best practice in accessible e-learning.

Daniels and Elliott (2003) present a set of generic guidelines and processes for testing the accessibility of e-learning Web sites based upon an earlier version of the W3C Web Content Accessibility Guidelines. This is in addition to the work on usability by Nielsen (1999), Thatcher et.al. (2002) and the mobility principles presented by Harper et.al.(2000). The result is a generic set of guidelines and whilst these guidelines are useful for ensuring e-learning Web sites are more accessible, the

analysis has a detailed Web-document focus and does not present a holistic perspective nor does it take into account other viewpoints and factors.

Prougestaporn (2010) produced the Web Accessibility for Visually Impaired People (WAVIP) model (see Figure 2.3). The components of this model include Web Content, Web Browsers, Authoring Tools and Assistive Technology. Prougestaporn suggests each component must be accessible and work inter-dependently.

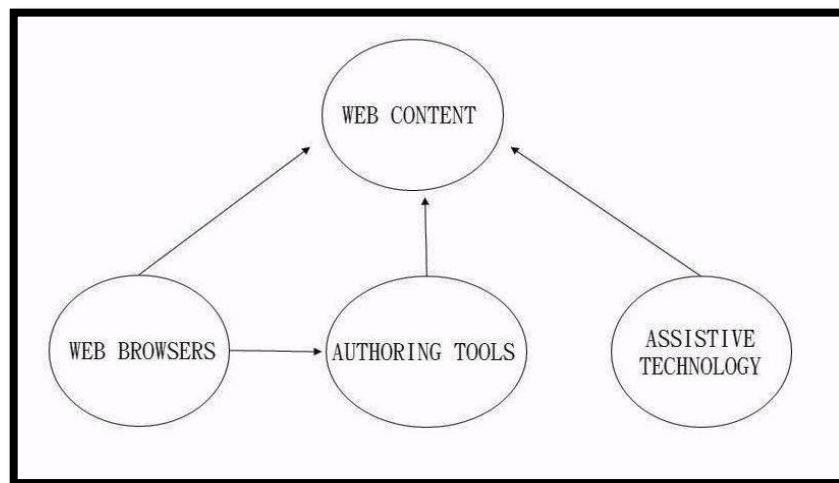


Figure 2.3: The WAVIP Model (Prougestaporn 2010)

Whilst any research that raises the awareness of improving accessibility is desirable, the WAVIP model is restricted to a collection of objects which are used in the process of generating Web content. This model is limited in its scope and application, taking little account of guidelines, learner needs, social influences, learning environments and other important factors that need to be considered in a more comprehensive view of developing accessible e-learning structures.

Lazar, Dudley-Sponaugle and Greenidge (2004) presented the Web Accessibility Integration Model on Web site accessibility, based upon the influences of stakeholder perceptions and societal foundations (see Figure 2.4). Lazar and colleagues argue that societal foundations are inadequate with regard to current levels of accessibility. The stakeholder perspectives included are those of the Web developer and client. These are the stakeholders who determine whether a Web site is built for accessibility and it is they who propose that guidelines and tools used to

guide the Web developer must also provide a working definition for Web accessibility. Whilst stakeholder perspectives are essential in the development of all e-learning Web sites, Lazar's model is not designed for direct application into the development of accessible e-learning environments for learners with disabilities.

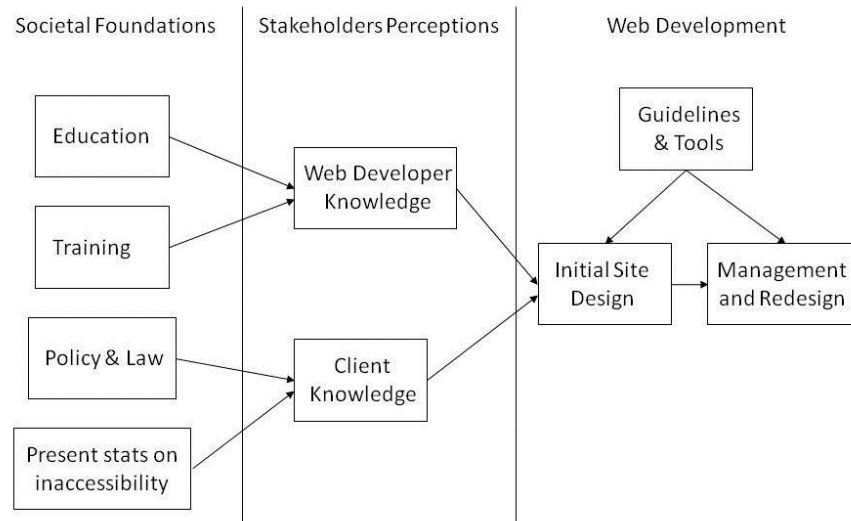


Figure 2.4: Web Accessibility Integration Model (Lazar et al. 2004)

Seale (2006) presented an accessible e-learning model that is contextual in nature and centres on the aspect of stakeholder involvement (see Figure 2.5). This model comprises accessibility drivers in the form of guidelines, standards and legal requirements, a wide collection of the views of stakeholders in higher education who influence or are influenced by accessibility and responses of these stakeholders via processes resulting in e-learning outcomes with some level of accessibility.

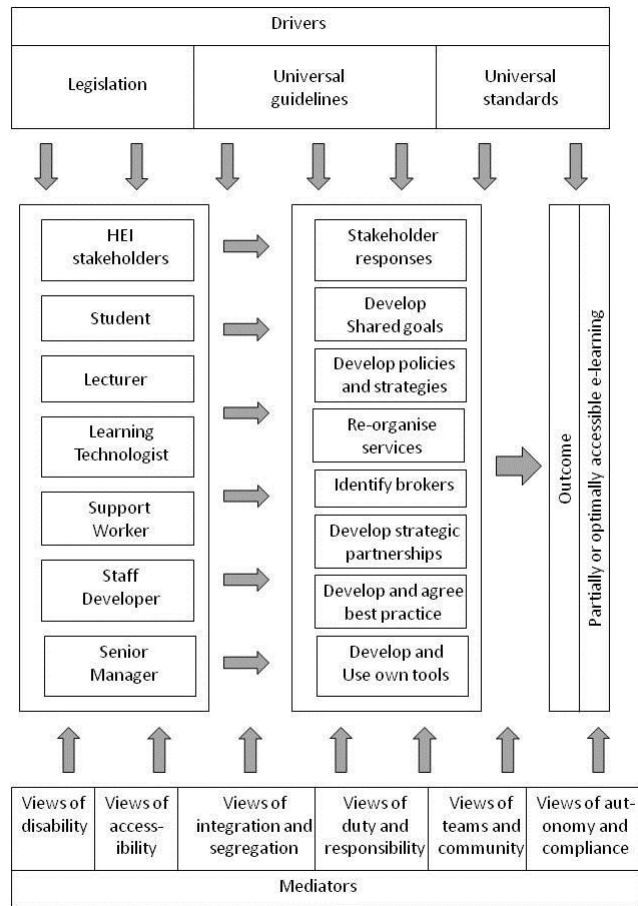


Figure 2.5: Contextualised Model of Accessible e-Learning Practice in Higher Education (Seale, 2006)

Source: <http://www.ascilite.org.au/ajet/ajet22/seale.html>

This model provides a more comprehensive approach to e-learning accessibility, and the focus on the stakeholders and their responses together with the drivers and mediators, enable a much richer understanding of the learning environment under study. Seale’s contextualized model is a process model rather than a holistic design framework with only partial applicability to accessibility for vision impaired learners with specific requirements.

The most holistic model for accessibility in e-learning comes from work at Bath University undertaken by Kelly, Phipps and Swift (2005). This model is circular in format and illustrates that learning is a holistic activity and cultural, political and social aspects need to be considered. The model also places the learner's needs at the centre of the circle (see Figure 2.6).



Figure 2.6. Holistic Framework for E-learning Accessibility (Kelly et al. 2005)

Source: <http://www.ukoln.ac.uk/web-focus/papers/alt-c-2005/html/>

Kelly and colleagues highlight the importance of considering individual needs, accessibility, usability of e-learning resources, the desired learning outcomes and local factors including institutional and subject discipline aspects. They also take into account the technical infrastructure. These factors are placed within the area of consideration of quality assurance where standards and guidelines provide a framework for development.

Whilst all these models provide valuable input into the design of specialized e-learning environments for the vision impaired, there is much subjective interpretation when such models are applied in practice. It is difficult in many circumstances to define what is included in a process and to demonstrate how each factor interacts with the others. It is also difficult to ascertain how these contribute to achieving the overall goals and objectives.

In an effort to identify an effective integration of components appropriate to e-learning environments for the vision impaired, further research was undertaken. This focused on the problems faced by the learners which then led to hypothesising potential solutions into a holistic framework.

Dunn (2003) states that the common problems of Virtual Learning Environments (VLE) or online learning for disabled learners are the communication tools (chat and whiteboard), navigational structure (over-complex frames-based architectures), and assessment procedures. Many users pointed to commonly poor usability which hindered accessibility, so that even if the product was technically accessible to a user with disabilities, it was still too complex to use with any helpfulness or effectiveness (Dunn, 2003).

Accessibility barriers within the content in online learning are often caused by invalid HTML codes being produced by authoring tools used by non-technical authors. A general lack of understanding of the principles of instructional design and the technical issues involved in Web accessibility, coupled with a lack of effective content development processes within institutions, have led to a poor level of content accessibility. It is also clear that very few institutions have implemented requirements for testing online courses with learners (Dunn, 2003; EducationalTechnology, 2004).

The rush by educational institutions to provide Internet-based courses for distance education raises some very interesting issues. These include:

- the effectiveness of the course content
- the quality of assessment and evaluation techniques and
- a fairly limited body of research into the effectiveness of online learning.

(EducationalTechnology, 2004; Petracchi & Patchner, 2001; Sims, Dodds, & Hand, 2001).

One of the main causes in the failure to evaluate the quality of course content and evaluation techniques is that there is no validated method available for measuring e-learning in virtual environments (Gunawardena, Lowe, & Carabajal, 2000). More

educational researchers also support that: “another problem leading to the lack of validity is in terms of the locations where the quality of education is being assessed.” (Goh & Fraser, 1998; Harvey, 2002; Reeves, 1994; Sims, et al., 2001).

There are obviously standards to evaluate learning environments for online courses (Oliver & Reeves, 1996). To this end, Dunn (2003) suggests the following reasons all contribute to inaccessible online learning:

- a lack of awareness about the needs of disabled learners
- a lack of user-centred design processes on the part of online instructors and education institutions
- a lack of knowledge of Web technologies on the part of online content authors
- too narrow a focus on technical standards compliance at the expense of broader learner-centred design principles
- a general ‘skills gap’ in the area of instructional design and
- a lack of strategic leadership within institutions in tackling the overall issue of inclusive learning and teaching.

In the past few years, the use of Learning Analytics has been raised on many occasions by the Learning and Teaching Advisory Committee at the Council of Australian University Librarians (CAUL) as being one of the major topics for considerations in e-learning environments. Learning Analytics can be described as the use of measurement, collection, analysis and reporting of data about the learners and their learning activities. This includes using analysis models to discover information and social relationships which can assist in predicting and assisting learners in their learning. The methods used in Learning Analytics include:

- Social Network Analysis (SNA) which includes the mapping and measuring of relationships and interactions between people, URLs, computers, groups and organisations
- Behavioural Trust Analysis uses instances of conversation and people communicating and using knowledge to generate new information as an indicator of trust

- influence and passivity measures that assess the influence of people and information by counting the number of times it is passed on, re-tweeted or cited
- Discourse Analytics are used to capture meaningful data on student interactions
- Social Learning Analytics explores the role of social interaction in learning and the importance of learning networks and
- Disposition Analytics seeks to capture data regarding students' learning characteristics and the relationship of these to their learning success. More curious learners may be inclined to ask many questions.

(Adali et al., 2010; Knoke & Yang, 2008; Romero, Galuba, Asur, & Huberman, 2010)

To date there has been little research that has explored the further implications of accessibility in the area of online learning technologies. While there are guidelines that exist to suggest strategies for the display and presentation of Web-based material, the design of the learning environments themselves has not been considered a part of this process.

It is possible that vision impaired learners need no further considerations in the design of online materials apart from ensuring that the resources meet general accessibility standards. In meeting those standards, however, it is possible that designers of online learning materials may need to vary some aspects of their instructional design strategies. There is a need for further research to explore and confirm this.

According to Coyne and Neilson (2001) Internet users with vision impairments are three times less likely to succeed in their quest for information than users with normal sight. This was also highlighted by Neumann (2004, p.41), the Technology Development Officer of the Royal National Institute for the Blind, who states: "learners with impaired vision using Web-based educational materials spend only around thirty per cent of their time actually using the materials; the rest of the time is spent in searching and navigating for pages and options."

Rothstein (2003) asserts that approximately one in eleven learners has a disability, a statistic which has tripled since 1978. Since this number is likely to increase as the population expands, the challenge for educational institutions will become more complicated and complex in the future.

2.8 Chapter Conclusion

E-learning is a powerful tool for the vision impaired and its use is growing throughout the world. It offers many advantages and generally learners everywhere are benefiting, particularly those who live in very remote locations. However, those with visual impairment are in need of appropriate tools for accessibility. It is important that any materials developed can be used successfully and independently.

The use of vision is an essential component for engagement in learning and any reduction of vision capacity can lead to problems in the classroom. Some learners are unable to digest and process information within the assigned time frame which leads to them falling behind in their studies and may affect their self-confidence. For some blind learners, adjusting to a new environment where furniture and fittings can be changed around on a daily basis can cause considerable distress.

For those with vision impairment, there are a number of issues which can affect successful learning and these include:

- lighting in lecture theatres may be too dim
- lighting in lecture theatres may be too bright
- printed materials may be too small
- presentation of media information may be in a completely unreadable format and
- colour choices of materials may be unsuitable.

One or more of these issues can limit accessibility, which results in a lack of opportunity to acquire information and knowledge.

Since accessibility is about ensuring equity by removing barriers, all the issues above must be taken into consideration in any learning environment where vision impaired learners are enrolled. It is interesting to note that in many cases, removing barriers

for vision impaired learners not only makes the environment more accessible for them but it can also assist some sighted learners.

The review of the literature has demonstrated that although there is considerable awareness and understanding of the legal requirements for accessibility in Web-based, and in particular, in online learning materials, in practical terms there is little guidance for the online designer and developer about how to implement these successfully.

To that end the research study commenced with one main aim seeking responses to the question:

- what are the characteristics and needs of the adult vision impaired learner in Web-based learning environments?

Included inherently in this question are the following:

- what are the components of effective accessible web-based e-learning environments for IT training and education and
- how do the components and vision impaired learners interact to form effective accessible online IT learning environments?

Chapter three will discuss the research methodology chosen in order to answer these research questions through an examination of issues relating to the development and implementation of the Cisco Academy for the Vision Impaired (CAVI) and the TruVision. These two e-learning environments presented as opportunities through which an appropriate inquiry into e-learning for the vision impaired was carried out.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the process by which a research methodology was chosen to answer the research questions in a suitable and reliable manner. The research questions were addressed through the investigation and analysis of e-learning models, e-learning environments and issues relating to vision impairment. The selection and planning of the methodology is described as well as the data collection methods and the tools selected.

3.2 Research Objectives

The main objectives of the research were as follows.

1. Investigate the features of effective e-learning environments for adult vision impaired learners.
2. Build a conceptual model of an effective e-learning environment for Information Technology (IT) courses for the vision impaired appropriate to their disability.

Achievement of these objectives provides a considerable contribution to the education of vision impaired learners. It assists those undertaking IT studies by developing a learning environment that is accessible and supports such learners in reaching the same learning outcomes as sighted learners.

3.3 Research Questions

The research questions for this study are detailed below.

1. What are the characteristics and needs of the adult vision impaired learner?
2. What are the components of effective accessible Web-based e-learning environments for IT education?
3. How do the components and vision impaired learners interact to form effective accessible Web-based IT e-learning environments?

Academic research consists of scholarly investigation and ends with the reporting of results. Scientific investigation consists of basic assumptions, problems which require solutions and a number of questions which need to be answered. These answers will come from careful empirical observations, assessment of causal procedures and value free research: “A key aspect of this type of research is that it seeks abstractions from the real world” (Blackburn, 2011).

In this study, two authentic e-learning environments for the vision impaired were selected and using the techniques outlined above this research attempted to find answers for the three preselected questions.

3.4 Qualitative versus Quantitative Research Approaches

Research methods can be classified in several ways. However, one of the most common distinctions is between qualitative and quantitative research methods (Myers, 1997a).

Qualitative research methods were developed in the social sciences to facilitate researchers in studying social and cultural events. Qualitative methods include action research, case study research and ethnographic research. Qualitative data sources include researcher observation and participant observation of fieldwork, interviews, questionnaires, documents and texts, followed by the researcher’s impressions and reactions (Myers, 2009).

In 1935, an early user of qualitative research was William Stephenson, a British physicist-psychologist. Stephenson was interested in providing a way to reveal the subjectivity involved in any situation. This included judgments, perceptions of the organisational role, political attitudes, appraisals of teaching style, experiences of bereavement and perspectives on life (R. Brown, 1996; Myers, 1997b). Brown and Myers further state that the reason for undertaking qualitative research, as opposed to quantitative research, comes from the observation that, if there is one thing which distinguishes humans from the natural world, it is the human ability to talk.

Qualitative research methods are designed to help researchers understand people and the social and cultural contexts within which they live. Kaplan and Maxwell (2005) argue that the goal of understanding a phenomenon from the point of view of the

participants and its particular social and institutional context is mostly lost when textual data are quantified.

Quantitative research methods were first developed in the natural sciences to study natural phenomena, and these quantitative methods are now well recognised in the social sciences. They include survey methods, laboratory experiments and formal methods such as econometrics, numerical methods and mathematical modelling.

3.5 Research Methodology

A research method is a form of inquiry which moves from the underlying rational assumptions to research design and data collection. The choice of a research method influences the way in which the researcher collects data. Specific research methods also involve different skills, assumptions and research practices (Myers, 1997b). This research involved a large amount of interaction with vision impaired learners and their teachers and investigation of their learning environments. Qualitative methods were predominantly used in this study in order to capture important aspects of human social and cultural factors which form an integral part of the total learning environment for vision impaired learners.

The research method used in this study was Design Science Research (Venable, 2006) which supports the use of both qualitative and quantitative approaches to data collection and analyses. Case studies were undertaken to build a picture of the current situation and to collect data to assist in answering the research questions.

3.5.1 Design Science Research

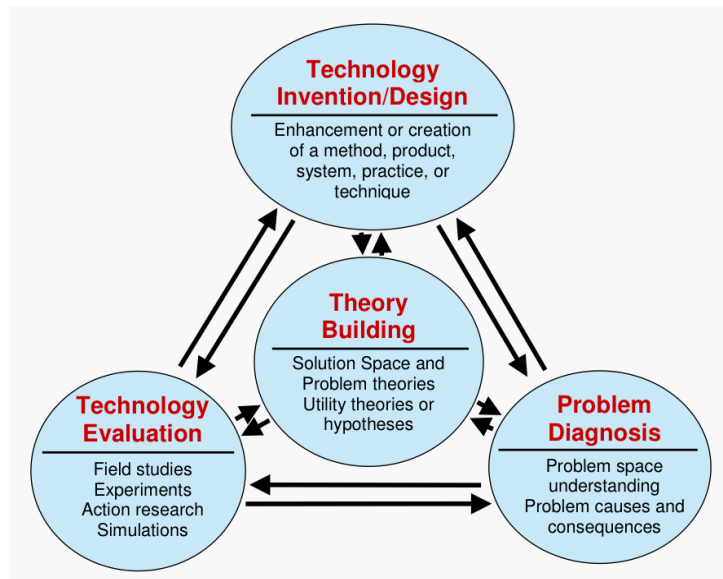


Figure 3.1: Design Science Research (Venable, 2006)

Design Science Research is an inventive, creative and problem solving activity, one in which solutions are designed and developed for groups experiencing a particular problem and for which new models, approaches, artefacts or technologies are the primary end products. This approach consists of two stages, build and evaluate. March and Smith, building on the earlier work of Simon, state: “building is the process of constructing an artefact for a specific purpose; evaluation is the process of determining how well the artefact performs” (March and Smith, 1995, p. 258).

Based upon the work of Hevner, March, Park and Ram (2004) Venable recommended a new name for this research method, namely “Solution - Technology – Invention” because this name more accurately reflects what the researchers are doing (Venable, 2006). Venable further enhanced the traditional design science approach by linking the elements of Theory Building, Problem Diagnosis, Technology Design/Invention and Technology Evaluation. Researchers now refer to the complete circular process as Venable’s Design Science Research approach (see Figure 3.1). Although ‘technology’ is the label used by Venable in his model, the phases Technology Invention/Design and Technology Evaluation actually refer to the design object or the artefact produced. This can be a method, a product or a system.

The final product of Design Science Research is a design model which is appropriate to the aims of this research. Kuechler, Vaishnavi and Kuechler (2006) believe that Design Science Research has largely achieved acceptance as an alternate research direction within the field of Information Systems.

The Problem Diagnosis stage occurs early in the Design Science Research process and it helps define a particular problem. It involves an in-depth analysis of the problem space in order to understand the whole problem situation and to decide on aspects for development of possible solutions.

The Theory Building activity is a key element of the research method. The Theory Building activity is centrally placed with interactive links to all the surrounding activities. This stage begins with a concept of a possible solution for an identified problem. It may come from rethinking problem spaces, imagining new technologies or creating new applications for existing technology.

The opinion of stakeholders is sought at this point and generally, the perceived difference between the current situation and the desired situation is a direct result of this process. A significant issue in this stage is identifying the source of the problem and building a theory upon which a method, practice or model can be conceptualized which will provide a foundation for the solution.

The Technology Invention/Design stage includes refining hypotheses and designing solutions to address the issues identified in the problem space. This stage may involve the enhancement of a method or technique. The solution can take either a conceptual or physical form, including a new conceptual model, a methodology, or a physical device or object. The Theory Building continues during the Technology Invention/Design stage of the project and is refined after the Evaluation stage.

The Technology Evaluation stage tests or evaluates the new design and assesses it in respect to how well it addresses the issues identified in the problem space (Hevner, et al., 2004). This stage can include evaluation of either new solutions or the enhancement of an existing method or design. Testing and assessment demonstrate the effectiveness of the new technology.

The two-way arrows in Figure 3.1 show that the chosen Design Science Research method allows interactive stages throughout the research process. This gives the

researcher flexibility in the research process, allowing flows, movement and interaction between the activities. Prior activities can be revisited and theories and designs can be built progressively as new issues and ideas come to light.

3.5.2 Case Study Method

Case studies were a significant tool used in collecting data for this research. The case study methodology is described as: “an umbrella term for a family of research methods having in common the decision to focus on inquiry around an instance” (Adelman, Jenkins, & Kemmis, 1977). According to Bell (1993), the case study method is particularly appropriate for individual researchers because it gives an opportunity for one aspect of a problem to be studied in some depth within a limited time scale. Bell also states that it is much more than a story about, or a description of, an event or situation. As in all research, evidence is collected systematically, the relationship between variables is studied and the study is methodically planned.

A similar view is also supported by Yin (1994). He highlights the underlying concept of a real life context because it is important to ensure that the lines between phenomena and the environment can be clearly distinguished. It is also vital to build a big picture of the interactions which exist within the context under study and this can be done through practical involvement (Nisbet and Watt, 1980) Although observation and interviews are most frequently used in case studies, no method is excluded. Methods of collecting information are selected which are appropriate for the task.

The great strength of the case study method is that it allows the researcher to concentrate on a specific instance or situation and to identify, or attempt to identify, the various interactive processes at work. These processes may remain hidden in a large-scale survey but may be crucial to the success or failure of systems or organisations.

Case studies may be carried out to follow up and to reject parts of a survey. They can precede a survey and can be used as a means of identifying key issues which merit further investigation, but the majority of case studies are carried out as freestanding exercises. The researcher identifies a situation, which could be the introduction of a new syllabus, the way a school adapts to a new role, or any innovation or stage of

development in an institution and observes, questions and studies. Every organisation has common and unique features. The case-study researcher aims to identify such features and to show how they affect the implementation of systems and influence the way an organisation functions. Bassey (1981) also considers that if case studies are carried out systematically and critically, if they are aimed at the improvement of education, if they are applicable, and if by publication of the findings they extend the boundaries of existing knowledge, then they are valid forms of educational research.

There are, however, some challenges with the case study method. Single researchers working to a deadline and within a limited timescale need to be very careful about the selection of the topic, ensuring that there is sufficient time to draw conclusions from the data collection. Yin (1994, p. 137) states that case studies have been carried out about decisions, about programs, about the implementation process and about organisational change. He further states that: “the more a study contains specific propositions, the more it will stay within reasonable limits.” All successful researchers therefore have to define reasonable limits, regardless of length and time constraints.

The case study method is comparatively adaptable because flexibility allows the researcher to begin with broad questions and then to narrow the focus as the project progresses, rather than requiring predictions of every possible outcome prior to the commencement of the study (CSU, 2001). By seeking to understand as much as possible about a subject, case studies specialise in deep data and provide information based on particular contexts that can give research a more human face (Bell, 1993; Gillham, 2000; Leedy & Ormrod, 2001; Yin, 1984). Furthermore, the case study methodology allows the researcher to concentrate on a specific example or situation and to identify, or attempt to identify, the different interactive processes at work.

A slightly different view is held by Benbasat and colleagues who state that it is necessary to employ a number of methods of data collection when conducting a case study and this must be done in a real context (Benbasat, Goldstein, & Mead, 1987).

Benbasat, Goldstein and Mead (1987, p.371) propose that the key characteristics of case studies are as follows.

- “A phenomenon is examined in a natural setting.
- Data are collected by multiple means.
- One or few entities (people, group, or organisation) are examined.
- The complexity of the unit is studied intensively.
- Case studies are more suitable for the exploration, classification and hypothesis development stages of the knowledge building process and the investigator should have a receptive attitude towards exploration.
- No experimental controls or manipulation are involved.
- The investigator may not specify the set of independent and dependent variables in advance.
- The results derived depend heavily on the integrative powers of the investigator.
- Changes in site selection and data collection methods could take place as the investigator develops new hypotheses.
- Case research is useful in the study of ‘why’ and ‘how’ questions because these deal with operational links to be traced over time rather than with frequency or incidence.
- The focus is on contemporary events.”

New researchers can be guided by experienced researchers in the choice of appropriate research methods. Benbasat and colleagues (Benbasat et al. 1987, p.372) suggest the following questions be asked before deciding upon the use of case studies.

- “1. Can the phenomenon of interest be studied outside its natural setting?
2. Must the study focus on contemporary events?
3. Is control or manipulation of subjects or events necessary?
4. Does the phenomenon of interest enjoy an established theoretical base?”

In terms of question one above, the research conducted on vision impaired learners in the learning environment can only be studied within the physical and virtual learning setting. This is necessary in order to identify the participants’ needs, observe and gather information about their disability, conduct conversations about how they

approach learning tasks and ascertain how they work around problems resulting from inaccessibility issues. This research could not be conducted outside the natural setting to achieve its goals.

IT education is an important area of current skill development, particularly for the vision impaired who rely heavily on technology in their daily lives. With legal and statutory requirements for equal opportunity, it is essential that the vision impaired be offered the same IT educational opportunities as sighted individuals, thus addressing question two above.

Question three relates to control and manipulation of subjects and this research focuses on studying how vision impaired learners go about their learning tasks and what works for them rather than controlling how things are done. It is important that participants are not controlled, but are studied in detail as they go about their activities.

The theoretical base of IT e-learning environments for the vision impaired is limited and early in its development. The research being undertaken in this field is highly exploratory and the research reported in this study builds a new theory based upon the findings of the investigation.

Another factor presented in the key characteristics list by Benbasat and colleagues. (1987) which is important to this particular research is the means of data collection. These include detailed observations, interviews, the study of documentation and the intensive study of two groups of vision impaired learners in structured e-learning environments. Also important to this research are the problems the participants face as well as known and potential solutions to the identified issues.

3.5.3 Shortcomings of Case Studies

One of the shortcomings of the case study method as suggested by Benbasat and colleagues, (Benbasat et al., 1987) is the lack of objectivity due to the subjective nature of the researcher's interpretation of data and actions in the context of the research. It is therefore important that the researcher be aware of possible subjectivity and bias in interpretations and the need to seek a range of possible reasons as to why certain results are evident.

Where a single researcher is gathering all the information, a selection has to be made. The researcher selects the area for study and decides which material to present in the final report. It is difficult to crosscheck information and so there is always the danger of distortion. Critics of the case study approach draw attention to this and point to the fact that generalisation is not always possible and question the value of the study of single events.

Other critics, such as Denscombe make the point that: “the extent to which findings from the case study can be generalised to other examples in the class depends on how far the case study example is similar to others of its type” (Denscombe, 1998, p.37). Bassey (1981) holds similar views, but prefers to use the term reliability rather than generalisability. In his opinion, an important criterion for judging the merit of a case study is the extent to which the details are sufficient and appropriate for a person working in a similar situation to relate his decision making to that described in the case study. The reliability of a case study is more important than its generalisability (Bassey, 1981).

Another problem which may be encountered by the case study researcher is that the researcher may become personally involved in the issues or situations under study. There may also be problems over confidentiality of data and competition from interest groups for access and control of the data. Additionally participants may have issues with the final publication and they may be concerned about anonymity. There may also be issues relating to the audience being unable to distinguish between the actual data and the researcher’s interpretation of the data (MacDonald and Walker, 1975).

Case Studies that provide research in e-learning environments for vision impaired learners seeking IT education are not common. In order to design a truly effective e-learning environment that is accessible to the vision impaired it was necessary to study the characteristics of the vision impaired learners. It was also necessary to design a setting that provides not only the technology they need to achieve the same learning outcomes as sighted learners, but also the social aspects that give these learners the confidence to complete the courses.

However, the advantages outweigh the disadvantages and case studies play a great role in this study, with two case studies providing the major source of information for this research.

3.5.4 Data Collection Methods

Common data collection methods used in case study research include observation, interviews, meeting notes and documentation. The methods used in this research were observation of participants and their teachers, interviews, questionnaires and documentation.

Observation is a highly skilled activity for which extensive background knowledge and understanding are required, as well as a capacity for original thinking and the ability to note significant events (Nisbet, 1977). There are two main types of observation, participant and non-participant. Participant observation is when the researcher participates in the activities of the group being observed in the same manner as the group members, either with or without their knowledge. Non-participant observation, on the other hand, is when the researcher does not become involved in the activities. The researcher remains a passive observer by watching and listening to the activities then draws conclusions from this observation (Kumar, 1999).

The observation techniques provide the data that enable the researcher to see things that participants cannot see themselves, are not aware of or are unwilling to discuss (Patton, 1990). This research encompassed observation of the vision impaired learners at work, listening to lectures, asking questions, discussing points amongst themselves, trying out commands on the computer, attempting physical activities (such as disassembling and reassembling computers), using of virtual and physical work spaces, devising workarounds where set actions did not work due to inaccessible materials or limitations in assistive technologies and generally following the learners' progressive learning.

Interviews are a time-consuming method of data collection, although they have the advantage of adaptability. A skilful interviewer can follow up ideas, explore responses and investigate motives and feelings (Bell, 1993).

Over the period of two years individual interviews with both learners and teachers were conducted and each took from forty-five minutes to sixty minutes. In this research, the interviews with vision impaired participants took a significant amount of time. Each participant needed introductory statements by the researcher and course teachers. These included e-mails, phone calls, meetings and casual catch up sessions which then led to the interview. Some participants preferred to participate only after recommendations from the others.

Neumann (2006) states that interviews, which are structured conversations, can result in an interviewer bias because it is possible for the respondent to be guided by the way in which the questions are structured.

Patton (1990, p.352) outlines six major areas of questions which can be asked in the interview.

- “1. Behaviours – questions about what a person has done or is doing.
2. Opinions - questions about what a person thinks about their experiences.
3. Feelings - questions about truthful information the respondent has on something.
4. Knowledge - to get facts about a topic.
5. Sensory - about what people have seen, touched, heard, tasted or smelled.
6. Background/demographics - standard background questions, such as age, education.”

Patton’s clarification of each area of possible interview questions played a great role in this research as it formed the basis for the establishment and finer points of interview questions. The researcher applied all six areas of questions in order to obtain the maximum information from the participants. Answers to these questions helped to clarify the needs and characteristics of accessible e-learning for the vision impaired.

Documentary evidence was used to supplement information obtained by other data collection methods. Such records also proved to be an extremely valuable source of data (Bell, 1993). This process provided information on the teaching materials, courses, institutional objectives and procedures, as well as valuable background information such as details regarding policies, actions, personnel and projects.

Approximately one hundred learners with acute vision disabilities were observed as they worked in the two learning environments and eighteen learners were interviewed and observed in detail. The interviews included answering a set of questions in addition to discussions of their actions and interactions gathered from the observations.

An interview sheet containing two parts was used to guide the researcher when conducting the interviews with the vision impaired learners (see Appendix E):

Part One: This section contained questions relating to characteristics, demographics and needs of the adult vision impaired learner.

Part Two: This section contained questions relating to the components of effective accessible Web-based e-learning environments for IT training and education.

The interview questions were designed to ensure that the data collected could be analysed in order to answer the research questions. The data collected is mapped to the research questions later in this chapter and full details of the questions asked and the data actually gathered are discussed in the following chapter.

3.6 Research Design

In order to achieve the research aims, the following steps were carried out, guided by the Design Science Research approach (see Figure 3.1)

3.6.1 Design Science and Research Steps

Step 1: The characteristics of approximately one hundred adult vision impaired learners, including the nature of their vision disabilities and their specific learning and accessibility needs were investigated using the two case study environments. The data were collected by observation of the vision impaired learners in their learning environment and semi-structured interviews with a small set of learners to identify their accessibility needs. This included studying how long they had been blind, the amount of vision they still had and how effectively they used that vision, if at all. Additionally, data were collected from these same learners to identify their specific needs in a Web-based learning situation. These accessibility needs were identified and analysed. Teachers working with vision impaired learners were also

interviewed in order to gain a greater understanding of the problems to be addressed. Information on guidelines for the development of accessible learning materials was also gathered. These activities are part of the Problem Diagnosis stage in the Design Science approach.

Step 2: Accessibility guidelines and legal and statutory requirements were investigated. This included documentation and standards from Canada, Europe, Australia, New Zealand and the USA in order to provide an international perspective. Guidelines for the design and development of Web-based materials were studied with particular application to accessibility issues. Those guidelines applicable and pertinent to the building of accessible e-learning and Web-based environments and curriculum were noted. Legal requirements were also investigated; however, different jurisdictions have different laws, and some are more stringent than others. These activities fall into the stage Problem Diagnosis of the Venable model.

Step 3: The components required to deliver an effective, fully accessible IT curriculum in two Web-based e-learning environments for the vision impaired were identified. These components included:

- equipment and settings
- assistive technologies used
- the nature of teaching materials
- the format of learning material presentation for accessibility including lessons, exercises and assessments
- delivery mechanisms and
- the skills required by teachers.

This information was compiled from studying the two learning environments for the vision impaired together with the information collected from the participants and the literature. Data instruments used in this phase were observations and semi-structured interviews with vision impaired learners and teachers. These activities fall into the Problem Diagnosis and Theory Building stages of the Venable model.

Step 4: The relationships between the characteristics and needs of the learner, and the components of the learning environment for an Information and Communications

Technology (ICT) curriculum were analysed. These activities involved the Problem Diagnosis and the Theory Building stages in the Venable model.

Step 5: Potential solutions were investigated and the conceptual model for an accessible e-learning environment for vision impaired learners was developed. This activity involved both the Technology Design/Invention and the Theory Building stages in the Venable model.

Step 6: An evaluation was carried out by a focus group of eight experts in the field of accessible and e-learning course design. The experts individually evaluated the model and the supporting description against the problems identified in step one. The focus group then met and discussed the model, suggesting additions and alterations based upon their experiences and knowledge in the field. The model was then modified to incorporate their suggestions.

3.6.2 Case Study Organisations Investigated

The first case study is the TruVision course, a Web-based environment specifically developed for providing basic IT skills to vision impaired learners. This e-learning environment provides accessible online learning for learners with both vision disabilities and normal sight. The second case study is the Cisco Academy for the Vision Impaired (CAVI) which provides a totally accessible e-learning environment specifically for vision impaired learners. The focus of these two case study environments is on accessibility for learners who are totally blind, who have very low vision or are legally blind. The common aim that makes these two e-learning situations relevant to this research is that they both provide vision impaired learners with skills in IT in preparation for employment or further studies.

Other potential case study e-learning environments for the vision impaired were sought. However, none was able to offer a truly accessible e-learning experience to learners with a severe vision disability. To be eligible for inclusion in this study the learning environment needed to:

- be fully operational
- be online
- be Web-based
- be accessible to the vision impaired

- contain a complete set of learning materials to fulfil stated learning objectives
- consist of practical tutorials designed specifically for the vision impaired and
- include IT skills in preparation for employment and be available for adult learners.

The case studies were conducted at the Association for the Blind of Western Australia in Perth, Western Australia and Curtin University, Perth Western Australia. The TruVision is an online learning environment designed to enable blind and vision impaired learners to develop skills and expertise in elementary and advanced information processing strategies. It supports several IT competencies at Certificate I in Information Technology in the Australian Technical and Further Education sector. The TruVision was designed to enable learners to seek full-time employment within industry in such positions as administrative assistants, help desk personnel and data entry operators.

The core design of the TruVision is a simulated workplace for people with vision disabilities and it features various ways of engaging learners. A number of different specialised qualities were incorporated into this environment to cater for different types of vision impairment. A graphical and highly visual interface was designed which allows partially sighted people to optimise their visual perceptions. Also provided are detailed hidden text descriptions which can be read by screen readers for those with no vision. The course content has been optimised for the use of standard and commonly used assistive technologies, such as the screen reader software program Job Access With Speech (JAWS) and the screen magnification software program ZoomText.

The CAVI is an accessible e-learning environment specifically designed to provide learners with acute vision disabilities advanced skills and knowledge in computer network design, implementation and management. It was established as a certified Cisco training program, offering numerous courses for vision impaired learners to gain industry standard Cisco certifications. The courses are offered to vision impaired learners across the globe with enrolment numbers varying between one hundred and one hundred and fifty annually.

The CAVI comprises accessible online learning modules, lectures and tutorials delivered via a virtual classroom and practical exercises conducted through a separate network. Learners can implement network topologies and test them, as well as access quizzes, tests and examinations.

As in the TruVision environment, the CAVI learners are expected to be able to use assistive technologies appropriate to their disability. However, the CAVI does not cater directly for sighted learners, as Cisco Incorporated already has courses achieving the same learning outcomes for able bodied learners available within their international learning program. This means that the CAVI environment concentrates directly upon accessible learning materials and practice for learners who are blind or acutely vision impaired.

3.6.3 Data Collection and Analysis

In order to gather information on the design of accessible e-learning environments for the vision impaired, predominantly qualitative data collection and analysis methods were used. The majority of data were collected by observation within the two vision impaired learning environments and by interviewing vision impaired learners. Data were also gathered from documentation, particularly in the investigation of statutory requirements and standards. The interview questions for this study were focused on the learners' background, demographics and any other factors that aided their learning experiences. In addition, meetings were recorded and the recordings used later in order to check the wording of any statements that might need to be quoted and to check that notes were accurate. Documentary evidence was used to supplement information obtained by others. An audio recording of each screen reading output and the interaction in the classroom were also consulted when necessary.

3.6.4 Participants

In this study, although a small number of vision impaired participants were studied in detail, the sample size was congruent with the population of seriously vision impaired adult learners. Lazar, Feng and Hochheiser (2010, p.401) recognised the difficulty in obtaining large samples of disabled participants: "Small sample sizes may be used when studying populations of disabled persons. For research focusing

on users with impairments, it is generally acceptable to have 5-10 users with a specific impairment take part in a study. In the recent proceedings of the ASSETS conference, a well-accepted high quality conference on this topic, most of the research studies in which blind users had to be physically present to take part in the research had fifteen or fewer blind individuals taking part in the research. This means that if a classic experimental design is used, that there will often be no more than one control group and one treatment group.”

This statement supports the view that although the sample size is small, it is relatively proportional to the population and based upon the sample sizes in past research there is a valid number of participants investigated in this research.

The researcher needed to gain the trust and familiarity of the vision impaired community in order to access the interviews and data collection process. This included several introductions from course teachers and course coordinators as well as the Assistive Technology technicians. Many interviews were also gained through social activities such as coffee breaks, functions and conferences in the accessibility area.

3.6.5 Mapping Research Questions to Data Collected

Table 3.1 details the questions selected together with methods used for eliciting responses, the rationale behind the research questions and data analysis.

Methods of data analysis included the following.

1. Clarifying the problem space by extracting and explaining the problems currently faced by the vision impaired learners in e-learning environments.
2. Investigating demographics and other possible characteristics for common problems, needs, and other factors of interest.
3. Matching potential solutions from the literature, standards, case study observations, interviews and documentation with problems and needs.
4. Identifying gaps where needs and issues had not been clearly addressed.
5. Analysing social network responses, undertaken to identify the relationships between learners and learners, learners and teachers and methods of electronic communication.

Table 3.1: Research Questions and Methodology

Research Question	Method	Rationale	Data Analysis
<p>Overall Research Question: What are the features of effective accessible Web-based IT e-learning environments for training and education for the vision impaired?</p>	<ol style="list-style-type: none"> 1. Observed vision impaired learners. 2. Interviewed vision impaired learners. 3. Photographed the example components (online curriculum, assessments, delivery mechanisms, equipment, assistive technologies). 	<p>To collect details of the:</p> <ol style="list-style-type: none"> 1. accessibility needs from vision impaired learners 2. specific needs in a Web-based online learning situation and 3. ways in which critical thinking is supported by W3C guidelines in the design process of learning materials. 	<ol style="list-style-type: none"> 1. Analysis of vision impairments, demographics, experience with IT and AT, navigation and usage patterns, accessibility tools features needs and patterns of communications. 2. Analysis of interviews and observations to categorise the problem area from the vision impaired learners' point of view.
<p>Sub Research Question 1: What are the characteristics and needs of the adult vision impaired learners?</p>	<ol style="list-style-type: none"> 1. Identified the components required to effectively deliver IT curriculum in a Web-based e-environment. 2. Defined the nature of teaching materials, format of learning material presentation for accessibility, delivery mechanisms, equipment, and skills required by teachers. 	<p>To collect details of the:</p> <ol style="list-style-type: none"> 1. components used in the two e-learning environments and their effectiveness and 2. subjects' attitudes and performances from recorded meetings, interviews, and observations to see how international standards, specifications and guidelines were applied. 	<p>Analysis of teaching and delivery environments including physical teaching environment, accessibility curriculum and delivery mechanisms.</p>
<p>Sub Research Question 2: What are the components of effective accessible web-based online IT learning environments for the vision impaired?</p>	<ol style="list-style-type: none"> 1. Observed vision impaired learners in various settings. 2. Conducted interviews both formal and informal. 	<p>To collect details of the:</p> <ol style="list-style-type: none"> 1. reactions to the use of Web sites from the vision impaired learners' viewpoints and 2. to rate the usability/accessibility for effective design of the following: <ul style="list-style-type: none"> - ease of use - setting time - difficulties - flexibility/graphics loaded, number of links - access time 	<ol style="list-style-type: none"> 1. Analysis of all data collected to identify crucial links between all components.

Research Question	Method	Rationale	Data Analysis
		<ul style="list-style-type: none"> - time engagement - feeling - learner satisfaction - teacher satisfaction - language - keystrokes problems - ease of navigation - ease of orientation - efficiency - impact of screen reader and - impact of zoom text. <p>3. To investigate the interactions between essential components identified in the questions. This included vision impaired learners interacting with the physical and virtual environments and with teachers and other learners.</p>	

3.6.6 Model Building and Evaluation

The findings from this analysis enabled the researcher to develop a model for an effective e-learning environment that was accessible for adults with a variety of vision disabilities. The model was developed gradually as the analysis progressed. This allowed a return to Venable's Problem Diagnosis stage and Theory Building stages as potential solutions were investigated. A holistic perspective was sought in the design of the model to ensure that a more balanced and flexible e-learning environment was the result of physically implementing such a model. The proposed final model is discussed in Chapter six.

The main objective of this research was to build a model of an e-learning environment for vision impaired learners. The aim was not to build and test such a model in this one piece of research, but to consider social, physical and technological factors that impinge upon the effectiveness of such an e-learning model. Building and testing the CAVI environment took more than four years, so building and testing the new model proposed in Chapter six will have to be the focus of future research. Evaluation of the model was carried out, however, and took the form of experts in the field estimating how well the problems and issues identified in the initial definition of the problem space had been met and where improvements in the model could be made. The evaluation is discussed in more detail later in Chapter eight.

3.7 Chapter Summary

This research used a variety of qualitative methods to achieve the research objectives. In this study the Design Science Research method was used to guide the researcher in the investigation of the problem space and in developing the design of a model for a solution. The Design Science Research approach was able to offer the researcher flexibility in moving between the problem and solution spaces, thus providing a solid basis for building the recommended accessible e-learning environment design.

The research involved the study of two e-learning environments to ascertain the characteristics of vision impaired learners and their needs for an accessible learning situation. The two case studies were accessible e-learning environments for learners with vision impairment who were already enrolled in courses. Data were gathered by

studying the online teaching materials, observing the learners and teachers as they were working and recording interviews by the vision impaired learners and their teachers.

Analysis of the data collected was carried out and a model incorporating physical, social and technological factors was developed and evaluated. The model generated was designed to be holistic in nature, rather than addressing individually the many issues faced by vision impaired learners.

The following Chapter provides a description of the two chosen case study situations. It includes details about the background and establishment of each environment, course delivery processes, entry requirements, curriculum content and the structure of teaching and learning materials.

CHAPTER FOUR

STUDY of E-LEARNING SYSTEMS for the VISION IMPAIRED

Before any data could be collected to provide answers to the research questions, it was necessary to study two online learning environments. The study of e-learning systems for the vision impaired is outlined in two sections: the Cisco Academy for the Vision Impaired (CAVI) and the TruVision, an online learning environment based on strict accessibility needs and guidelines.

4.1 The Cisco Academy for the Vision Impaired (CAVI)

This section provides a description of the Cisco Academy for the Vision Impaired (CAVI). The CAVI is an accessible e-learning environment which was established at the Department of Electrical and Computer Engineering, Curtin University, Perth, Western Australia, as part of the Cisco Networking Academy Program (CNAP). This is a worldwide education program that provides learners with the knowledge and skills to design, build, troubleshoot and secure computer networks. The course is designed to increase access to ICT and computer networking employment for vision impaired adults. The academy offers an online course, virtual classroom and labs, interactive teaching materials and hands on teaching and learning activities.

The CNAP comprises many separate courses. The courses available to vision impaired learners are the Cisco Certified Network Associate (CCNA) Discovery 1 and 2 and Information Technology Essentials 1 and 2. These Cisco courses are taught as stand-alone industry certifications and they are also part of an undergraduate curriculum.

The CAVI courses provides the vision impaired learners with skills so that they can install, configure, operate computer networks, resolve networking issues, build a computer and install different versions of industry standard operating systems.

One of the key aspects of the CAVI approach is the use of Assistive Technology (AT). These applications allow learners to access the computer via large print or speech output. The Cisco course content and delivery methods are modified to ensure accessibility for vision impaired learners. Screen Reader and screen magnification are the main forms of assistive software. These include accessible

Flash content and diagram descriptions. Currently, the course has learners located throughout Australia, the USA, Germany, India and Sri Lanka.

The CAVI offers training in specific technologies for vision impaired learners prior to their commencing the network and IT training components of the course, thus ensuring that the learners have the prerequisite skills necessary to succeed in the course of study.

Using a specifically designed network established and situated at Curtin University and the Association for the Blind of Western Australia (ABWA) learners can access the remote equipment via the Internet, performing the network design and configuration exercises from any location. Each course runs for one semester or two terms.

4.2 The Cisco E-learning Environment

The CAVI vision impaired learners range in age from eighteen to fifty five and have a variety of computer technical skills and prior experience. The course is available to both vision impaired and blind learners. ITE1 and ITE2 have a pre-skills test that is not counted towards learner's marks.

All the CAVI vision impaired learners must have a Cisco academy student login which allows access to many important online resources. This login is also used to read the Cisco curriculum for the course and it is used by the teachers to monitor all student online progress and to record final marks in the grade-book. The login also records which courses learners have completed and gives them access to the Alumni resources allowing Cisco graduates to retain access to the online curriculum after course completion. Learners who have a functional and accurate academy login receive certificates for completing the courses.

4.2.1 Software Hardware and Equipment

The Cisco e-learning environment comprises software, hardware and equipment and it is the integration of these that gives value to this program. The CAVI vision impaired learners need a full computer workstation or laptop computer with Windows, UNIX operating systems plus Flash version 9 or later installed and a

browser. Some learners require a Screen Reader or Screen Magnifier so that Flash content can be accessed. Javascript, popup windows and cookies must be enabled.

The virtual classroom provides the facilities for learners to communicate with colleagues as well as to communicate with the teachers, which results in an environment similar to that of a normal classroom. The lectures are recorded and made available in audio files on the CAVI Web site along with other teaching and learning materials for easy access by the learners at any time. Remote communications occur via Voice over Internet Protocol (VoIP), with most learners using freeware applications such as Skype (see Figure 4.1) and Ventrilo (see Figure 4.2).

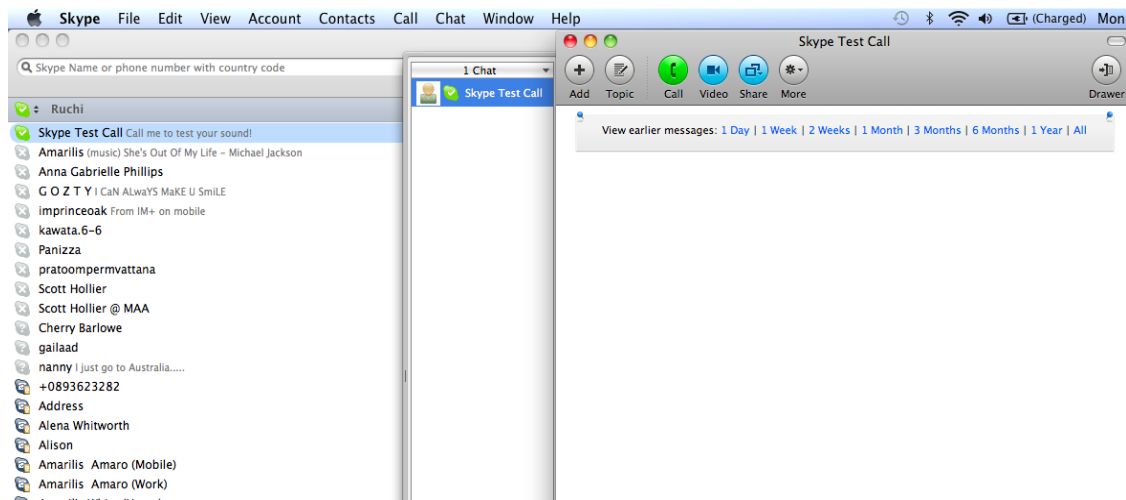


Figure 4.1: Skype Session

Skype is a free software application that allows Internet users to make voice calls to other Skype users over the Internet at no cost. Calls to traditional landline telephones and mobile phones can be made for a small fee. Skype has six hundred and sixty three million registered users as of 2010.

Ventrilo is a VoIP program which includes text chat and allows up to eight users to communicate with each other on the same server. A microphone and speakers, or a headset, must be connected to each person's computer to use the program. The server software is available for Microsoft Windows, Mac OS X, Unix alternatives such as Linux, Kopi, Solaris and Free BSD. Ventrilo is widely used by gamers and they refer

to Ventrilo as “Vent”. Ventrilo is chosen by gamers because it uses very minimal CPU resources. The gamers can communicate with the others more quickly than by typing messages. It also helps gamers retain attention on the game interface because voice chat can be used which is more efficient than typing text. Ventrilo is also used on radio shows and it is frequently used for general voice chat.

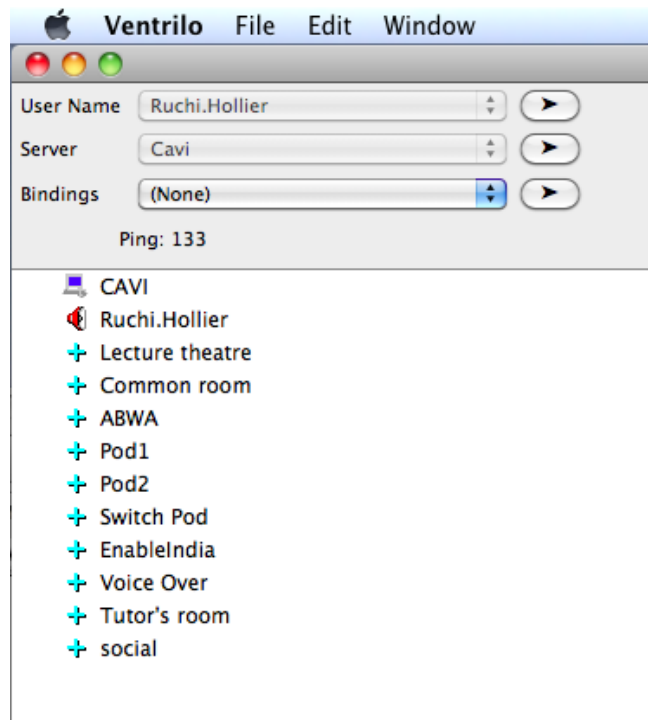


Figure 4.2: Ventrilo Session

4.2.2 Accessible Equipment in the CAVI

In order to provide accessible e-learning environments to the vision impaired learners, many teaching and learning materials were developed to support the needs of the group.

4.2.2.1 Pegboard

Accessible teaching and learning tactile devices in mathematical subjects such as binary and hexadecimal conversions have been developed by the senior academic instructors (Murray & Armstrong, 2005). These include the Binary Abacus or Pegboard, a device that allows the tactile calculation of networking mathematics for vision impaired learners (see Figures 4.3 and 4.4).



Figure 4.3: Pegboard Top View

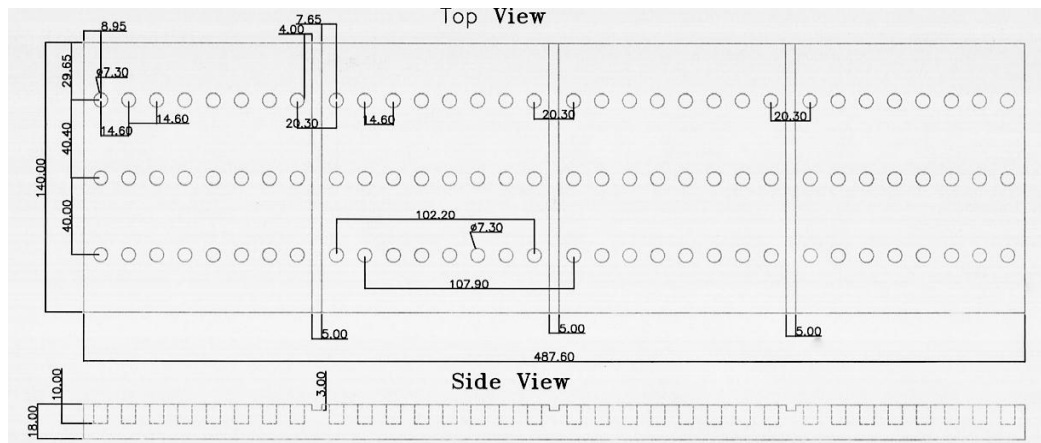


Figure 4.4: Top and side view of Pegboard

The Pegboard consists of a plastic board measuring two hundred and ninety millimetres by one hundred and forty millimetres. It has three rows of thirty two drilled holes. Each row may represent an IP address, subnet mask, a binary number or a network range. Binary one is represented by a pin and binary zero is represented by the absence of a pin (see Figure 4.3). A pin is made of a standard rawlplug. All of these materials are available from hardware shops (Murray & Armstrong, 2004).

Figure 4.5 shows the pegboard being used by a vision impaired learner and a vision impaired teacher.



Figure 4.5: Vision Impaired Learner and Teacher with Pegboards

4.2.2.2 Network Dominoes

Network dominoes are blocks of different sizes and shapes and they are used to describe the physical layout of networks. Sighted learners of Cisco courses are presented the network topologies and device interconnections in printed and electronic forms. Vision impaired learners are presented with network dominoes. These are also used to describe the physical layout of networks. They are made from ten millimetres thick plastic PVC. Network dominos are combined to present tactile diagrams. These consist of different blocks representing all network components and devices. All blocks are manufactured to match those in the Cisco course materials (see Figure 4.6)

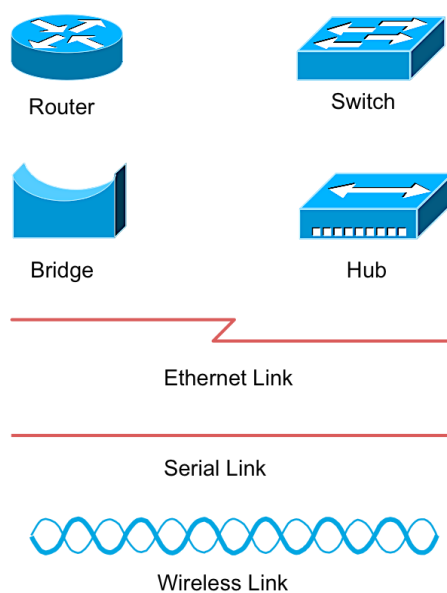


Figure 4.6: Standard Graphical Shapes used in the Cisco Network Diagram

For the CAVI, the rectangular shapes with four arrows represent switches, the round shapes represent routers, the rectangle with double headed arrows represents a bridge and pipe cleaners illustrate wave forms and serial links (see Figure 4.7).

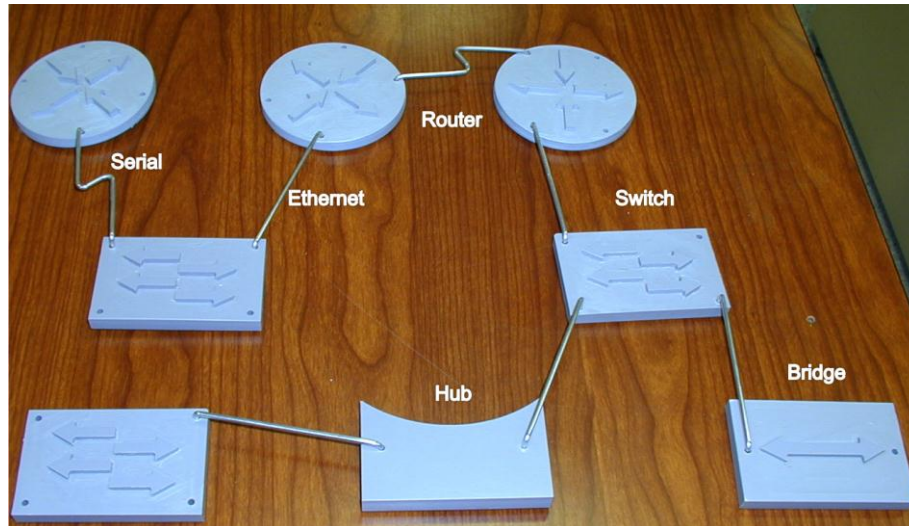


Figure 4.7: The CAVI Network Dominoes Representation of Network Diagrams

4.2.2.3 The Blocks

The CAVI program uses both high and low technology to create accessible teaching and learning materials. Blocks of different shapes, size and colour are used to illustrate network models and the breakdown of packets. Vision impaired learners can feel the size of the blocks and their position (see Figure 4.8).

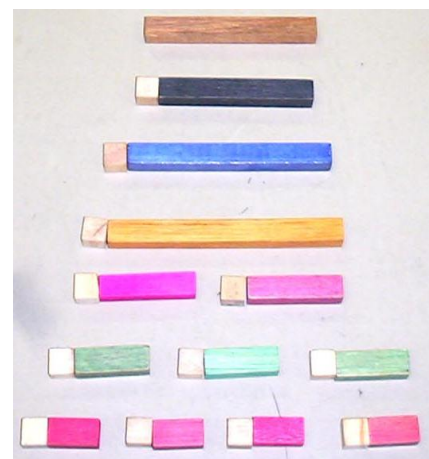


Figure 4.8: Blocks of Different Shapes and Sizes

Blocks help the learners understand the meaning of packetisation of data such as the decomposition of messages. By using the coloured blocks and with the addition of

packet headers (small white blocks) packets can be broken down into frames and bits using the smaller blocks with headers attached (see Figure 4.9).

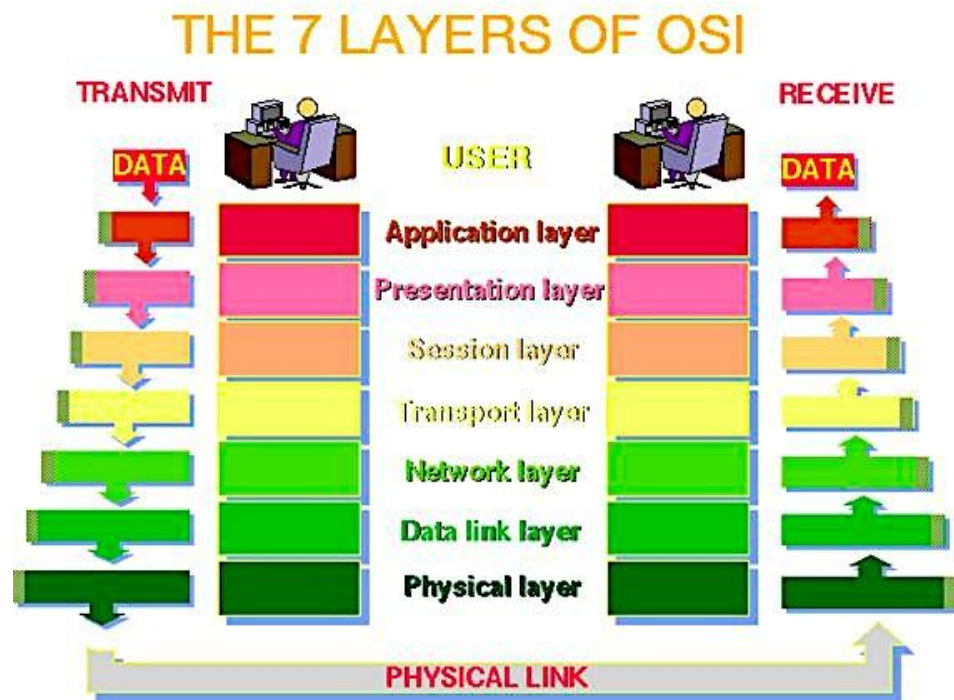


Figure 4.9: The 7 layers of Open System Interconnection
(http://wiki.olc.edu/index.php/Computer_Networking, 2011)

All the resources for the vision impaired learners are made of common materials which are readily available in hardware shops and are easily assembled. Figure 4.10 shows a hands-on session between a vision impaired learner and a vision impaired teacher.

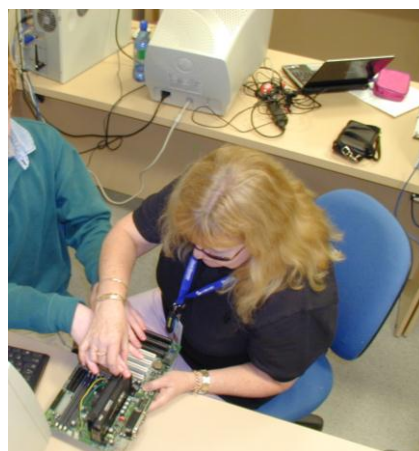


Figure 4.10: Hands on Session, Vision Impaired Teacher and Vision Impaired Learner

4.2.2.4 Tactile Graphic Printing

Another tool used as part of the CAVI teaching materials is the tactile graphic printer that produces raised surfaced diagrams. The Picture in the Flash (PIAF) machine used is illustrated in Figure 4.11. The PIAF tactile printer applies heat to the special capsule paper causing the capsules to expand thus raising the printed surface. By running a hand over the surface the vision impaired learner can feel the raised area on the paper.



Figure 4.11: Picture in the Flash (PIAF)

The poised print out produced by the PIAF printer can then be read by the learner (see Figure 4.12).

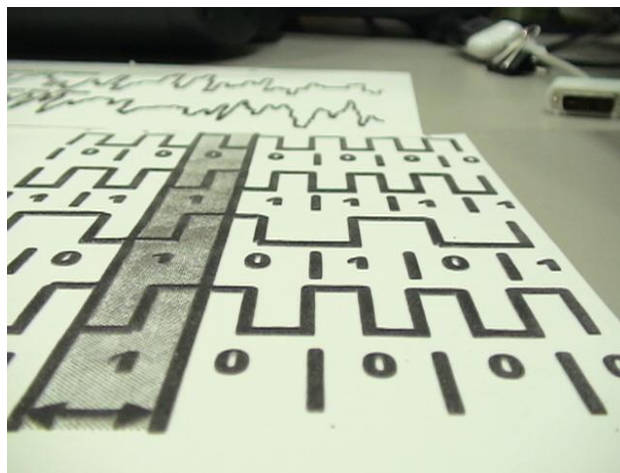



Figure 4.12: PIAF Print Out

4.2.3 Instruction for Use of Teaching Materials

The written instructions for Cisco teaching materials have been converted to speech output. This includes tables, diagrams and graphics. An example of an image with text description is shown in Figure 4.13.



"Module 1.0 The Internet and its Uses 1.0 ?

Chapter Introduction 1.0.1

Introduction

Single Diagram

Diagram 1,

Slideshow The globalization of the Internet has succeeded faster than anyone could have imagined. The manner in which social, commercial, political and personal interactions occur is rapidly changing to keep up with the evolution of the Internet. This expansion has created a wider audience and a larger consumer base for whatever message, product or service can be delivered. Today, there are millions of individuals connected to this global network and the number is growing. After completion of this chapter, you should be able to: Describe how the Internet is evolving and the various ways that businesses are using the Internet. Describe the importance of standards in the continuing growth of the Internet. Describe the purpose of an Internet Service Provider (ISP) and the services that it offers. Describe the hierarchical structure of the Internet and the purpose of the Point of Presence (POP) and the Internet Exchange Point (IXP). Identify the types of devices used by the ISP to provide services and describe the importance of scalability in the ISP network. Describe the various network support teams that work at an ISP and the roles and responsibilities of each one.

Figure 4.13: Example of a Diagram from Module 1

4.3 Course Delivery

The CAVI courses are delivered to local learners who are physically present at the ABWA and to remote learners internationally via the Internet. All references to time in the program timetable are given in Perth, Western Australian time which is Greenwich Mean Time plus eight hours.

4.3.1 Teaching Delivery Methods

Local learners are enrolled at the ABWA, India and Sri Lanka. International learners access courses through the Internet. The lectures and tutorials of the CAVI are delivered by vision impaired teachers in the local classroom (see Figure 4.14). The lectures and tutorials are broadcast to the other teachers and remote learners. All the lectures and tutorials are recorded and stored as audio files for later access. There are module diagram descriptions for each section. Labs and worksheets for each section are also provided in this area. Learners complete each task by reinforcing learning through practical activities. Audio lectures are provided in mp3 format. These materials form a repository of accessible learning resources for learners and they include recordings of past lectures and tutorials.



Figure 4.14: The CAVI Physical Classroom with Sighted Teacher

4.3.2 The Use of Ventrilo and Skype for Virtual Classroom Environments

The CAVI vision impaired learners use e-mail to communicate with the teachers but the use of Ventrilo and Skype also play an important role in their virtual classroom. During these sessions or time lines, learners can ask questions about the course content, teaching and learning materials, the use of assistive technology, software and hardware. These sessions also help learners and teachers, or learners and learners, build virtual relationships.

Instructors are both sighted and vision impaired. All instructors are Cisco certified and have completed teacher training at the certificate level as a minimum. The majority of the course lectures are delivered by vision impaired teachers (see Figure 4.15).



Figure 4.15: Vision Impaired Teacher Presenting a Lecture during a CAVI Course

4.3.3 Student Resources

Vision impaired learners access the CAVI environment through a student resources page which details all materials and equipment. These resources are often referred to as “class notes by the admins”. This informative page contains links to the essential components of the learning processes, including orientation, general instruction, Thursday Chats, E-mail Communication, Mailing lists, Extras and Virtual Machines (see Figure 4.16).

Back to Student Resources			
	Name	Last modified	Size
	Parent Directory		-
	networking/	29-Sep-2010 13:38	-
	orientation/	03-Feb-2011 13:43	-
	pegboard/	29-Sep-2010 13:34	-
	accessing cisco site 20080123.txt	23-Jan-2008 14:06	3.0K
	accessing cisco site 20101203.txt	22-Jan-2010 21:09	2.7K
	accessingcurriculum.mp3	08-Feb-2007 12:16	4.2M
	accessing curriculum with HAL.mp3	24-May-2007 21:06	5.4M
	cavi hunt.doc	24-Jul-2010 22:45	25K
	CaviIntro2009.mp3	04-Feb-2009 11:10	22M
	courses_overview2011.txt	25-Jan-2011 19:35	8.8K
	setting_up_ventrilo.html	28-Jan-2011 12:42	7.2K
	student.php	25-Jan-2011 20:11	5.6K
	student_information2011.txt	28-Jan-2011 12:53	9.6K
	ventrilo cavi tutorial for windows.mp3	29-Jul-2010 08:50	11M

Apache/2.2.14 (Ubuntu) Server at www.cucacat.org Port 80

Figure 4.16: Student Resources Page

There are links to each subject and course. Inside each link learners find additional resources which may be of relevance. The Student Resources pages cover the following areas.

General Instruction

This section contains text documents and audio tutorials about aspects of participating in the course (see Figure 4.17 for the Welcome Page).

Thursday Chats

These run through Ventrilo or Skype and include lectures on special subjects of interest, some of which are given by guest speakers.

Email Communication

Because of the remote nature of the CAVI course, the communication tool between learners and teachers is via email.

Mailing Lists

This section is where teachers detail important information such as time changes for lectures, announcements of assessments and posting of extension labs. All learners must be subscribed to this list. Learners cannot post to this list.

Extras

This section contains software that may be useful to learners participating in the course. It also contains Assistive Technology (AT) training documents for Jobs Access With Speech (JAWS) or Ventrilo for Mac users.

Virtual Machines

This section contains virtual images used in the coursework and it is password protected. The learners obtain a password from the administrative officer once enrolment is completed.

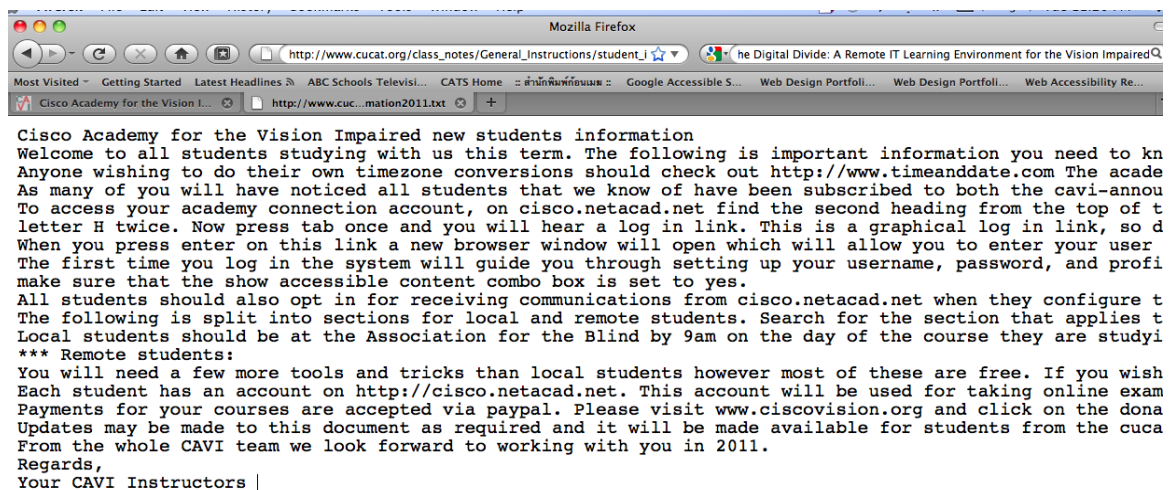


Figure 4.17: Sample Page “Welcome Statement”

4.3.4 THE CAVI Curriculum

The CAVI currently offers two sets of courses in an accessible format. These are IT Essentials and the Cisco Certified Network Associate (CCNA) Discovery. The IT Essentials course provides a comprehensive overview of computer fundamentals and advanced concepts. It composes six components:

- describing the internal components of a computer
- assembling a computer system
- installing an operating system
- troubleshooting using system tools and diagnostic software
- connecting computers to the Internet and
- sharing resources in a networked environment.

The CCNA Discovery course covers the types of practical networks that learners may face. These range from simple home and office networks to complex enterprise models.

The CCNA Discovery course is comprised of four components:

- networking for home and small business
- working at a small to medium business
- introducing routing and switching in the enterprise and
- designing and supporting computer networks.

Each component is a prerequisite for the next. The curriculum offers a hands-on approach to learning. Examples of the skills that vision impaired learners can perform after completing each course include assembling a computer system, installing an operating system and designing a supporting computer network.

4.4 Learning Content Design and Curriculum Structure of CAVI

The teaching and learning resources of the CAVI consist of lectures, laboratory exercises, online learning content, simulation tools (images and diagrams), examinations and quizzes. Table 4.1 shows the modifications which are made to the Cisco program to meet the requirements of vision impaired learners.

Table 4.1: Details of Modifications of Cisco Program

For Sighted Learners	The CAVI for Vision Impaired learners
Lectures	Audio lectures and Virtual Classroom through Skype and Ventrilo
Laboratory Exercises	Braille Lab manuals, Remote Bundle, Audio demonstration
Cisco Online learning materials	Text descriptions and Chat Quizzes

Tools (Images and Diagrams)	Text Descriptions
Simulators tools	Network Dominos, Pegboard and iNetSim
Examinations and Quizzes	Examinations with text descriptions and Chat Quizzes
One on one tutorial sessions	Skype, Ventrilo and e-mails.

4.4.1 The CAVI Labs and Worksheets

Learners complete the labs and worksheets for each module from each course, and email their answers to the teachers for marking. Learners must complete all labs and worksheets unless advised otherwise by a teacher. Labs and worksheets are downloaded from the website (see Figure 4.18).

4.4.2 Online Examinations

There are numerous examinations for each module, and a final examination at the end of a CAVI course. ITE and Discovery courses have one examination per module and final examinations. There is also a course feedback option which advises learners which sections need to be studied in more depth.

The learners take a module examination once each module is completed. Learners are allowed multiple attempts at a module examination. A mark higher than 75% is considered a pass for a module. The CAVI examinations need to be activated by the teacher. Module examinations can be active for a week at a time before they need to be reactivated. A student has two hours to complete each module examination.

Vision impaired learners who have a problem seeing a diagram in an examination are able to open the diagram descriptions from the Curtin University Centre for Accessible Technology (CUCAT) Web site in a separate window or tab before commencing. Online research is not forbidden in an examination but it is not recommended.

“1.1.6 Operating System Basics

Replace the XXX with the correct term

- 1. LANs were first created by installing XXX in the PCs and then connecting the adapters using XXX wire.*
- 2. As network servers became more powerful, they began to take on the functions once handled by XXX and XXX.*
- 3. Whether designed for a stand-alone desktop computer or a multi-user network server, all operating system software includes the following components:*

XXX, XXX, and XXX.
- 4. The XXX is a relatively small piece of code that is loaded into memory when the computer boots.*
- 5. The XXX is the component of the OS that the user interacts with. It acts like a bridge between the user and the kernel.*
- 6. Some GUI software can consume more than one hundred times the storage space that CLI software does. Because GUIs are more complicated than CLIs, GUI software requires significantly more XXX and XXX.*
- 7. When deployed as NOSs, UNIX and Linux are often configured without XXX components.*
- 8. Name the file systems supported by the following operating systems:*

Operating System Windows 3.x

Windows 95, 98, ME

Windows NT, 2000

Windows XP

IBM OS/2

Linux”

Figure 4.18: Example of Worksheet Content, ITE2

4.4.3 Final Examinations

There are final examinations for the CAVI course. A final examination usually takes three hours to complete and contains over fifty questions. Final examinations can only be active for an eight hour time window. Learners specify a time at which they

wish to take an examination, and it is activated for them. The diagram descriptions are emailed to learners before taking final examinations.

On completion of a CAVI course, the learner is provided with a list of tasks and skills attained as part of the course. Learners receive a certificate if they pass and no grades are included. Learners must pass every module of the course. Those who do not adequately complete all sections do not pass regardless of marks in other sections.

The breakdown of marks is as follows:

- labs and worksheets 30%
- module examinations 30%
- final examination 30%

The remaining 10% is awarded for either a practical task or the teacher's observations of the learner during practical work.

Learners can retake one or more modules and the final examination at additional cost.

4.5 Key Aspects of the CAVI Environment

This section investigates the CAVI environment and notes issues that need to be rectified in order to design and develop accessible online learning environments for vision impaired learners. The following section shows the areas which are essential components. They are the physical classroom, the virtual teaching classroom, the curriculum and teaching materials, and social aspects and learners.

4.5.1 The Physical Classroom

The physical classroom components for the CAVI include:

- accessible teaching and learning equipment and materials, which comprise physical teaching materials, such as pegboards, networks dominoes, the blocks and tactile graphic painting
- a personal computer/laptop
- routers
- printer

- cables
- microphones
- computer desks set in a U shape for easy access for vision impaired teachers and local learners
- switches
- wireless access points
- Cisco Packet Tracer installed (network simulation and visualization software) and
- the physical classrooms at Curtin University, Western Australia, India, and Sri Lanka.

4.5.2 The Virtual Classroom

The virtual classroom components for the CAVI include:

- Jobs Access with Speech (JAWS) Screen Reading software
- ZoomText Screen Magnifier software
- Voice over Internet Protocol (VoIP) application such as Ventrilo and Skype. which play an important role in the virtual classroom as part of social networking and
- e-mail software which plays an important role between the community.

One of the key aspects of the CAVI is the use of assistive technologies, as all of the learners need to access computers via large print or speech output.

The teachers with visual impairments play a significant part during course delivery because their own understanding of problems and issues provides them with the ability to analyse a learner's difficulties and easily devise solutions.

The virtual classroom provides the facilities for vision impaired learners to communicate with each other in a way similar to that which occurs in a normal classroom.

Cisco provides a suite of tools that can be used as an additional student resource and these include:

- Cisco Academy ATLAS 550 Configuration Guide

- CiscoPedia
- Packet Tracer v5.2
- Router eSim
- Subnet Calculator
- Cisco Configuration Register Decoder
- Password Recovery and
- Eight Steps to Router Configuration Success.

4.5.3 Curriculum and Teaching Materials

Disabilities of the learners were considered during program development.

Accessible curriculum and teaching materials contain components such as:

- lectures available live and recorded
- laboratory exercises where learners can use the pegboards and/or the dominoes
- online learning content where text description is provided with appropriate contrast of the interface
- simulation tools such as images and diagrams
- E-doing tool- accessible examinations, games and quizzes and
- accessible timelines in teaching and learning.

The Cisco Certified Network Associate (CCNA) curriculum flows from

- networking for Home and Small Businesses
- working at a Small-to-Medium Business or ISP
- introduction to Routing and Switching in the Enterprise and
- designing and Supporting Computer Network.

4.5.4 Social Elements

Learners in the CAVI program are linked together in their teaching and learning community. They form a vision impaired sub group of the CAVI community. The CAVI offers them more than a learning place because of accessible learning styles. Furthermore, the teaching and learning environments lead them to personal social activities later on including leisure, sports, shopping and cultural activities.

Learners use the telephone, e-mails, Ventrilo and, Skype to communicate with other learners. Learners also use e-mail, Ventrilo and Skype to communicate with their teachers.

4.5.5 Learners

Learners may range in age from eighteen to fifty five and have a variety of computer technical skills and prior experience. They must also have access to the Internet.

The types of visual impairment can vary from limited eyesight to total blindness.

These conditions include:

- Optic Atrophy
- Nystagmus
- Macular Degeneration
- Glaucoma
- Diabetic Retinopathy (as a result of Diabetes)
- Cataracts
- Ocular Albinism
- Oculocutaneous
- Albinism and
- Retinitis Pigmentosa (RP).

The level of visual impairment can vary from:

- 20/70 to 20/200 - moderate visual impairment, or low vision
- 20/200 to 20/400 - severe visual impairment, or severe low vision - legal blindness
- less than 20/1,000 - near-total visual impairment, or near total blindness
- no Light Perception - considered total visual impairment, or total blindness.

Summary of CAVI

This section describes the CAVI e-learning environment which includes the structure of the course, accessible teaching and learning materials, curriculum, course delivery, physical/virtual classroom, assignments activities and assessment.

4.6 The TruVision

This section provides a description of the TruVision, a project within the Flexible Learning Toolboxes Project, a component of the Australian Flexible Learning Framework for the National Vocational Education and Training System (AFL Framework). It was funded for two years by the Australian National Training Authority (ANTA) and the initiative was designed to stimulate online learning opportunities in a targeted equity area. It is an online learning environment designed for learners who are blind and vision impaired. Sighted learners without a disability are also able to use TruVision.

The TruVision employs a number of strategies to support vision impaired learners, many of which are not evident in other online courses. They include detailed textual descriptions to enable the readers to describe the physical interface to vision impaired learners, an organised set of links replicating the navigation buttons, written HTML code and screen displays to aid screen magnification.

These factors have been designed into the course in ways that make them invisible to sighted learners and in ways which give vision impaired learners access to the same learning materials or their text-based equivalents. The data were collected before the TruVision was discontinued due to lack of further funding for updating the project.

4.7 The TruVision E-learning Environment

The TruVision learners range in age from fifteen to sixty five and have a variety of computer skills and prior experience. The course is available to vision impaired, blind and sighted learners. The TruVision Certificate I in IT is comprised of the following six units:

- operating a personal computer
- operating a word processing application
- operating a spreadsheet application
- operating database application
- operating a presentation package and
- sending and retrieving information over the Internet by using browsers and e-mail.

4.7.1 Learning Schedule

The flexibility of online learning, as offered by the TruVision, gives more freedom to the learners, especially the vision impaired group, as they manage, start, learn and finish the tasks on their own. The learning schedule of the TruVision represents forty hours of instruction/practice for each application. However, the times vary depending on the abilities of the learners.

4.7.2 Learning Guidelines

The learning guidelines of the TruVision site were designed initially to be used in conjunction with the teacher to assist the first time user. For the target group of the TruVision site, each learner requires an individual who can assist them with the use of the Assistive Technology required to set up the computer and position the chair and table. In addition, some learners may need to use a Video Magnifier (see Figure 4.19).



Figure 4.19: Video Magnifier

4.7.3 Software

The TruVision e-learning environment comprises software, hardware and Assistive Technologies such as screen reader JAWS, screen magnifier ZoomText and also video magnifier for vision impaired learners who prefer to read long text in large print.

Learners need an IBM compatible computer or laptop with Microsoft Office. A sound card must be installed and learners require a valid e-mail address. The screen resolution set up at with display of 1,024 x 768 is recommended.

4.7.4 Accessible Authentic learning

The core design of the TruVision is a simulated workplace for the vision impaired, and it features imaginative ways of engaging learners. The accessible learning materials of TruVision are designed as an office simulation and offer “an authentic” working environment. The design is based on a real office setting with the home page showing a desk, a receptionist and doors behind the desk. This is typical of a reception area in a real office.

This format gives learners an opportunity to deal with concepts such as office equipment work spaces, the location of office materials, and the speciality of each office member. The developers of this site believe that this setting, based on many real-world images, assists in making learners comfortable because they are employed in a real-world environment (see Figure 4.20).



Figure 4.20: The TruVision Reception, a Simulated Real Office Environment

4.7.5 Instruction for Use of Teaching and Learning Materials

The TruVision accessible materials are designed so that learners master each feature of the software. There are usually four to five features to learn for each full task. Learners learning Microsoft Word are required to create, save, retrieve and print documents via the following steps:

- starting MS word and creating a new document

- saving a document with a different name
- saving on a different drive
- creating, saving and closing a document
- retrieving documents
- printing single and multiple copies and
- printing a specific text.

After learners have had some directed practice with the software application, they complete a task and print it out for verification by the teacher. After completing each task, they then complete a larger assignment which tests all areas of the software application. This assignment is very similar to a real project in a working environment. A student may need to produce an appropriate document based on requirements from a customer. One assignment in the TruVision learning system is shown in Figure 4.21.

“I've just had a call from Terry Kinkaide from Kinkaide's Terrace Restaurant. He has been negotiating with the Western Australian Tourism Commission to advertise his restaurant with tour guides catering for Japanese tourists. He is expecting a significant increase in the number of Japanese patrons dining at Kinkaide's Terrace Restaurant within the next month.

As a consequence, Mr Kinkaide's staff need to quickly become familiar with some aspects of Japanese etiquette - in particular table manners. He has found some excellent information on www.japan-guide.com and has requested that TruVision put some of this information into a document that he can give his staff to study and refer to as necessary.

Mr Kinkaide has also sent over a list of his suppliers and service providers with their contact details. He would like the list put into a table format to be used as an easy reference for staff to use when ordering supplies. I would like you to complete the following tasks for Mr Kinkaide.”

1. Access the information contained in the attached file 'Dining.doc'. Find the section beginning '**How to eat....**' rice, noodles, soup, etc. Use the information to create:
 1. a numbered list version
 2. a bulleted list version.
2. Use the information regarding the rules for using chopsticks to create a separate document in both bulleted and numbered formats. Add a suitable Theme to the bulleted copy. Mr Kinkaide will compare both formats and choose the one that he prefers.

3. Use the Professional letter template from General Templates in the New Document task panel to write a covering letter to Mr Kinkaide asking him to choose his preferred format from the documents you have created - mention which documents you have enclosed. Include your e-mail address in the letter.
4. Create a table using the list of suppliers contained in the attached file 'Supplier.doc'. Be sure to use appropriate font sizes and design features to make it easily read.
5. Insert the following into the table: "Refrigeration Mechanic: Frease & Kolde Pty Ltd, 17 Thore Place, UPTON WA 6100 Phone: 9456 7812"

"Mr Kinkaide will compare both formats and choose the one that he prefers."

Figure 4.21: One Example of an Assignment.

This assignment gives learners an opportunity to apply the skills they have learned to a simulated real-world environment.

4.8 Course Delivery

The TruVision course is delivered to local student learners who are present at the ABWA and to remote learners nationally via the Internet. The TruVision was designed with a home page simulating a reception area. Learners are first greeted by the TruVision receptionist who directs them to the three main areas of the site. The three areas consist of the Orientation Room, the IT Support Room, and the Trainee Workstation (see Figures 4.22 and 4.23).



Figure 4.22: The TruVision Orientation Room



Figure 4.23: The TruVision IT Support Room

4.8.1 Teaching Delivery Methods

In the local context learners are expected to attend a session at the ABWA to trial the use of the TruVision site and to become familiar with use of the Screen Reader software program JAWS or the Screen Magnifier software program, ZoomText. Although the site was designed for online learning it was felt learners would still need to attend classes guided by a teacher to make the most of the opportunities.

In a classroom based setting, the TruVision is well supported by a teacher and learner ratio of one to six among vision impaired learners. Remote learners use e-mail to communicate with teacher and phone calls for assistive technology support from the technician at the ABWA.

4.8.2 Student Resources

The TruVision has been designed with a broad range of learning resources that can be used within the online setting. In terms of accessibility, TruVision generally provides significantly more content than other online learning environments.

4.8.2.1 Nature of the Resources Design of the TruVision

The TruVision materials have been designed to include various forms of learning resources adapted from the print materials. The site contains a combination of learning support materials including audio online presentations, images of staff, office materials, office spaces, instructions, sample files and JavaScript interactive

elements. TruVision was designed to provide a real working environment for the learners to prepare them for a real office situation.

4.8.2.2 Authentic Resources Design

TruVision was created with very detailed resources. One such feature focuses on allowing learners to hear audio information in every section of the site. Learners can hear descriptions of each room as read by Screen Reader software (JAWS). This design was intended to enable vision impaired learners to imagine a real office setting and adapt themselves to working in this setting.

4.8.2.3 Work Assignments/Training Activities

The learning resources in the TruVision site are mainly developed in HTML. Work assignments can be accessed from the Trainee Workstation and the Training activities from the Training Room. The work assignments are designed to allow the learners to use, develop and build IT skills. Each assignment gives the student a number of “authentic” IT tasks to complete.

While completing some work assignments, learners are presented with further work which needs to be completed immediately. This design function allows them to participate in a real work environment where employees are presented with a need to prioritise tasks.

4.8.2.4 Self-Test

The developers designed the site to make learning as flexible as possible. The TruVision includes a self-test feature as a regular part of the learning resources. After the completion of each unit, the learners check their knowledge by doing the self-test which is located at the end of the training activity in the Training Room (see Figure 4.24). Learners can start the self-test at any time even before completion of the training activities and it can be used as many times as required.

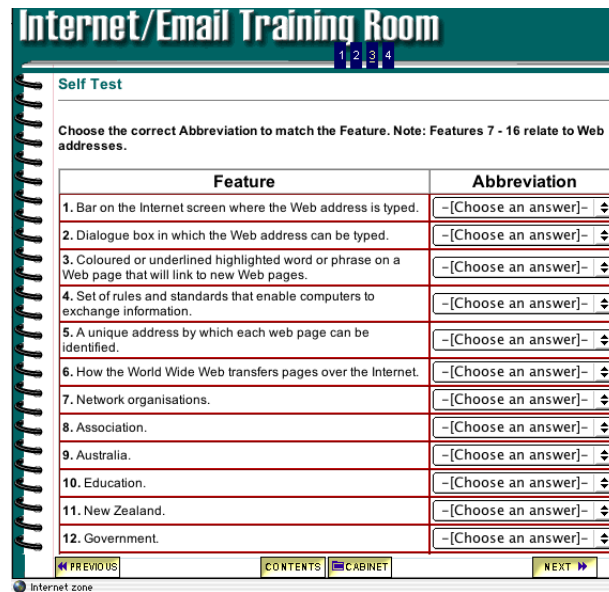


Figure 4.24: A sample TruVision Feedback Access Screen

4.8.2.5 Feedback

The feedback provided by the teacher to the learner at the end of each training activity is designed to guide learners to their next task (see Figure 4.25).



Figure 4.25: TruVision Feedback Sample

4.8.2.6 JavaScript

Throughout the TruVision, JavaScript is used within the interface to highlight links. The rollovers animate the graphic links when the mouse arrow moves over particular sections of the pages. In addition, audio is provided for the VI users. The audio facility "speak" is used to indicate that the link has been activated. The developers have also provided keyboard navigation and a text alternative to suit both sighted and VI users. As a result, navigating the page with either the mouse or the keyboard commands will move the learners sequentially through the graphical links.

The self-tests located at the end of the training activities are designed using JavaScript to create an interactive Web page. A text-based alternative has been provided to enable these resources to be understood by the screen readers.

4.8.2.7 Audio and Macromedia Flash

The TruVision site contains synchronised audio as a spoken description of the environment and activities are presented through the alt attribute (ALT) tags.

The main interfaces of the TruVision site, such as the Reception, Orientation, IT Support Room, Trainee Workstation and the audio pop-ups are developed using Macromedia Flash. The audio description is recorded on a separate track which describes key visual elements of the presentation. The developers of TruVision used audio description that includes information describing the characters, the scenes, the body language of the IT Officers and other visual elements.

4.8.2.8 The Glossary of Terms Used in TruVision

The Glossary of Terms provides a definition of the relevant term for each topic. Learners click on the linked glossary term to access a definition. Sighted and VI users can access the glossary from the work area of the IT Support Officer. This learning resource is developed in HTML.

4.8.2.9 Discussion/Group Work Topics

The TruVision site also includes a number of discussion and group work topics to provide more activities and resources for learners. Such learning resources are developed in HTML and can be accessed from the notice board in the IT Support Room (see Figure 4.26).

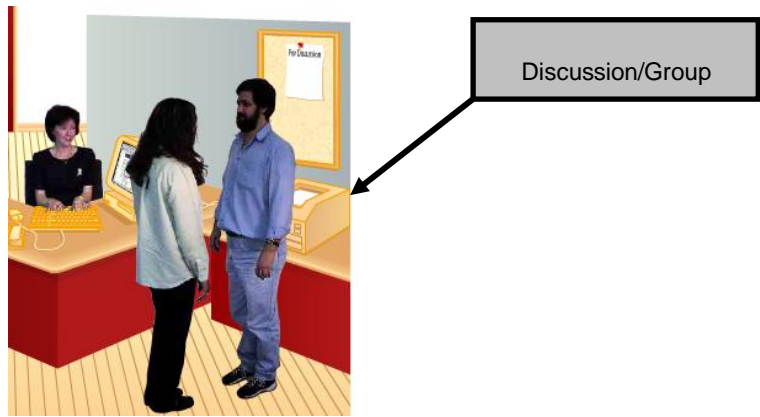


Figure 4.26: Notice Board for Discussion and Group Work Topics

4.8.2.10 Unit Information

Unit information is provided to learners in the form of a whiteboard which can be accessed in the Orientation Room. This is also designed in HTML to suit the use of JAWS. The TruVision only provides online material unit information to the learners. This design requires learners to spend the first two weeks on site with teachers to familiarise themselves with The TruVision (see Figure 4.27).



Figure 4.27: TruVision Unit Information Page

4.9 The TruVision Curriculum

The TruVision offers units in accessible format and is composed of six competencies:

- operating a personal computer

- operating a word processing application
- operating a spreadsheet application
- operating a database application
- operating a presentation package and
- sending and retrieving information over the Internet using browsers and email.

Successful completion of these units enables learners to seek full-time employment within industry in such positions as administrative assistants, help desk personnel and data entry operators.

4.10 Learning Content Design and Curriculum Structure of the TruVision

The course was previously delivered through print-based materials. During the design of the learning materials, the instructional designer followed the learning design from print-based material. The TruVision contains the same content as that used by sighted learners studying in a face-to-face or online learning environment.

A consistent strategy within the TruVision site is to introduce learners to a basic subset of features within each application. They are then required to complete a larger task list throughout the progression of the course. Once the application has been mastered, learners move forward to the assessment stage and pass the completed assessment activities to the teacher in print form.

During the development of TruVision, a comprehensive user testing program was undertaken as part of the design process and feedback was gathered from learners in a variety of contexts. These included vision impaired learners using screen readers and screen magnification, and learners using no assistive technologies at all.

4.10.1 The Structure of the TruVision

The TruVision was designed with a home page simulating a reception area. Learners are first greeted by the TruVision receptionist who directs them to the three main areas of the site. The three areas consist of the Orientation Room, the IT Support Room, and the Trainee Workstation (see Figure 4.22 and Figure 4.23).

4.10.2 The Orientation Room

The content of the Orientation Room provides an induction for learners on their first day at theTruVision. The learner has the option of either accessing a brief introduction to each of the units or accessing the main TruVision presentation. Both options provide basic information about the TruVision staff, their roles and the different rooms available to the learners.

The whiteboard in the Orientation Room provides learners with access to specific unit information. This information includes:

- details of the competency and performance criteria
- prerequisites
- instructor contact details
- assessment details
- recommended resources
- a study schedule
- how to navigate through TruVision including an explanation of the functions of buttons and icons
- information about online communication tools and how these can be used and
- tips for working online.

4.10.3 The IT Support Room

IT Support Officers are located in the IT Support Room. This room provides access to each of the IT support officers as a help strategy. Learners have the option of contacting a support officer within this area of the site. In addition, the notice board in the IT Support Room provides learners with suggested discussion/group work topics. Each unit has its own support area.

4.10.4 The Trainee Work Station

The Trainee Workstation is where learners access activities, also known as work assignments, using the icons from the workstation, the desk, the chair, the notice board, and the files and boxes of tasks that need to be done. Learners assume the role of a trainee and it was intended that this role would give them the feeling of being in a workplace setting as they completed their tasks.

A Training Room, accessed via the IT Support Officer, allows learners to gain access to IT training activities to support their learning. This room employs the metaphors of an officer, a desk, a computer and a filing cabinet to guide the learners to each activity in the unit.

Although the TruVision site is designed to cater for vision impaired users, much emphasis is placed on the visual aspect of the site, providing the same form of online experience as might be gained by sighted users. For this reason, the interface is designed to represent best practice from an instructional design perspective and an accessible version was then planned that could provide the same experience for vision impaired learners.

4.10.5 Assessment

The work assignments, available from the trainee workstation, are designed to form the collective assessment for each unit. There is an option, however, for each assignment to be used as a stand-alone assessment, or to be added to or deleted as required.

4.10.6 Style of assessment

The Trainee Workstation is one of the examples from the interactive assignment area for learners. Each competency level has a workstation associated with it, and learners need to check a box on the whiteboard to select the workstation they require.

Working by memo or by e-mail, assignments are submitted using a range of methods including:

- in person
- by the TruVision manager and
- by voice mail.

Summary

This section describes the TruVision site in order to enable an understanding of the nature of the learning environment in fine detail.

The description focuses on discussing the organisation and structure of the entire site, the learning design that is employed, the scope, extent and form of the resources that are included, and the learning supports provided as well as the interface design.

The description of the site highlights the appearance of TruVision as it shows itself to a sighted user. The description indicates how this appearance has been replicated in the technical development so that it might also appear this way when “viewed” by vision impaired learners using various assistive technologies, including screen readers and screen magnifiers.

4.11 Key Component of the TruVision Environment

4.11.1 Physical Teaching Environment

One of the key components of the course is the physical teaching environment where the ABWA provides a room with equipment for use in the training program. The equipment in the lab comprises:

- six computers with AT software installed, which are laid out in a U shape for maximum access by the teacher
- the video magnifier machine, which plays a significant role in this classroom for vision impaired learners
- access to the printer as part of course assessment
- a router
- cables and
- speakers.

4.11.2 Virtual teaching environment

The TruVision virtual classroom only offers email between teachers and learners. The speed of communication is always based on the time made available by the teacher.

4.11.3 Curriculum and Teaching materials

The principal design of the TruVision is a simulated workplace for the vision impaired. It features imaginative ways of engaging vision impaired learners who are

learning IT. It provides an office simulation that reflects a real life office situation including the key people, furniture and equipment in the office.

The design of the TruVision environment gives learners an opportunity to deal with concepts such as office spaces, the locations of office materials, and the speciality of each office member.

The accessible curriculum includes:

- online learning content, such as
 - the Orientation Room- induction for learners
 - the IT Support Room- Direction on how to use IT applications
 - the training room- for learners to increase their IT skills
 - the trainee work Station-interactive assignment
 - assessment- work assignments
- a flexible assessment timeframe
- lab exercises which are the core considerations for curriculum of TruVision
- learning resources within the online setting. This part includes:
 - work assignments and training activities
 - self-test
 - feedback provided by the instructor at the end of each training activity
 - audio and Macromedia Flash as spoken description of the environment and activities presented through ALT tags
 - the glossary of terms used and
 - discussion and group work topics.
- the TruVision Certificate I in IT is comprised of six units:
 - operating a personal computer
 - operating a word processing application
 - operating a spreadsheet application
 - operating database application
 - operating a presentation package and
 - sending and retrieving information over the Internet by using browsers and e-mail.

4.11.4 Social Elements

During the first two weeks of the course, when the vision impaired learners are on site at the ABWA, they have the opportunity of physically meeting fellow learners. Following this, learners can communicate with each other by various electronic means and they thus form a sub- group of the learning community. This can lead to personal social activities including leisure, sports, shopping and group outings.

4.11.5 Learners

Learners may have the following characteristics:

- a range in age from fifteen to sixty five
- have experienced a variety of computer skills and
- have knowledge of AT.

Extended hours are available from the teacher and an AT specialist. This allows for flexibility in the time taken to achieve given tasks.

Types of visual impairment can vary from limited eyesight to total blindness. These conditions include:

- Optic Atrophy
- Nystagmus
- Macular Degeneration
- Glaucoma
- Diabetic Retinopathy (as a result of Diabetes)
- Cataracts
- Ocular Albinism
- Oculocutaneous
- Albinism and
- Retinitis Pigmentosa (RP)

The level of visual impairment can vary from:

- 20/70 to 20/200 - moderate visual impairment, or low vision
- 20/200 to 20/400 - severe visual impairment, or severe low vision - legal blindness
- less than 20/1,000 - near-total visual impairment, or near total blindness

- no Light Perception - considered total visual impairment, or total blindness.

The local classroom is only available at the ABWA.

Summary of the TruVision

This section describes the TruVision e-learning environment which includes the structure, the details of teaching and learning materials, curriculum, course delivery, teaching delivery methods and work assignments/training activities.

4.12 Chapter Summary

This chapter provides details of the two case studies in this research. An overview of the two environments is included in this Chapter. However, substantially more information was gathered than can be presented. The features of these two environments were investigated with relation to the physical classrooms, the virtual classrooms, physical and virtual laboratory working spaces, accessible learning materials, teaching methods, learning outcomes, adherence to accessibility guidelines and standards, means of social interaction, and profiles of the learners and teachers. This information, together with additional data collected from observations, interviews and documentation was used in the formation of the new model proposed later in the thesis. The next Chapter describes data collection methods and data analysis for this research.

CHAPTER FIVE

DATA COLLECTION AND ANALYSIS

5.1 Introduction

The main objectives of this data collection exercise were to:

1. investigate the characteristics and needs of adult vision impaired learners
2. investigate the components of effective Web-based e-learning environments for vision impaired learners and
3. investigate how the components and vision impaired learners interact.

Data collection instruments used in this phase included questionnaires, observations and interviews with vision impaired learners. The information was collected and compiled from studying the two learning environments for the vision impaired.

This chapter describes the data collected from the questionnaires and observations during the case study investigations.

5.2 Structure and Content of the Questionnaire

The questions were divided into two parts.

The questions in part one were designed to elicit information about the characteristics, demographics and needs of the adult vision impaired learner. They were designed to collect information from the learners' perspective about how their characteristics and their geographical situations affected their needs and resulted in common problems. The questions involved factors such as their degree of independence, their use of assistive technology, course availability and identification of gaps where issues had not been clearly addressed. The questionnaire also gathered details about age, IT, assistive technology background and the types and conditions of visual impairment.

The questions in part two were designed to gather information about the components of effective accessible Web-based e-learning environments for IT training and education.

Additional questions were related to social interaction elements. These were designed to collect information from the learners' perspective about successful electronic communications methods which enhanced their learning success.

The researcher identified the courses and then contacted the learners enrolled in those courses. There were no set criteria for inclusion into the sample researched except that each learner filled the profile for enrolment into the selected courses.

There was no possibility of increasing the number of participants as the TruVision and the CAVI were the only two e-learning environments available to the researcher.

The questionnaire was issued electronically to approximately one hundred learners and teachers in the CAVI environment. This included those participants who were interviewed personally where the interviews were structured using the same questions. The TruVision course was discontinued due to lack of funding and it was not possible to contact the vision impaired learners enrolled due to privacy restrictions once the project was discontinued.

For full details of the questionnaire, see Appendix E.

5.2.1 Characteristics and Needs of Adult Vision Impaired Learners

Age and Gender

There were five female and thirteen male respondents. They were aged from fifteen years to sixty five years.

Table 5.1: Gender and Age Range

Question 1 Gender	Male	Female
	13	5

Question 2 Age Range	Male	Female
--------------------------------	------	--------

15-25	4	1
26-35	4	0
36-45	2	1
46-55	0	2
56-65	4	0
over 66	0	0

5.2.2 Demographics

All respondents were from an English speaking background. Fourteen participants attended the physical classroom situated at the Association for the Blind of Western Australia (ABWA) in Perth, Western Australia and one hundred students were undertaking their studies through e-learning environments.

5.2.3 Use of Assistive Technologies

Table 5.2 summarises the response to questions relating to the use of assistive technologies. All the participants used a screen reader and a screen magnifier but the amount of usage varied. Fifteen participants reported using both technologies all the time. Two participants reported using both items for part of the time and one participant reported that he used a screen reader often but that he only used a screen magnifier when the specific task made it necessary.

5.2.4 Choice of Assistive Technologies

Table 5.2: Choice of Assistive Technologies

Questions 9 & 10	Screen Reader	Screen Magnifier
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Choice of Assistive Technologies		
	JAWS 15	ZoomText 2
	Window-Eyes 2	Zoom+ 0
	NVDA 1	Dolphin Lunar 0
	VoiceOver 3	Magic 1
	Other – please give detail 1	DesktopZoom 0
	Not stated	Other – please give details 4 Not stated
Note: Some participants selected multiple answers		

5.2.5 Assistive Technology Updates

Question eleven was designed to ascertain how frequently vision impaired users update their assistive software. The responses summarised in Table 5.3 demonstrated that this group quickly purchased the latest versions of the assistive technologies which were applicable to them.

Table 5.3: Assistive Technology Updates

Question 11: How soon do you update your screen reader/screen magnifier after a new version is released?	Number	Comments
Immediately	6	
Within 1 month	1	
Within 3 months	5	
First 6 months	1	
6-12 months	2	
1-2 years	NIL	
2-3 years	NIL	

3+ years	NIL	
Other – please give details	3	<ul style="list-style-type: none"> • when something breaks • when funding available • when operating systems update

Table 5.3 shows that 66% of respondents update within three months of the release date of a new version of assistive technology. This suggests that vision impaired users are keen to work with the most modern available format and this could be considered a characteristic of the group.

5.2.6 Technical Proficiency

All participants had basic computer technical skills and prior experience. For some courses there is a pre-skills test which ensures a minimum technological competence before enrolment is accepted.

5.2.7 Type of Vision Impairment

Vision Australia (2012) defines ten conditions as being the most common forms of visual impairment. These ten were chosen for use in question number four in order to ascertain information concerning the category of the participants' conditions. These were:

- Optic Atrophy which can be defined as damage to the optic nerve resulting in a degeneration or destruction of the optic nerve
- Nystagmus which can be defined as rapid involuntary movements of the eyes
- Macular Degeneration which can be defined as eye disease caused by degeneration of the cells of the macula lutea which results in blurred vision and can cause blindness
- Glaucoma which can be defined as a condition of increased pressure within the eyeball, causing gradual loss of sight
- Diabetic Retinopathy which can be defined as retinopathy involving damage to the small blood vessels in the retina as the results of chronically high blood glucose levels

- Cataracts which can be defined as a cloudiness or opacity in the normally transparent crystalline lens of the eye which can cause a decrease in vision and may lead to eventual blindness
- Ocular albinism which can be defined as an inherited condition in which the eyes lack melanin pigment, while the skin and hair show normal or near-normal colouration
- Oculocutaneous which can be defined as an hereditary disorder characterized by deficiency of the pigment melanin in the eyes, skin and hair
- Albinism which can be defined as the congenital absence of pigmentation in the eyes, skin and hair and
- Retinitis Pigmentosa which can be defined as a chronic hereditary eye disease characterized by gradual degeneration of the retina.

The two most common conditions were optic atrophy and retinitis pigmentosa, each of which had three respondents. Nystagmus and diabetic retinopathy each had two respondents and macular degeneration and glaucoma each had one respondent.

It is essential to understand the characteristic and needs of those with the above condition which can be used to enhance and improve their learning environment. As one example, the learner with Retinitis Pigmentosa will require:

- accessible Web design which contains principles such as page design contents starting from the top left hand side
- obvious colour contrast to accommodate varying degrees of tunnel vision
- large screen resolution and
- consistency in the physical classroom.

The questions also provided the opportunity for the respondents to detail conditions not included above.

Six of the respondents indicated that they had other conditions. Two of these reported that they had optic nerve damage due to excessive oxygen; one indicated that he had Leber's Congenital Amaurosis; one indicated that he had Retinopathy of Prematurity and one indicated that he had Microphthalmia Coloboma.

According to the report “Accessibility considerations for people with disabilities” (ISO/IEC TR 29138) people who are blind

- cannot usually access information presented only via graphics.
- cannot usually find public devices
- cannot usually see to read
- cannot usually see what is displayed on visual display units
- cannot usually determine the current function of Soft keys like Liquid Crystal Display (LCD) display and
- some cannot read Braille.

(International Organization for Standardization, 2009)

People with low vision share many problems with those who are totally blind. This group might find it difficult to:

- discriminate foreground and background differences
- separate colours
- deal with glare from the environment or a screen which is too bright
- process information if it is delivered whilst they attention is elsewhere and
- track moving and scrolling texts.

The reading of signs and labels is also problematic for those with low vision.

This is particularly so when:

- the text is too small
- the contrast with the background is too low
- the text is presented as small raised letters in the same colour as the background
- information is colour coded
- glare is present which conflicts with light sensitivity and
- there is insufficient ambient light.

(International Organization for Standardization, 2009)

Congenitally Blind

Table 5.4 summarises the vision level of the interviewed participants. There are four participants who have been blind since birth (included in the ‘no light perception’ row in Table 5.4) and the other fourteen have become blind for various reasons.

Statistics would suggest that the nine participants in the lowest row with total visual impairment or total blindness (no light perception) are among those least likely to be employed in the business sector (Australian Bureau of Statistics, 2009). The researcher noted that these nine learners were keen to complete their course successfully and as a consequence their attitude, enthusiasm and application were consistently obvious.

Table 5.4: Vision Level

Question 6 Vision Level	Level	Number
	20/70 to 20/200 - moderate visual impairment, or low vision	3
	20/200 to 20/400 - severe visual impairment, or severe low vision - legal blindness	4
	Less than 20/1,000 - near-total visual impairment, or near total blindness	2
	No Light Perception - considered total visual impairment, or total blindness	9

5.2.8 Computer and Screen Reader Proficiency

The questionnaire offered five levels of proficiency in computer and screen reader expertise. They ranged from expert to no proficiency at all. Table 5.5 summarises the participants’ levels of proficiency in computers and screen readers. All participants responded that they were in the expert, advanced or intermediate range in terms of using a computer. The majority had high skill levels in the use of screen readers and two participants indicated that they were only at the beginning stage in the use of screen reader.

Table 5.5: Computer and Screen Reader Proficiency

Questions 7 & 8: Proficiency	Computer Proficiency	Screen Reader Proficiency
Expert	5	3
Advanced	7	10
Intermediate	6	3
Beginner	0	2
None	0	0

5.2.9 Hardware and software

Questions twelve to fifteen were designed to ascertain the use of current hardware and software in order to determine the needs of vision impaired learners in both the physical and virtual classroom.

In terms of customising assistive technology the respondents ranged in their responses (See Table 5.6). This was due to the fact that customisation is a personal issue dependent on the needs of the individual.

Table 5.6: Types of Hardware Devices

Questions 13: What types of hardware devices do you use? What features do you use on these devices?	Number	Comments
Desktop	15	There were multiple choices selected.
Laptop	13	
Mobile phone	14	
Other - please give details	01	
None	NIL	

Desktop, laptop and mobile phone are the preferred hardware devices used by the group and this has implications for both the physical and virtual classroom layout.

Table 5.7: Internet Connection Type

Questions 14: What is your Internet connection type? Why?	Number	Comments
Broadband	14	There were multiple choices selected.
Naked DSL	04	
Mobile Broadband	02	
Dialup	NIL	
WIFI Hotspots	01	
Other - please give details	NIL	
None		

Table 5.7 summarises the responses for the type of Internet connection. The most used Internet connection is broadband. However, Naked DSL and WIFI hotspots are also used and these data have implications for both the physical and virtual classroom layout.

Table 5.8: Web Browser(s)

Questions 15: Which web browser(s) do you currently use with a screen reader/screen magnifier? Why?	Number	Comments
IE6	01	There were multiple choices selected.
IE7	NIL	
IE8	13	
Firefox	08	
Safari	04	
Google Chrome	NIL	

Other - please give details	NIL	
None	NIL	

The data summarised in Table 5.8 shows that the preferred browser is Internet Explorer 8 and this has implications for both the physical and virtual classroom structure as well as the accessibility of learning materials.

The responses to the above set of questions provide detailed information about the preferred software and hardware needs of the vision impaired group. When designing either a physical or a virtual classroom, and accessible learning materials it is essential that these responses be taken into account.

5.2.10 Web Use

Questions 16 to 21 were designed to establish the needs of the vision impaired group when accessing Web pages for e-learning courses. Information about navigating, searching, use of site maps, access to text only versions and the use of access keys was collected.

Table 5.9: Web Page Behaviour

Question 16: Web page behaviour	Number	Comment
Read through the home page	6	
Navigate through or listen to the links on the page	7	
Use the Search to find what I'm looking for	2	
Look for a site map or site index	NIL	
Other - please give details	3	

Tables 5.9 – 5.11 summarise the responses for questions relating to Web page navigation and searching behaviour. Researching and finding key information for the vision impaired is a major factor in successful e-learning. It is therefore important that good descriptive links are included in the Web page design so that it is easy to navigate.

The data demonstrate that accessing links is the most common behaviour of this group. When first accessing a new unfamiliar Web page, well designed links result in less browsing time and faster access to required information.

Table 5.10: Web Page behaviours

Question 17,18,20 and 21:Web page behaviour	I use Access keys	I navigate by headings	How often do I use Site map if it is available?	How often do I use Text only version if it is available?
Whenever they're available	3	8	NIL	4
Often	4	4	NIL	1
Sometimes	4	3	6	7
Seldom	3	NIL	7	3
Never	4	2	5	3

These data demonstrate that headings are an important factor in the navigation of Web pages. As well as saving time, headings separate sections of information and simplify the organisation of large amounts of factual text.

Table 5.11: Web Page Searching Behaviour

Question 19: Locating search- How do you usually try to locate the site search?	Number
Read through the page content until the search form is encountered	2
Tab through page elements until the search form is encountered	1
Find the word "Search"	4
Jump to the first text/edit field on the page	7
Jump to the first button on a page and go back one element	NIL

Jump to the first form element in a page	2
Other - please give details	2

The data in Table 5.11 demonstrate that a reasonable number of participants usually jump to the first text/edit field on the Web page. Any Web designer or developer should take this into consideration, because for vision impaired learners in particular, considerable time can be saved through the use of this element.

The learners' characteristics and needs as identified above demonstrate a clear range of individual differences. In order to meet the needs of vision impaired learners the characteristics of each must be considered and modifications and adaptations made so that learning outcomes can be successfully achieved. Learner characteristics are therefore a significant feature of a theoretical model for accessible e-learning.

5.3 Components of Effective Web-based E-learning Environments

Questions 22 to 26 covered the range of features and elements which are found on Web pages and Web-based learning environments. The responses provided information about those elements which participants preferred and those elements which participants actively disliked.

In most areas the responses did not provide any significant preference or dislike. However, two specific responses demonstrate that text description for images, tables and diagrams is highly essential and interactive multimedia content such as Flash is considered highly undesirable.

5.4 Interactions between the Components and Vision Impaired Learners

The questions in part two gathered information about the components of effective accessible Web-based e-learning environments for IT training and education. They were designed to elicit information from the learners' perspectives about what features are necessary for the design of an effective accessible IT e-learning environment.

Question twenty eight aimed to ascertain the characteristics of a successful e-learning environment. Some students had only enrolled in their first course and were only able to provide information about that one example. Other students had completed other courses from other institutions and were thus able to indicate what

they felt constituted the characteristics required for success. The respondents listed the following as priorities:

- fully accessible materials
- the provision to work at their pace
- the advantage of blind teachers
- an accessible environment
- achievable goals
- skills and knowledge for use in daily living and
- diagrams which are easy to follow and understand.

Question 29 asked respondents to detail problems they have encountered while accessing e-learning environments for IT training and education.

The responses were varied as each respondent had experienced different problems. The major problems were as follows:

- Web sites do not always follow international standards
- document formats are not consistent
- in many instances there are too many words in text description
- Web formatting is not consistent
- diagrams and graphics are too complicated
- tasks and activities are not relevant to real life situations and
- it is difficult to stay focused away from a physical classroom.

Each of the above cause major delays in learning which affect the speed which vision impaired learners absorb and process information. The first five of these points fall under the auspices of standards, guidelines and legal requirements, demonstrating that these are therefore a significant feature of a theoretical model for accessible e-learning.

Questions 30 and 31 asked participants to nominate an e-learning environment which they found totally accessible and to comment whether orientation was reliable and consistent. All participants were enrolled in a CAVI course and the data demonstrate that the majority were extremely happy with the materials presented. The following reasons were provided:

- materials were accessible
- text descriptions were appropriate
- the entire course could be completed online, including tests and examination
- lectures were recorded and available online and
- all documents, graphics and images were easy to access through screen readers.

In terms of page orientation, the majority of respondents approved the CAVI layouts.

Questions 32 to 35 asked the participants about easily accessible Web site components. They were also asked which components were difficult to access. The most common responses are listed below.

Accessible Components

These included:

- a glossary of resources
- HTML descriptions
- links and headings in curriculum materials
- consistent formatting and
- ease of downloading.

Inaccessible components

These included:

- Flash content
- texts containing too many words
- the lack of a search engine and
- a non user friendly system for contacting academic staff.

All respondents were entirely happy with the navigation systems provided in the CAVI environment.

The above data demonstrate some successful and some unsuccessful features of an accessible Web-based IT course. The information gathered was valuable in the development of an accessible curriculum for the new theoretical model.

Question 37 asked respondents about functionality of the keyboard and the responses are summarised in Table 5.12. This is important for those who are totally blind and for those with very limited vision. It is a significant issue in speed of accessibility and completing functional tasks.

Table 5.12: Keyboard Functionality

Question 37: These online learning environments make all functionality available from a keyboard?	Number
Strongly disagree	NIL
Disagree	2
Neither agree nor disagree	3
Agree	7
Strongly agree	6

The responses to questions 38 to 42 were based entirely on the content of the CAVI course. All participants stated that sufficient time was provided allowing them to complete tasks at their own pace.

All respondents stated that the CAVI Web site design was predictable and easy to follow. All but one respondent also stated that text content was readable and easy to understand.

Question 41 provided numerous responses about what assisted learners in avoiding and correcting mistakes. These included:

- an ability to re-select a wrong answer
- the use of HTML which resulted in a clear and concise curriculum
- the importance of the use of Voice over IP applications
- the usefulness of e-mail for sharing information
- the ability to review assignments before submission and
- the willingness of instructors to communicate and advise.

Question 43 asked respondents what suggestions they could offer in order to make improvements to the CAVI course content. These included:

- labelling of Flash buttons if used
- shortening text description for non text content
- upgrading to HTML5
- reducing interruptions to the lecturer when delivering in the virtual classroom and
- decreasing the number of anecdotal stories.

One suggestion was that the provision of work experience should be included in the course. This links to question 44 where it was evident from the responses that all participants had goals for the future.

Questions 45 to 48 asked participants whom they had approached for advice on learning, technical matters, accessibility issues and general matters. The responses are summarised in Tables 5.13-5.16. In every instance all participants had approached the course delivery instructors, some had consulted with other students and some had approached friends.

Table 5.13: Table of the Frequency of Consultation on Learning

Learning	Occasionally	27
	Monthly	02
	Weekly	09
	Daily	06
	None	NIL

Table 5.14: Table of the Frequency of Consultation on Technical Matters

Technical Matters	Occasionally	13
	Monthly	06

	Weekly	NIL
	Daily	NIL
	None	08

Table 5.15: Table of the Frequency of Consultation on Accessibility

Accessibility	Occasionally	16
	Monthly	NIL
	Weekly	04
	Daily	NIL
	None	11

Table 5.16: Table of the Frequency of Consultation on General Matters

General Matters	Occasionally	16
	Monthly	NIL
	Weekly	08
	Daily	NIL
	None	11

These tables show that the highest number of students ask about general learning issues, although they only do this occasionally. Students also enquire about general matters and accessibility issues although only occasionally.

The researcher believes, however, from observations over time that this group is reluctant to express a lack of knowledge because they do not want colleagues and instructors to become aware of their low degree of understanding. The students were observed to repeatedly go over the learning materials and seek out additional

explanatory sources from the Internet before approaching instructors and others for clarification of unclear concepts.

Question 49 referred to communication methods and Table 5.17 summarises the responses.

Table 5.17: The Use of Communication Methods

Question 49: How often do you use the following communication methods to contact other students and instructors?	Occasionally	Monthly	Weekly	Daily	Never
Skype	05	01	02	02	06
Ventrilo	02	01	11	01	NIL
Twitter	01	NIL	01	02	10
Facebook	NIL	NIL	NIL	01	14
MySpace	NIL	NIL	NIL	NIL	14
E-mail	04	02	04	04	NIL
Discussion Board	02	NIL	NIL	NIL	12

The data in Table 5.17 show that all students use e-mail for communication although in varying frequency. There is no student who does not use this form of communication. The researcher has observed that e-mail is generally used by most students to contact instructors out of the normal contact hours.

Ventrilo and Skype are the next most favoured forms of communication, with all students using Ventrilo and most using it weekly. Both these applications are free,

are easy to use and are therefore favoured by students. Ventrilo and Skype are also two applications which work well with assistive technology.

The final question invited the participants to state the factors in the CAVI courses they had undertaken which contributed to the following five areas.

1. What makes the virtual classroom a 'place' rather than 'space'?
2. What provided a sense of belonging?
3. What contributed to meaningful and enriching learning?
4. What positive emotions were generated?
5. What assisted the growth of direction and guidance?

Place not Space

The responses to this question were varied in terminology but many students commented that the group was like a family where members could use each other as problem solving resources. The importance of social activities was stressed and these in turn led to good group dynamics which resulted in an environment in which students found it easy to work. One student coined the phrase, "It's a lifestyle for the vision impaired" which clearly demonstrates that the 'place' had become a real and live 'space'.

Sense of Belonging

The responses demonstrated that vision impairment was a significant factor in creating a sense of belonging. Although individuals had their own specific problems and needs, the group had common problems which could be discussed and solutions sought. Many respondents stated that there was a friendly atmosphere where all had equal access to instruction and where all were working towards a common goal.

Meaningful and Enriching

The most significant response in this area was the acknowledgement of the accessibility of course materials. This was closely followed by statements concerning excellent additional resources which enriched the curriculum content by widening and expanding information on related but non-essential topics.

The flexible time line was an important factor as it allowed students to progress at their own rate and in their own time.

Tactile demonstrations as a learning method were seen as being most successful for those with vision impairment. The offering of practical solutions to assistive technology issues was also seen as a factor in stating why learning was successful and thus meaningful.

Positive Emotions

The respondents stated that being able to share experiences with others with vision impairments resulted in very positive outcomes and emotions. The quality and personality of the instructors were seen as an important factor in this area and several respondents stated that instructors really cared about the students. This was manifested by the statement that there was always an instructor available on line to consult and advise which resulted in immediate answers to problems and issues thus reducing frustration levels. The lectures were described as being “good fun” and containing a wealth of knowledge so students felt the course was worthwhile.

Direction

No respondent provided any comment in this area.

5.5 Observations

The research participants consisted of a good cross section of age, gender, educational achievement and IT experience. All had some form of visual impairment, ranging from total blindness to a moderate level of sight, however all learners were classified as legally blind.

Whilst studying the two e-learning environments specifically for vision impaired learners, detailed observations were made over a period of two years. The researcher attended classes along with the vision impaired learners and observed their actions, and listened to conversations. The researcher also questioned the teachers, technicians and learners.

5.5.1 The TruVision Environment

Each class consisted of eight vision impaired students and two teachers, providing a teacher/learner ration of 1:4. Each teacher had a very high understanding of

curriculum materials as both teachers were part of the design and development team for the TruVision course. This understanding assisted the learners to work effectively because the teachers were able to problem solve at the point of need.

One negative aspect was noted on a number of occasions. When the teachers were unable to solve technical problems and required the services of a technician, there was a considerable wait for assistance. In some cases the learners left the class in a disappointed frame of mind because the problem would not be remedied until the following scheduled lesson. This also delayed the learning process of the vision impaired students as each had a very high expectation of what they wished to achieve during each visit to the classroom.

Observations of the Learners in the Physical Learning Environment

Learners arrived at the classroom in the morning and sat at their own desk which was chosen by themselves with help from the teacher in the first lesson. The physical layout did not change once the course had started. This ensured that each learner was familiar with their physical surroundings and could move around the classroom easily and safely when necessary.

The classroom was set up in an accessible U-shape figure as described in Chapter four. This assisted the teacher in moving quickly around the classroom and providing individual help as requested by the learners.

The classroom for the TruVision class was located in the most appropriate position in the building as it was on the ground floor and easy to evacuate in case of an emergency.

The room was bright at all times as there was a high level of natural light which could be increased by electric lighting as and when required.

Observations of the Learners in the Virtual Learning Environment

Several problems faced by the vision impaired learners were evident in this environment. The most prominent difficulty was their lack of in-depth knowledge of the assistive technologies used in the learning environment. When problems arose with assistive technologies, learners were frequently unable to rectify them and

required the help of technicians. This led to delayed progress as steps needed to be repeated and there was often a long gap before the next session.

On occasions, the IT system itself failed to operate and learners could not retrieve the work they had completed and again had to wait for technical help.

A further problem was the complicated nature of the navigation system. In order to complete a task the learner was required to perform numerous steps from both the browser and their own computer. When problems arose and the task was postponed for several days, vision impaired learners had great difficulty in remembering the necessary steps and in effect began the task all over again.

Observations of the Delivery of the Course

The age of the learners in the TruVision course ranged from fourteen to sixty five years of age. This wide range in age did not facilitate interaction between the learners who had little knowledge of fellow learners before the course began. Seating was arranged for common access to specific assistive technologies, which did not take into account the social element of communication with a similarly aged learner at least on one side.

Learners were expected to work at their own pace which resulted in individuals studying different tasks at any given time. This precluded collegial discussion about common problems; interaction was not encouraged by the teachers whilst the researcher was present. Also the students progressed at different rates, so that problems they encountered at a particular point in time were not common with other learners. The students were not encouraged to ask questions of each other or assist in solving other learners' problems.

Observations of the Curriculum

There were no obvious means of evaluating the courses or the educational environment in the TruVision situation. This indicated that the designers and educationalists were not fully cognisant of the problems faced by the learners. Neither did they take into account the need to correct or enhance the learning environment nor to improve the accessibility of the learning materials.

There were very few considerations of incorporating legal requirements and standards, as the guidelines that were current at the time of development (2002) were fundamental and difficult to implement by instructional designers and developers.

Observations and Interviews with Teachers from TruVision.

The researcher observed two issues which affected the delivery of the TruVision curriculum. The first of these was that learners were not encouraged to problem solve amongst themselves, but were expected to wait until a teacher became available. In a few cases this led to considerable frustration and some students dropped out of the course.

The second issue concerned the online delivery of the curriculum. When the course entitled Certificate One in Information Technology was designed, little thought was given to providing future options for upgrading software and hardware as technology improved and developed. Feedback from teachers and learners was limited and therefore improvements to course delivery could not meet the personal needs of many learners.

In interviews with teachers, two major issues were raised. The first of these was as a result of the long timeframe between the design and development of the course and its implementation. Teaching and learning materials produced over the prior two years did not allow for the improvements which had occurred in the technological field during that time. Many instructions did not match the new software and for the vision impaired students this presented great difficulties.

A second issue was the complicated number of steps in navigation systems. Because of this many learners found it extremely hard to memorise their way through a large number of steps and often needed to return to the beginning of the task. This also resulted in some frustration.

The researcher and the teachers agreed that a lack of assistive technology knowledge was a considerable issue. This resulted in the fact that learners were often required to wait for the services of an assistive technologies technician to solve problems. The teachers stated that more knowledge on their part would reduce waiting time for such services and allow them to assist at the point of need.

5.5.2 The CAVI Environment

Over twenty five vision impaired participants attended the physical classroom situated at the Association for the Blind of Western Australia in Perth and over one hundred learners were undertaking their studies through an e-learning environment. All respondents were from an English speaking background.

Observations of the Learners in the Physical Learning Environment

Learners arrived at the classroom and randomly selected seating to suit their personal needs. Desks were arranged in rows with a space down the middle facing a whiteboard. Those students with guide dogs generally sat near the middle space which allowed them to leave with the least disruption to the class when it was necessary to attend to the needs of their dogs. Also choosing a seat near the middle space was one learner in the wheelchair. This choice allowed easy access and ensured emergency evacuation could occur if required.

The classroom was on the ground floor; it was big and spacious but relied heavily on artificial lighting. There was a range of learners with various disabilities as well as learners with no disabilities.

Observations of the Learners in the Virtual Learning Environment

Fewer problems were faced by vision impaired learners in this environment and the researcher noted that the level of knowledge in assistive technology was much higher for both learners and teachers.

It was very evident that the learners were encouraged to contact others for assistance with technological and learning problems. Because this was done online, feedback was fast and in many cases problems were solved with no waiting time.

The course is Australian based and delivered by Australian institutions according to local daylight hours. This presented a problem for learners who wished to participate in live lecture situations and group sessions whose local timeframe could differ by up to twelve hours. Whilst overseas learners could access teaching materials during their daytime they could not participate in live sessions.

Observations of the Delivery of the Course

The learners ranged in age from eighteen to fifty five years and because social contact and communications were encouraged, small groups of similar age and similar interest developed as the course progressed. A feeling of belonging was obvious and it was clear that the learners felt secure and confident.

There was always a vision impaired teacher available which led to a good understanding of possible problems and the sighted teacher provided the knowledge and skills to solve technical problems immediately. The sighted teacher was also able to ensure occupational health and safety regulations were upheld, ensuring a continued safe physical environment for the staff and learners.

The learners were able to work at their own pace and the course was accessible from anywhere in the world with an Internet connection. This also made it flexible as learners could access materials when it best suited them.

The parts required for the accessible teaching aids were easy to purchase at local hardware stores and simple to assemble. If preferred, the complete item could be purchased online.

Observations of the Curriculum

The researcher noted that the curriculum content was firmly based within the broad principles of equal opportunity and social justice. It was also evident that Section 508 of the Rehabilitative Act in ICT (1998, amended) was taken into consideration and the information provided online was comparable in access to that provided for those with no disabilities.

The guidelines published by the AVCC (2004) recommend that learners with disabilities should have equal access to all courses and teaching materials need to be made accessible to all learners with disabilities. The curriculum endeavoured to meet all the above.

At the completion of the course, all participants were asked to complete an online evaluation. The analysis of these data was taken very seriously and where improvement and enhancement were possible, changes were implemented prior to the succeeding course.

The course coordinator established a group of vision impaired consultants during the design stage of the curriculum and this group continues to meet at irregular intervals to provide further expert evaluation.

Observations and Interviews with Teachers from the CAVI.

The researcher noted that the two vision impaired teachers had already completed the course themselves so they were fully aware of possible problems and how these could be prevented or overcome. They were extremely competent in their role of course deliverers.

The role of the two sighted teachers was to facilitate administrative details such as enrolment procedures and student logons.

In interviews with the teachers the most significant issue raised was that of the necessity of developing ongoing support for job opportunities both for themselves and for the learners. They also indicated that the development of accessible courses in other disciplines was required.

5.6 Conclusion

Overall, the analysis of the findings revealed many previously unknown elements of specific problems faced by students with acute vision impairments. The analysis includes how e-learning environments need to address these problems in order for the learner to achieve the same learning outcomes as sighted students.

Links to the New Model

Legal Requirements, Standards and Guidelines

Data collected and analysed from question 29, “What problems have you encountered whilst utilizing ... online learning environments?” demonstrated that adherence to legal requirements, standards and guidelines played an important part in successful e-learning by vision impaired learners. This is particularly relevant in the design aspect of Web pages and Web sites. The respondents noted that:

- document formats were frequently inconsistent
- Web formatting was often confused
- text descriptions were too wordy and
- Web pages did not always follow international standards.

All these issues can result in delays in accessing information which in turn affect the user's ability to process and ingest the information at an acceptable speed and results in some tasks taking considerable time and effort.

Data collected and researcher observations demonstrated that the area of Legal Requirements, Standards and Guidelines is an important section for inclusion in the VIVID model.

Physical Classroom

For those with a visual impairment, the layout of the classroom is very significant in achieving success when attending lectures on campus. Following observations by the researcher and informal discussions with the learners, data collected demonstrated that there were a number of physical requirements which would ensure safety in the environment and provide ease of movement. Quick and easy access by the lecturer was also stated as a requirement as this prevented "wait" time for attention which raised frustration levels. Individual connections from the USB whiteboard were preferred as information could be transferred to individual computers where necessary adjustments could be made by the learners to suit their visual impairment.

Data collected and researcher observations demonstrated that the considerations for the Physical Classroom should be encompassed within the VIVID model.

Virtual Classroom and Delivery

It became evident from observations made by the researcher that for some learners actually attending a campus classroom presented difficulties. Data collected from informal discussions indicated that the most common problem for the visually impaired learner was the amount of time taken to find appropriate public transport which would enable arrival at the required lecture time. For this group of learners, a virtual classroom proved to be a better option. Members of this group stated that they were able to access course materials when it best suited their life style. They also stated that they were able to more easily access enrichment and enhancement materials such as recorded lectures, recommended additional reading on various Web sites and that they were able to communicate quickly with the staff at the institution through social media.

Requirements for the Virtual Classroom and Delivery of e-Learning are essential components for the new model as supported by the analyses of data from the surveys, literature and observations.

Accessible Curriculum

In an e-learning environment for those with a visual impairment, being able to access Web pages easily is an essential requirement. A number of questions sought information about Web page behaviour and navigation habits.

The data collected demonstrated that there were key elements which increased accessibility. These included appropriately designed Web pages with HTML descriptions, consistent formatting and links and headings in course materials.

The data collected also demonstrated that there were key elements which decreased accessibility. These included Flash content, wordy texts and the lack of a search engine.

Whilst other data collected demonstrated additional accessible and inaccessible elements, those above were common to all participants and are the most important.

The area of Accessible Curriculum has been shown to be essential for the design of all e-learning environments for learners with vision impairment and must therefore be included in the VIVID model.

Social Elements

The researcher observed over time that learners with visual impairment enrolled in a specific institution developed close friendships in the classroom and from informal discussions it became evident that there were social activities away from the institution on a regular basis. The participants were asked to respond to the question, “What positive emotions were generated?”

Data collected from the various answers clearly demonstrated that being able to share experiences with other learners with a visual impairment provided opportunities for problem solving, in depth informal exploration of the curriculum and companions for outings and expeditions unrelated to the course content. A number of learners stated that as a group they felt as if they were a family and they thus formed a supportive and close knit sub group of all learners enrolled in the program.

Inclusion of Social Elements will provide an opportunity to integrate social and cultural aspects into the holistic VIVID model, ensuring a more comprehensive perspective for the design of new learning environments.

Learning Outcomes

Through informal discussions and formal interviews with the participants, it became evident that all learners felt very strongly that they should achieve the same learning outcomes as their sighted colleagues. This provided them with a recognised qualification so that they could compete with all other applicants in the employment market. All the participants, however, stated that because of their visual impairment, individual progress was not as fast as that of their sighted counterparts as they required more time to complete tasks. One participant stated very clearly that tutors and lecturers, particularly those who were sighted, needed to fully understand and accept this fact and be prepared to provide time extensions for completion of assignments. The same respondent also stated that learners should inform lecturers and tutors of the learning consequences of their visual impairment so that, with mutual respect and consideration, the required outcomes could be successfully achieved.

The area of Learning Outcomes is an essential section for inclusion in the VIVID model in order to ensure the learning outcomes are appropriate for both vision impaired and able-bodied learners.

Learner Characteristics

The early research questions were designed to establish the individual needs and characteristics of the learners. The data collected demonstrated that all participants required Assistive Technologies and their market choices were closely related to the severity or otherwise of their visual impairment. In order to achieve the outcomes of the course or unit, it was essential that the preferred Assistive Technologies were able to be accessed easily during classroom sessions. In some cases, this required modification to the physical layout of the space so that equipment could be housed appropriately and was ready to hand when required.

Data collected and researcher observations demonstrated that the area of Learner Characteristics is an important section for inclusion in the VIVID model.

Evaluation, Feedback and Enhancement

Evaluation and feedback from the TruVision and CAVI courses occurred on a broad base throughout the research questions and more specific information in this area was gained through formal interviews, informal discussions with the learners and researcher observations. Key points were recorded by the researcher in the form of brief notes. All participants, whatever their age and gender, were keen to note comments made by lecturers or tutors on individual assignments and were eager to share their successes with fellow learners. This was noted on a number of occasions when the researcher was present in the classroom. Participants were forthcoming about features of the learning program which provided easy and consistent access to learning materials and equally forthcoming about features which hampered their progress. Questions 16 – 21 provided useful data in terms of evaluation and feedback and also provided good suggestions for future enhancement.

Evaluation, Feedback and Enhancement is a crucial consideration for inclusion in the VIVID model as it supports ongoing evaluation against objectives and continual adjustment and improvement.

The next chapter presents and describes a new holistic model developed specifically for e-learning environments for the vision impaired. This model was progressively developed over the term of the research based upon relevant literature, past research in this area and the data gathered from the interviews, observations and other documentation.

CHAPTER SIX

VISION IMPAIRED USING VIRTUAL IT DISCOVERY (VIVID)

6.1 Introduction

It is evident from both past research and the analysis conducted in this research that vision impaired adult learners require different features in a learning environment from sighted learners. This Chapter presents a new model for the vision impaired learner. This is a Web based IT e-learning design model entitled Vision Impaired using Virtual IT Discovery (VIVID) and it is illustrated in Figure 6.1.

The model was developed after considering;

- the relevant literature and past research in this area
- the study of the TruVision and the Cisco Academy for the Vision Impaired (CAVI), two e-learning environments and
- the analyses of the observations and interviews of both vision impaired teachers and learners.

6.2 The VIVID Model

The research gathered data from interviews and observations from sighted and vision impaired teachers and learners to identify characteristics of a range of vision disabilities and the needs associated with these.

The interview data collected and analysed within this research have demonstrated the components needed for effective Web-based learning environments for vision impaired learners.

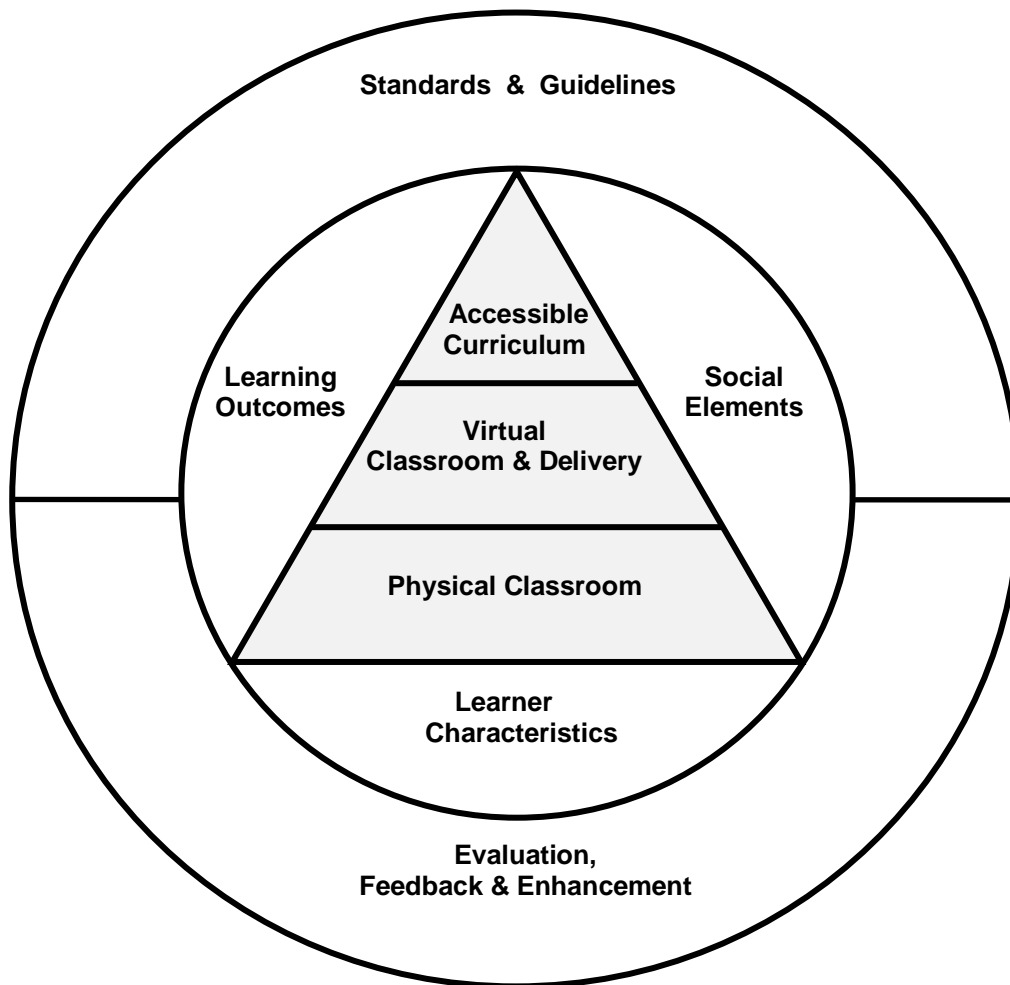


Figure 6.1: The Vision Impaired Virtual IT Discovery (VIVID) model

These components include:

- accessibility standards and guidelines
- accessible physical classroom
- accessible virtual classroom
- accessible curriculum and teaching materials
- social elements
- learning outcomes
- learner characteristics and
- evaluation, feedback and enhancement.

The components in VIVID are based upon:

- available standards and guidelines
- the needs of vision impaired learners
- a simple theoretical base
- assistive technologies and accessible teaching materials to assist vision impaired learners
- social elements which help the learners build self confidence
- better learning outcomes through interconnected components
- flexibility, as the cost and time for teaching materials can be modified and
- evaluation techniques

The details of the eight proposed components are discussed below.

6.2.1 Accessibility Standards and Guidelines

The need to embrace accessibility standards and guidelines was evident from the basic lack of accessibility of e-learning materials and environments identified in the literature, past research and the observations and interview results. The move to provide equal access by all has been growing over the recent past with many countries passing legislation for equal opportunity to address the need to rise above discrimination. International guidelines provide a standardised foundation for the building of accessible Web-based products that are available to all regardless of their level of ability.

The World Wide Web Consortium (W3C) is the main entity in providing specific specifications to support Web accessibility. The W3C released the Web Content Accessibility Guidelines (WCAG) version 2.0 in 2008 (See Appendix F).

All Australian Commonwealth, State and Territory Governments have policies that require their departments and agencies to provide at least one of a number of accessibility services including:

- captioning all television commercials and public information videos
- providing information in a suitable accessible format, or providing an alternative format on request and
- applying the WCAG 2.0 standards by 2015.

In February 2010, the Commonwealth Government committed to making all of its Web sites compliant with WCAG 2.0 by 2015 (Australian Government, 2010).

Additionally, the Web Accessibility National Transition Strategy states:

“Australian governments at all levels have endorsed WCAG 2.0, and require all government websites (federal, state and territory) to meet the new guidelines at the minimum compliance level A by the end of 2012. In addition, the Australian Government requires all federal websites to meet the medium conformance level AA by the end of 2014”. (Australian Government, 2010).

The United Kingdom Office of Communications (Ofcom) is the UK media and communications regulator, which is similar to the Australian Communications and Media Authority. Ofcom has very limited powers to regulate access to online media and notes that it has no: “specific powers to encourage broadband take-up or promote media literacy” although it does have a requirement to: “secure wide range of electronic communications services” (Access and Inclusion Statement, 2009, p 38).

Broadband has not been designated in legislation as a universal service and Ofcom, therefore, has no power to enforce access to broadband. Ofcom does, however, promote the W3C Accessibility Guidelines.

“Canadian Government Websites are covered by the Standard on Web Accessibility, replacing the relevant part of the Common Look and Feel 2.0 Standards for the Internet” (Media Access Australia, 2011c). The Canadian Government notes that:

“the Web channel is an important part of the Government of Canada's commitment to multi-channel access and service delivery. The Government of Canada is committed to ensuring that a high level of Web accessibility is applied uniformly across its Web sites” (Treasury Board of Canada Secretariat, 2011).

The Canadian Standard on Web Accessibility requires that all departmental Web sites which are available to the public must conform to Level AA of the WCAG 2.0 and the following are required:

- archived Web pages and
- video content produced exclusively for media re-use.

Material from other sources over which the Canadian Government has no control must be made as accessible as possible if published on a departmental Web page.

In Canada the transition to Level AA is to be finalised by 31 July 2013 in three phases and the standard is to be reviewed after five years, or earlier if warranted.

The New Zealand Government Web Standards (NZGWS) help ensure fair access to online government information and services. The NZGWS include WCAG guidelines recommended by W3C.

All the above countries, therefore, are applying the Web Content Accessibility Guidelines for Government Web sites but Web sites which do not conform are not penalised at this point in time. This issue will need to be addressed.

Web Content Accessibility Guidelines

The Web is fundamentally designed to work for all people, whatever their hardware, software, language, culture, location, or physical or mental ability. When the Web meets this goal, it will be accessible to people with a diverse range of hearing, movement, sight, and cognitive abilities. The use of the Web removes many communication and interaction barriers because people with disabilities are now able to access information online. This avoids the necessity of dealing with the physical demands of the outside world. However, when Web sites, Web technologies, or Web tools are badly created, they can form barriers that exclude people with disabilities from gaining the optimum benefit from the Web.

In 1997, the Web Accessibility Initiative (WAI) was introduced by the W3C to improve accessibility issues for people with disabilities. The mission of the WAI is to lead the Web to its full potential to be accessible, enabling people with disabilities to participate equally. The W3C is the leading international standards organisation for the Internet. A key part of its work is to ensure that all Internet users are able to access online material. The WAI includes the creation of the Web Content Accessibility Guidelines (WCAG) and other standards and techniques designed to make Internet content more accessible.

The WCAG 2.0 covers a wide range of recommendations for making Web content more accessible. Following these guidelines will make content accessible to a wider

range of people with disabilities, including blindness and low vision, deafness and hearing loss, learning disabilities, cognitive limitations, limited movement, speech disabilities, photosensitivity and combinations of these. In addition, following the guidelines will also make the Web content more accessible in general to users without disabilities.

WCAG 2.0 is based around four design principles which state that, in order for a Web site to be accessible, it must have content that is:

- perceivable
- operable
- understandable and
- robust.

Each guideline has testable success criteria, each of which has an associated level.

- Conformance Level A: all priority one checkpoints are satisfied.
- Conformance Level AA: all priority one and two checkpoints are satisfied.
- Conformance Level AAA: all priority one, two and three checkpoints are satisfied.

The conformance levels were discussed previously in Chapter two.

Each design principle has a number of guidelines associated with it. There are twelve guidelines in total. The needs of each design principle are based on the accessibility level of the project requirements

Details of each design principle are summarised in Tables 6.1-6.4.

1. Perceivable: information and user interface components must be presented to users in ways that they can be perceived.

Table 6.1 WCAG 2.0 Perceivable Design Principles
(Source: WCAG 2.0 at <http://www.w3.org/TR/WCAG/>)

Design principle	Details	Level
1.1 Text alternatives	Provide text alternatives for any non-text content so that it can be changed into other forms people need, such as large print, braille, speech, symbols or simpler language.	
1.1.1 Non-text Content	All non-text content that is presented to the user has a text alternative that serves the equivalent	A

	<p>purpose, except for the situations listed below.</p> <ul style="list-style-type: none"> • Controls, Input: If non-text content is a control or accepts user input, then it has a name that describes its purpose. (Refer to <i>Guideline 4.1</i> for additional requirements for controls and content that accepts user input.) • Time-Based Media: If non-text content is time-based media, then text alternatives at least provide descriptive identification of the non-text content. (Refer to <i>Guideline 1.2</i> for additional requirements for media.) • Test: If non-text content is a test or exercise that would be invalid if presented in text, then text alternatives at least provide descriptive identification of the non-text content. • Sensory: If non-text content is primarily intended to create a specific sensory experience, then text alternatives at least provide descriptive identification of the non-text content. • CAPTCHA: If the purpose of non-text content is to confirm that content is being accessed by a person rather than a computer, then text alternatives that identify and describe the purpose of the non-text content are provided, and alternative forms of CAPTCHA using output modes for different types of sensory perception are provided to accommodate different disabilities. • Decoration, Formatting, Invisible: If non-text content is pure decoration, is used only for visual formatting, or is not presented to users, then it is implemented in a way that it can be ignored by assistive technology. 	
<p>1.2 Time-based media</p>	<p>Provide alternatives for time-based media.</p>	

1.2.1 Audio-only and Video-only (Pre-recorded)	For pre-recorded audio-only and pre-recorded video-only media, the following are true, except when the audio or video is a media alternative for text and is clearly labeled as such: <ul style="list-style-type: none"> • Prerecorded Audio-only: An alternative for time-based media is provided that presents equivalent information for pre-recorded audio-only content. • Prerecorded Video-only: Either an alternative for time-based media or an audio track is provided that presents equivalent information for pre-recorded video-only content. 	A
1.2.2 Captions (Pre-recorded)	Captions are provided for all prerecorded audio content in synchronized media, except when the media is a media alternative for text and is clearly labeled as such.	A
1.2.3 Audio Description or Media Alternative (Pre-recorded)	An alternative for time-based media or audio description of the prerecorded video content is provided for synchronized media, except when the media is a media alternative for text and is clearly labeled as such.	A
1.2.4 Captions (Live)	Captions are provided for all live audio content in synchronized media.	AA
1.2.5 Audio Description (Pre-recorded)	Audio description is provided for all pre-recorded video content in synchronized media.	AA
1.2.6 Sign Language (Pre-recorded)	Sign language interpretation is provided for all pre-recorded audio content in synchronized media.	AAA
1.2.7 Extended Audio Description (Pre-recorded)	Where pauses in foreground audio are insufficient to allow audio descriptions to convey the sense of the video, extended audio description is provided for all prerecorded video content in synchronized media.	AAA
1.2.8 Media Alternative (Pre-recorded)	An alternative for time-based media is provided for all prerecorded synchronized media and for all prerecorded video-only media.	AAA
1.2.9 Audio-only (Live)	An alternative for time-based media that presents equivalent information for live audio-only content is provided.	AAA
1.3 Adaptable	Create content that can be presented in different ways (for example simpler layout) without losing information or structure.	
1.3.1 Info and Relationships	Information, structure, and relationships conveyed through presentation can be programmatically determined or are available in text.	A
1.3.2 Meaningful Sequence	When the sequence in which content is presented affects its meaning, a correct reading sequence can be programmatically determined.	A
1.3.3 Sensory Characteristics	Instructions provided for understanding and operating content do not rely solely on sensory characteristics of components such as shape, size, visual location, orientation, or sound.	A
1.4 Distinguishable	Make it easier for users to see and hear content including separating foreground from background.	

1.4.1 Use of Colour	Colour is not used as the only visual means of conveying information, indicating an action, prompting a response, or distinguishing a visual element.	A
1.4.2 Audio Control	If any audio on a Web page plays automatically for more than 3 seconds, either a mechanism is available to pause or stop the audio, or a mechanism is available to control audio volume independently from the overall system volume level.	A
1.4.3 Contrast (Minimum)	The visual presentation of text and images of text has a contrast ratio of at least 4.5:1, except for the following: <ul style="list-style-type: none"> • Large Text: Large-scale text and images of large-scale text have a contrast ratio of at least 3:1; • Incidental: Text or images of text that are part of an inactive user interface component, that are pure decoration, that are not visible to anyone, or that are part of a picture that contains significant other visual content, have no contrast requirement. • Logotypes: Text that is part of a logo or brand name has no minimum contrast requirement. 	AA
1.4.4 Resize text	Except for captions and images of text, text can be resized without assistive technology up to 200 percent without loss of content or functionality.	AA
1.4.5 Images of Text	If the technologies being used can achieve the visual presentation, text is used to convey information rather than images of text except for the following: <ul style="list-style-type: none"> • Customizable: The image of text can be visually customized to the user's requirements; • Essential: A particular presentation of text is essential to the information being conveyed. <p><i>Note:</i> Logotypes (text that is part of a logo or brand name) are considered essential.</p>	AA
1.4.6 Contrast (Enhanced):	The visual presentation of text and images of text has a contrast ratio of at least 7:1, except for the following <ul style="list-style-type: none"> • e Text: Large-scale text and images of large-scale text have a contrast ratio of at least 4.5:1; • Incidental: Text or images of text that are part of an inactive user interface component, that are pure decoration, that are not visible to anyone, or that are part of a picture that contains significant other visual content, have no contrast requirement. • Logotypes: Text that is part of a logo or brand name has no minimum contrast requirement. 	AAA

2. Operable: user interface components and navigation must be operable.

Table 6.2 WCAG 2.0 Operable Design Principles
 (Source: WCAG 2.0 at <http://www.w3.org/TR/WCAG/>)

Design principle	Details	Level
2.1 Keyboard accessible	Make all functionality available from a keyboard.	
2.1.1 Keyboard	<p>All functionality of the content is operable through a keyboard interface without requiring specific timings for individual keystrokes, except where the underlying function requires input that depends on the path of the user's movement and not just the endpoints.</p> <p><i>Note 1:</i> This exception relates to the underlying function, not the input technique. For example, if using handwriting to enter text, the input technique (handwriting) requires path-dependent input but the underlying function (text input) does not.</p> <p><i>Note 2:</i> This does not forbid and should not discourage providing mouse input or other input methods in addition to keyboard operation.</p>	A
2.1.2 No Keyboard Trap	If keyboard focus can be moved to a component of the page using a keyboard interface, then focus can be moved away from that component using only a keyboard interface, and, if it requires more than unmodified arrow or tab keys or other standard exit methods, the user is advised of the method for moving focus away.	A
2.1.3 Keyboard (No Exception)	All functionality of the content is operable through a keyboard interface without requiring specific timings for individual keystrokes.	AAA
2.2 Enough time	Provide users enough time to read and use content.	

2.2.1 Timing Adjustable	<p>For each time limit that is set by the content, at least one of the following is true:</p> <ul style="list-style-type: none"> • Turn off: The user is allowed to turn off the time limit before encountering it; or • Adjust: The user is allowed to adjust the time limit before encountering it over a wide range that is at least ten times the length of the default setting; or • Extend: The user is warned before time expires and given at least 20 seconds to extend the time limit with a simple action (for example, "press the space bar"), and the user is allowed to extend the time limit at least ten times; or • Real-time Exception: The time limit is a required part of a real-time event (for example, an auction), and no alternative to the time limit is possible; or • Essential Exception: The time limit is essential and extending it would invalidate the activity; or • 20 Hour Exception: The time limit is longer than 20 hours. <p>Note: This success criterion helps ensure that users can complete tasks without unexpected changes in content or context that are a result of a time limit. This success criterion should be considered in conjunction with Success Criterion 3.2.1, which puts limits on changes of content or context as a result of user action.</p>	A
2.2.2 Pause, Stop, Hide	<p>For moving, blinking, scrolling, or auto-updating information, all of the following are true</p> <ul style="list-style-type: none"> • Moving, blinking, scrolling: For any moving, blinking or scrolling information that (1) starts automatically, (2) lasts more than five seconds, and (3) is presented in parallel with other content, there is a mechanism for the user to pause, stop, or hide it unless the movement, blinking, or scrolling is part of an activity where it is essential; and • Auto-updating: For any auto-updating information that (1) starts automatically and (2) is presented in parallel with other content, there is a mechanism for the user to pause, stop, or hide it or to control the frequency of the update unless the auto-updating is part of an activity where it is essential. 	A
2.2.3 No Timing	Timing is not an essential part of the event or activity presented by the content, except for non-interactive synchronized media and real-time events.	AAA
2.2.4 Interruptions	Interruptions can be postponed or suppressed by the user, except interruptions involving an emergency.	AAA
2.2.5 Re-authenticating	When an authenticated session expires, the user can continue the activity without loss of data after re-authenticating.	AAA

2.3 Seizures	Do not design content in a way that is known to cause seizures.	
2.3.1 Three Flashes or Below Threshold	Web pages do not contain anything that flashes more than three times in any one second period, or the flash is below the general flash and red flash thresholds.	A
2.3.2 Three Flashes	Web pages do not contain anything that flashes more than three times in any one second period.	AAA
2.4 Navigable	Provide ways to help users navigate, find content, and determine where they are.	
2.4.1 Bypass Blocks	A mechanism is available to bypass blocks of content that are repeated on multiple Web pages.	A
2.4.2 Page Titled	Web pages have titles that describe topic or purpose.	A
2.4.3 Focus Order	If a Web page can be navigated sequentially and the navigation sequences affect meaning or operation, focusable components receive focus in an order that preserves meaning and operability.	A
2.4.4 Link Purpose (In Context)	The purpose of each link can be determined from the link text alone or from the link text together with its programmatically determined link context, except where the purpose of the link would be ambiguous to users in general.	A
2.4.5 Multiple Ways	More than one way is available to locate a Web page within a set of Web pages except where the Web Page is the result of, or a step in, a process.	AA
2.4.6 Headings and Labels	Headings and labels describe topic or purpose.	AA
2.4.7 Focus Visible	Any keyboard operable user interface has a mode of operation where the keyboard focus indicator is visible.	AA
2.4.8 Location	Information about the user's location within a set of Web pages is available.	AAA
2.4.9 Link Purpose (Link Only)	A mechanism is available to allow the purpose of each link to be identified from link text alone, except where the purpose of the link would be ambiguous to users in general.	AAA
2.4.10 Section Headings	Section headings are used to organize the content.	AAA
2.4.10 Section Headings	Section headings are used to organize the content.	AAA

3. Understandable: information and the operation of user interface must be understandable.

Table 6.3 WCAG 2.0 Understandable Design Principles
(Source: WCAG 2.0 at <http://www.w3.org/TR/WCAG/>)

Design principle	Details	Level
3.1 Readable	Make text content readable and understandable.	
3.1.1 Language of Page	The default human language of each Web page can be programmatically determined.	A
3.1.2 Language of Parts	The human language of each passage or phrase in the content can be programmatically determined except for proper names, technical	AA

	terms, words of indeterminate language, and words or phrases that have become part of the vernacular of the immediately surrounding text.	
3.1.3 Unusual Words	A mechanism is available for identifying specific definitions of words or phrases used in an unusual or restricted way, including idioms and jargon.	AAA
3.1.4 Abbreviations	A mechanism for identifying the expanded form or meaning of abbreviations is available.	AAA
3.1.5 Reading Level	When text requires reading ability more advanced than the lower secondary education level after removal of proper names and titles, supplemental content, or a version that does not require reading ability more advanced than the lower secondary education level, is available.	AAA
3.1.6 Pronunciation	A mechanism is available for identifying specific pronunciation of words where meaning of the words, in context, is ambiguous without knowing the pronunciation.	AAA
3.2 Predictable	Make Web pages appear and operate in predictable ways.	
3.2.1 On Focus	When any component receives focus, it does not initiate a change of context.	A
3.2.2 On Input	Changing the setting of any user interface component does not automatically cause a change of context unless the user has been advised of the behavior before using the component.	A
3.2.3 Consistent Navigation	Navigational mechanisms that are repeated on multiple Web pages within a set of Web pages occur in the same relative order each time they are repeated, unless a change is initiated by the user.	AA
3.2.4 Consistent Identification	Components that have the same functionality within a set of Web pages are identified consistently.	AA
3.2.5 Change on Request	Changes of context are initiated only by user request or a mechanism is available to turn off such changes.	AAA
3.3 Correct Mistake	Help users avoid and correct mistake	
3.3.1 Error Identification	If an input error is automatically detected, the item that is in error is identified and the error is described to the user in text.	A
3.3.2 Labels or Instructions	Labels or instructions are provided when content requires user input.	A
3.3.3 Error Suggestion	If an input error is automatically detected and suggestions for correction are known, then the suggestions are provided to the user, unless it would jeopardize the security or purpose of the content.	AA
3.3.4 Error Prevention (Legal, Financial, Data)	For Web pages that cause legal commitments or financial transactions for the user to occur, that modify or delete user-controllable data in data storage systems, or that submit user test responses, at least one of the following is true Reversible: Submissions are reversible. Checked: Data entered by the user is checked for input errors and the user is provided an opportunity to correct them.	AA

	Confirmed: A mechanism is available for reviewing, confirming, and correcting information before finalizing the submission.	
3.3.5 Help	Context-sensitive help is available.	AAA
3.3.6 Error Prevention (All)	For Web pages that require the user to submit information, at least one of the following is true: <ol style="list-style-type: none"> 1. Reversible: Submissions are reversible. 2. Checked: Data entered by the user is checked for input errors and the user is provided an opportunity to correct them. 3. Confirmed: A mechanism is available for reviewing, confirming, and correcting information before finalizing the submission. 	AAA

4. Robust: content must be robust enough that it can be interpreted reliably by a wide variety of user agents, including assistive technologies.

Table 6.4 WCAG 2.0 Robust Design Principles
(Source: WCAG 2.0 at <http://www.w3.org/TR/WCAG/>)

Design principle	Details	Level
4.1 Compatible	Maximize compatibility with current and future user agents, including assistive technologies.	
4.1.1 Parsing:	In content implemented using markup languages, elements have complete start and end tags, elements are nested according to their specifications, elements do not contain duplicate attributes, and any IDs are unique, except where the specifications allow these features.	A
4.1.2 Name, Role, Value	For all user interface components (including but not limited to: form elements, links and components generated by scripts), the name and role can be programmatically determined; states, properties, and values that can be set by the user can be programmatically set; and notification of changes to these items is available to user agents, including assistive technologies.	A

The standards and guidelines above are recognised by Governments and Web site agencies. A prospective Web designer and developer should refer to them if accessibility is to be achieved.

6.2.2 Accessible Physical Classroom

The analysis of the research data and the observations of the researcher over the four year period of this study confirmed that physical classroom layout plays a significant part in ensuring the accessibility and comfort of those with vision impairments. It is also important to note that changes should not be made during the course as once learners are familiar with the layout they can move easily as required and have confidence that equipment remains as demonstrated during orientation. The analysis demonstrated that the needs of an accessible physical classroom for vision impaired learners should include consideration of the physical elements shown in Figure 6.2. In the observations and interviews learners and teachers highlighted the need for appropriate furniture and room layout, plus provision of physical equipment that was necessary to access not only the learning materials and complete the learning tasks assessments but also to ensure the vision impaired learners and staff were in a safe environment. A discussion of the elements recommended follows.

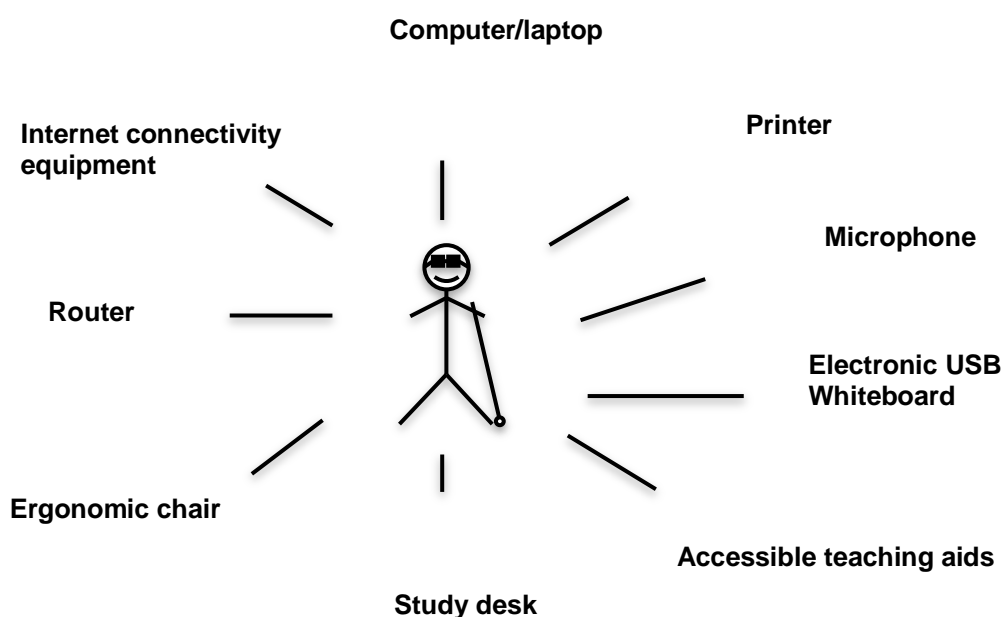


Figure 6.2: Physical Classroom Components

Computer desks need to be simple in design, providing sufficient leg room and space for bags, canes and guide dogs. Desks and drawer cabinets with sharp edges should be avoided. The desks should be grouped into a U-shape arrangement with

the middle space clear at all times for best access by the learners. The U-shape should face the classroom entrance for the most efficient entry and exit of learners and teachers (see Figure 6.3).

This setting also supports access to the machines by the AT technicians and teachers when required. With this configuration the teachers also have best access to the learners' computer screens when needed. The number of desks in the classroom for local vision impaired learners is recommended to be eight to twelve to ensure that the teacher has sufficient time to provide individual assistance.

The physical classroom setting in U-shaped also encourages interaction among the learners as the need to have eye contact does not apply to vision impaired learners. The U-shape classroom layout also minimises the risk of injury from cords and equipment.

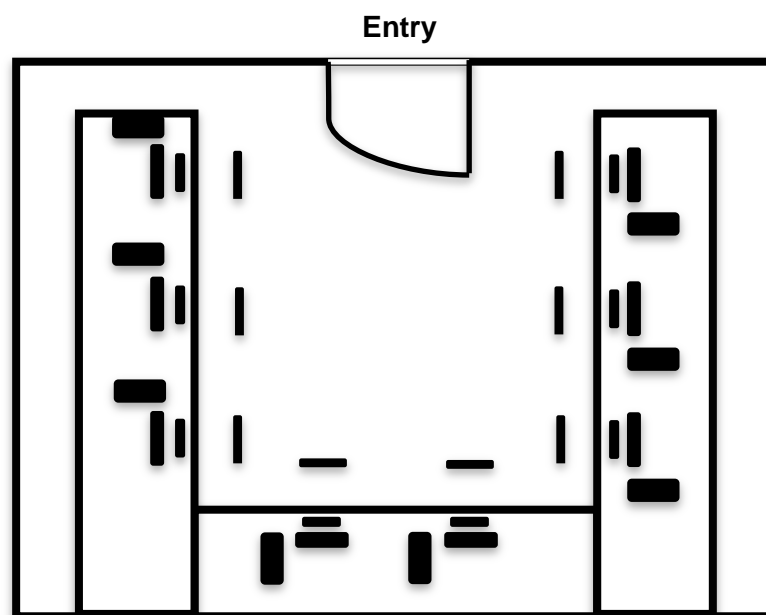


Figure 6.3: U-shaped Classroom Settings

The type of desk is also an important consideration. Many vision impaired learners bring additional materials such as mobile phones, handheld video magnifiers or microphones as part of their additional study supporting devices. A study desk that provides various adequate organisational spaces will help vision impaired learners organise their belongings. A desk that has a compartment or extra space for supporting devices helps vision impaired learners locate their items quickly and their belongings can always be stored in the same place (see Figure 6.4).



Figure 6.4: Portable Video Magnifier (Source: <http://www.visionaustralia.org.au/info.aspx?page=1240>)

Ergonomic chairs play a significant role in the physical classroom setting for the vision impaired. An ergonomic chair can promote good posture and reduce the fatigue that comes with sitting in one position for an extended period of time. A good ergonomic chair should be highly adjustable, including adjustability in the back tilt and the height of the arm rests. It should also have a padding that supports the body. A sturdy frame and good support especially in the lumbar region should also be included (see Figure 6.5).



Figure 6.5: Ergonomic Chair

(Source: <http://www.orthopedicchair.net/orthopedic-chair-office.html>)

Personal Computers (PC) and laptops for vision impaired learners should have access to standard operating systems such as Windows and UNIX plus the latest version of Flash installed and the most accessible browser. Some learners require Screen Reader or Screen Magnifier so that flash content can be accessed. Javascript, popup windows and cookies must be enabled.

Today, most computer Operating Systems (OS), mobile phones and tablets include accessibility as a built-in. This includes the opportunity to access low cost or free open-source programs, which incorporate the ability to change icon and text sizes.

To suit the needs of vision impaired learners, built in accessibility features need to contain;

- an adjustable a cursor width and blink rate
- a mouse pointer where size and movement can be altered
- a colour scheme which can be configured to high contrast
- a magnifier full-screen in Windows operating systems and
- a narrator (a built in screen reader but features for changing settings were limited).

In addition, free screen reader programs such as Non Visual Desktop Access (NVDA) can provide similar or better access than purchased commercial products like Job Access With Speech (JAWS) for Web browsing (Hollier, 2011).

The microphone for vision impaired learners should provide clear recording and be easy to use. There are many styles to be considered for vision impaired learners. The first style is a microphone and headphone set. This type of microphone is a popular choice as it has one or two features that can benefit Skype or other Voice Over Internet Protocol (VoIP) applications. It has features such as an inline volume control and an on and off switch for the microphone. The headphones are useful for private conversations, but the disadvantage is the cable from the headset could trail over the top of the keyboard. It has an USB connection for easy installation. This type of microphone can be purchased and the price can range from low to high.

Some of the high range products can also enhance gaming and multimedia with full range stereo sound. These are designed for multimedia applications such as games, music and speech recognition. Some of the features could allow users to adjust the microphone and audio characteristics like volume, treble and bass (see Figure 6.6).



Figure 6.6: Microphone and Headset

(Source: <http://www.plantronics.com/us/product/prod440044>)

Another style of microphone is the USB microphone. Some of these products can provide many features for creating recordings directly to the computer. A good quality microphone can capture anything with clarity and ease of use (see Figure 6.7).



Figure 6.7: Yeti (USB) Microphone

(Source: <http://www.bluemic.com/yeti/#/desc/>)

Printers. According to Murray (2008) vision impaired learners often have additional medical conditions. The most common condition is diabetes. This medical disorder affects the blood circulatory system in the body and leads to system failure. The loss of feeling emanating from the fingers may lead to disturbing levels of pain when trying to use assistive technologies that rely on users to interpret sensations in the fingertips caused by device pins. This problem can be a great barrier in the use of Braille.

Picture in a Flash (PIAF), a tactile graphic maker, is an assistive technology device that makes raised line drawings on special paper, called capsule or swell paper. Users can draw, print or photocopy pictures onto the swell paper and pass it through the PIAF. The heat of the PIAF machine make the lines swell and then the drawing can be read with the fingers. It claims to be an ideal machine for vision impaired and blind users. The PIAF is being used in a variety of educational institutions, corporations and is also common in personal use. According to Murray (2008) in many circumstances the PIAF can provide a satisfactory solution to show an image or basic diagram but the machine cannot produce high quality images due to the lack of resolution both of the material used (capsule paper) and the sensitivity of the fingers (see Figure 6.8).

The PIAF machine can be used to introduce shapes and basic concepts. Although not high quality, images of building layouts and area maps for orientation and mobility training can be produced by the PIAF. For employment, vision impaired staff can access the information on a computer screen, the structure of the organisation and understand business charts. This can save explanation time and clarify details, thus reducing ambiguity in interpretation.



Figure 6.8: Picture in a Flash (PIAF) Printer (Source: <http://www.humanware.com>)

The Electronic USB Whiteboard is a screen or whiteboard that works electronically without the use of ink. The board displays digital images and has the capacity to track drawings and writings in different colours (see Figure 6.9).

This type of whiteboard comes with a large interactive display that connects to a computer and a projector. A projector projects the computer's desktop onto the board's surface where users control the computer using a pen, finger, stylus, or other

device. The board is typically mounted to a wall or stands on the floor. Although learners with no vision are not able to see the projected image, this type of whiteboard is ideal for those with reduced vision who require magnification of computer screen output.



Figure 6.9: Electronic USB Whiteboard

(Source:<http://www.panasonic.com.au/Products/Electronic+whiteboards/Business+whiteboard/UB-7325/Overview>)

Accessible teaching aids for the accessible online IT environments need to be designed specifically for vision disabilities. These teaching aids will require development by teachers in conjunction with instructional designers experienced in the design of accessible materials, and will be discipline specific. Whilst many teaching aids will be appropriate for vision impaired learners in general, even though two vision impaired learners have the same impairment, they may have different needs. They may use the same device but still utilise different settings based on familiarity with the computer or their particular level of comfort. One learner may have ZoomText setting with a yellow arrow and the other may use a built in screen magnifier with reverse colour settings. The settings may differ from person to person.

To create the teaching aids, the learner's previous educational experience needs to be considered as some may have already developed effective study skills, while others may have only recently developed an understanding of their vision impairment. Some examples include the magnifier with a light or something as simple as a writing pad with black line instead of blue lines.

Teachers also need an in-depth knowledge of assistive technologies in order to aid the learners complete learning tasks. Ideally, teachers will be vision disabled themselves. According to collected data from this research, vision impaired teachers provided the maximum support with prompt response to the learners. Observations of the learners within their learning environments confirmed that vision impaired teachers solved problems related to assistive technologies in approximately half the time of sighted teachers, and produced solutions that were not considered by the sighted teachers.

Firstly it is important to employ teachers who understand vision disabilities and the barriers the learners face on a daily basis in relation to their learning achievements. Secondly, the teachers are able to solve learning problems related to their disability, because of their own experiences.

Network and Communications Equipment include all the equipment necessary for the computer network in the classroom, connection to the Internet, computer laboratory equipment and any additional equipment required to be studied in achieving the learning outcomes. This equipment needs to be situated in positions away from entry and exit access ways with cables stored in closed cabinets or casings. Easy access to equipment requiring learner access for study purposes and setting of parameters is required. Equipment that is not used constantly should be stored in cabinets and labelled in Braille. The position of each item should not change over time, so the learners have confidence that they know where to find devices, and know they have the correct device. Technical support for the equipment needs to be on hand during times of use by the vision impaired learners to ensure continuity of learning and confidence in their ability to use this equipment. Manuals for the operation of equipment should be available electronically and be accessible through the assistive technologies used.

6.2.3 Accessible Virtual Classroom

The analysis of the research data and the observations of the researcher over the four year period of this research demonstrated that the use of assistive technologies in the virtual classroom plays a very important part in the success of the learners. Ensuring that each learner has appropriate assistive technologies for their needs assists in the accessibility of curriculum materials, as do appropriate communications applications. The data clearly reinforced the fact that vision impaired teachers were highly acclaimed by the learners as they had an in depth knowledge of the problems and issues vision impaired learners face.

A virtual classroom is an essential element in a Web-based learning environment. The observations and interviews have indicated that this component is the backbone for the accessible learning situation, providing the means to present the major components of the learning not only in an accessible format but also by providing the interaction mechanisms required for solidifying the learning experience and building trust and confidence in the education process.

Virtual classroom refers to a learning environment where teachers and learners are separated by space or time or both, and the teacher provides course content through the use of course management applications, such as multimedia resources, the Internet, and video. Learners receive the contents and communicate with the teachers via the same technologies. Skills in using assistive technologies such as screen readers or screen magnifiers are a pre-requisite for vision impaired learners who require a sound working knowledge of these tools and their limitations.

Virtual classroom teachers are encouraged to use more technology in the classroom. Therefore, discussions of problems, problem solving exercises, case studies and questions assist the learner to better understand what they have learned. The virtual classroom learning is delivered at the learner's pace. Teachers in virtual classroom environments are often needed to act as guides to facilitate learning.

Communication in the virtual classroom is presented in a two-way learning experience. Learners are encouraged to interact with class members through Web conferencing technologies.

Virtual classrooms for vision impaired learners should also include consideration of the virtual elements illustrated in Figure 6.10.

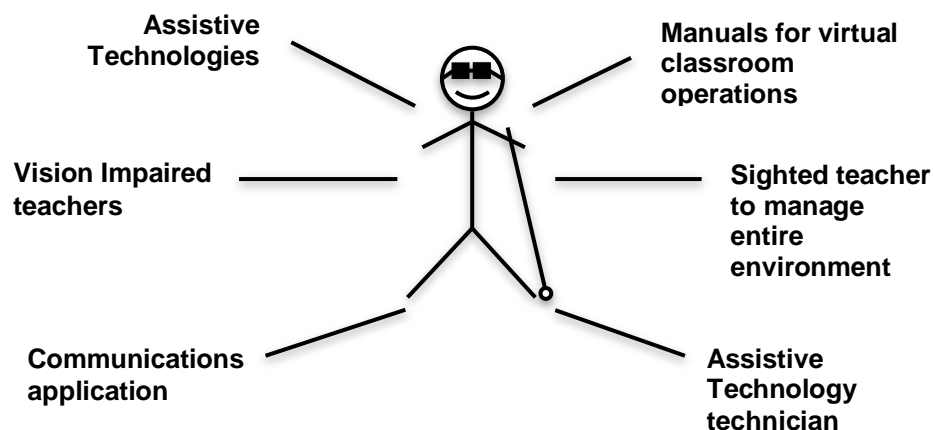


Figure 6.10: Virtual Classroom Elements

Assistive Technologies comprise accessible devices such as tools, hardware and software that enable users with a disability to perform tasks that they may find difficult to access. During the recent past, the developments in assistive technology have significantly improved opportunities for access to information and education for people with a disability. Each learner's needs are different and should be individually evaluated to ensure successful outcomes. There are many kinds of assistive technologies used by learners with a disability. These include screen magnifiers, text to speech, speech to text, Closed Circuit Televisions (CCTV), tactile graphics systems and Optical Character Recognition. In this section, two types of assistive technologies commonly employed by vision impaired students are discussed at length: screen magnifiers and screen readers.

A Screen Magnifier is a piece of computer software that can enlarge a portion of the computer screen. It allows the vision impaired user to see the screen more easily. Screen magnifiers can be useful for older people who have decreasing clearness of vision as the result of eye conditions such as cataracts, macular degeneration, glaucoma and diabetic retinopathy (Media Access Australia, 2011b).

The magnification scale in a screen magnifier refers to the maximum enlargement ratio between the magnified image and the original size. 16x magnification means

that users can enlarge the screen or its selected parts up to 16 times using the screen magnifier. While a larger magnification scale might seem to be the better option, jagged and difficult to read objects that are magnified more than 10x become blurry, making the text difficult to read.

The three most common modes of magnification are full-screen mode, lens mode and fixed window mode. Not all of the screen magnifiers in the market offer all modes. In addition, different modes are suitable for different activities such as reading, drawing and Web browsing. The use also depends on the personal preferences of the users who are vision impaired.

Full-screen mode enables the user to enlarge the entire computer screen at once. The user can move around the enlarged area by moving the cursor or using the arrow keys. In this way, the user can move round different sections of the magnified screen. Some screen magnifiers offer a small diagram in the right bottom corner of the desktop so that the user can see the actual position on the original screen.

In lens mode, the area around or near the mouse cursor is enlarged. As the user moves the mouse around the screen, the magnified area moves along with it. Some screen magnifiers allow the user to customise the size of the enlarged area and also customise distance from the cursor. Lens mode is very useful when users do not need to see most of the screen at once. The user can focus on selected objects and magnify them according to the specific needs. Some magnifiers, however, do not allow the user to change the size of the enlarged area or customize the cursor, which can make it difficult to navigate around the screen.

In fixed window mode, the user can magnify a selected part of the screen, leaving the rest of the desktop unchanged. This feature is the opposite of the lens mode and the enlarged area does not move along with the pointer. It stays in a fixed position that can usually be customized. Users can choose the area to be enlarged by moving the cursor or by using arrow keys. Fixed window mode is particularly convenient when reading a large amount of text. The user can easily focus on the selected area while seeing the layout of the screen at the same time.

Colour Inversion features allow users to invert all screen colours, not just black and white text. If the screen magnifier software does not allow the user to set the colour inversion or contrast, these options are available in the operating system.

Sometimes when screen images are magnified, the edges of text characters become jagged and difficult to read. The greater the magnification level, the more difficult the text will be to read. Screen magnifiers possess a smoothing feature that is able to reduce these problems and provide clear and easy to read text at all magnification levels.

A Transparency Alteration feature allows users to set the level of transparency for the enlarged area. With transparency, the desktop image is visible through the magnified space. In lens mode user can see the original screen under the enlarged area as they move the mouse.

Cursor Enhancement allows the user to customise the size, shape and colour of the mouse pointer. This tool can improve the visibility of the cursor and help users to navigate more easily around the screen. If the screen magnifier software does not allow users to customise the cursor, this option may be found in the operating system.

The Portability feature permits the user to easily transfer the magnifying screen software from one computer to another. This option allows the user to put the screen magnifier on the USB stick and have it with them in any location.

A Dual Monitor feature enables users to move the enlarged area across two monitors connected to a dual screen. This feature is particularly useful for professionals who are vision impaired and use multiple monitors for their work.

The Saving Settings option remembers old preferences from the last visit. The users do not have to change all the settings every time the software is accessed.

Teachers and learners need to be aware that the features offered by free and low-cost screen magnifiers may vary, so care must be taken in selecting the screen magnifier that is right for each vision impaired user.

Table 6.5 summarises the features of free and low cost screen magnification products available at the time of writing this thesis. Table 6.6 presents information on the features of the two most prominent screen magnifier products currently available.

Another common assistive technology is the Screen Reader. This type of technology is considered one of the most popular in the vision impaired community.

Screen reading software translates the written text displayed on the screen for the voice synthesizer which then reproduces the text to speech. There are a number of free and low cost screen readers and in recent years, these products have developed to a point where they are complex enough to fulfill the needs of everyday use for vision impaired users.

The most common features of screen readers include the ability to;

- change the rate, pitch, and tone of the voice synthesizer
- modify the way the voice synthesizer pronounces the word, symbols or characters
- move the mouse pointer using keyboard controls and
- read out a selected computer screen, or read out a document from start to finish.

(Vision Australia, 2009)

Earlier versions of Microsoft Windows (XP or Vista), include a very basic screen reader that will read parts of the screen out to the user. However, due to a number of limitations with this feature, it is not particularly useful for a person who is totally blind.

Table 6.5 Comparison table of the features in free and low cost screen magnifiers

Screen Magnifier	Supported platforms	Cost	Magnification scale	Full-screen mode	Lens mode	Fixed window mode	Colours inversion	Smoothing	Transparency alteration	Cursor enhancement	Portability	Dual monitor	Saving settings option
Desktop Zoom	Windows	Free	10x	Yes	Yes	Yes	Yes	Yes (only in Full-screen mode)	Yes	Yes	Yes	No	Yes
Magnifier	Windows	Free	40x	No	No	Yes	No	Yes	No	No	No	Yes	Yes
Magnifying Glass Free	Windows	Free	32x	No	Yes	Yes	Yes	No	Yes	No	No	No	No
The Magnifier	Windows	US \$49.95	40x	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Virtual Magnifying Glass	Windows, Mac OS X, Linux	Free	16x *	No	Yes	No	Yes	No	No	No	No	Yes	Yes
Windows 7 Magnifier	Windows	Free	16x	Yes	Yes	Yes	Yes	No	No	No**	No	No	No
Zoom	Mac OS X	Free	20x	Yes	No	No	Yes	Yes	N/A	No	No	No	Yes

*The software documentation claims a system magnification scale of 32x. The menu only offered 16x magnification scale.

**The cursor can be enhanced in the Control Panel of the Windows 7 operation system

***The software documentation claims a system magnification scale of 40x. The menu only offered a 20x magnification scale.

(Media Access Australia, 2011b)

Table 6.6 Comparison of the features of the most popular screen magnifiers

Screen Magnifier	Supported platforms	Cost	Magnification scale	Full-screen mode	Lens mode	Fixed window mode	Colours inversion	Smoothing	Transparency alteration	Cursor enhancement	Portability	Dual monitor	Saving settings option
ZoomText	Windows	\$395	36x	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes Vista & XP	Yes
Magic	Windows	\$395	36%	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Mac OS X 10.4 “Tiger” by Apple includes a fully featured screen reader known as VoiceOver. It provides a wide variety of requested feature enhancements. These include high speed, high quality voice, plug-and-play support for refreshable Braille displays, international language support and an interactive built-in tutorial.

Besides using a voice synthesizer, many screen readers are also designed to work with electronic or refreshable Braille displays.

According to the Screen Reader User Survey results conducted by Web Accessibility in Mind (WebAim, (2011), even the choice of screen reader is dependent on the **platform** (Microsoft Windows, Mac OS X or Linux), the **cost** and the **features**. The results from the survey indicated that 47.9% of respondents agreed that free or low cost screen reader software is a viable alternative to commercial choices. Table 6.7 summarises free and low cost screen reader products available at the time of writing this thesis. Table 6.8 compares the features of the most commonly used screen readers.

Vision Impaired and Sighted Teachers

At least one sighted teacher is needed to manage the environment due to safety reasons in the classroom. These include fire prevention, occupational health and safety, assistance with evacuation routes and procedures, awareness and removal of hazards.

The vision impaired learners and teachers interviewed have highlighted the need for vision impaired teachers who have already faced similar problems in their learning and who can provide important role models for learners. This plays an important role in providing accessible learning experiences.

Table 6.7 Comparison of free and low cost screen readers

Screen Reader	Supported platforms	Cost	Change the rate, pitch, and tone	Modify the voice synthesizer pronounces	Can move the mouse pointer	Read out selected computer screen	Read out document	Multiple Languages
WebAnywhere	Windows, Linux, Mac OS -Web activated	Free	Yes	Yes	Yes	Yes	Yes	No
VoiceOver	Mac OS	Free	Yes	Yes	Yes	Yes	Yes	Yes
NVDA	Windows	Low Cost	Yes	Yes	Yes	Yes	Yes	Yes
SAToGo	Windows-Web activated	Free	Yes	Yes	No	Yes	Yes	No
ORCA	Linux	Free	Yes	Yes	Yes	Yes	Yes	No

Table 6.8 Comparison of the most commonly used commercial screen readers

Screen Reader	Supported platforms	Cost	Change the rate, pitch, and tone	Modify the voice synthesizer pronounces	Can move the mouse pointer	Read out selected computer screen	Read out document	Licence
JAWS	Windows 2000, 2007, Vista, XP	\$1,095	Yes	Yes	Yes	Yes	Yes	Yes
WindowEyes	Windows 7, Vista, Windows Server® 2008	\$1,250	Yes	Yes	Yes	Yes	Yes	Yes

Virtual Classroom Communications

The virtual classroom requires communications software to manage the communications between multiple users and teachers during the broadcasting of lectures, tutorials and other teaching delivery. Examples of applications that can fill this role are Ventrilo, Best Virtual Classroom, Skillsoft Dialogue, Lotus Virtual Classroom and Cisco Virtual Classroom. Skype is also used extensively by vision impaired people for free communication.

VoIP in general plays a great role in virtual classroom settings. VoIP can be a benefit for reducing communication and infrastructure costs between teacher and learners. Some examples of VoIP applications can be found in Chapter 4.

Manuals for Virtual Classroom Operations

In general, one of the first tasks for a teacher in a regular learning environment or classroom is to provide a short introduction to learners and to offer a quick orientation of the room and building. This includes emergency exits and restrooms. The same should be true for virtual classrooms. While teachers may not explain where to find the nearest restroom, they can provide orientation for learners new to the virtual classroom concerning the operations that they are using. The manual needs to describe how to access features such as gaining access and logging off, course materials, how to navigate the whole learning environments, important information, demonstrate locations on the screen in the menu system and show how to access useful resources. This manual should be electronic, in an accessible format and easily available to individuals seeking information.

Assistive Technology Technician

The technician plays an important role in the learning progress as the delay or absence of operational technology can affect the speed of learning for vision impaired learners.

6.1.3 Accessible Curriculum and Teaching Materials

The analysis of the data collected from the literature, observations and interviews over the period of the research confirmed that learners with vision impairments can achieve the same outcomes as sighted students provided that course materials are

accessible. This can be achieved through good design at the initial stages of the development of Web materials for the course. It was also apparent that learners preferred the most up to date versions of software and hardware as advanced enhancements in both provide increased accessibility to course materials.

The analysis demonstrated that the needs of accessible curriculum and teaching materials for vision impaired learners should include consideration of the accessible elements illustrated in Figure 6.11.

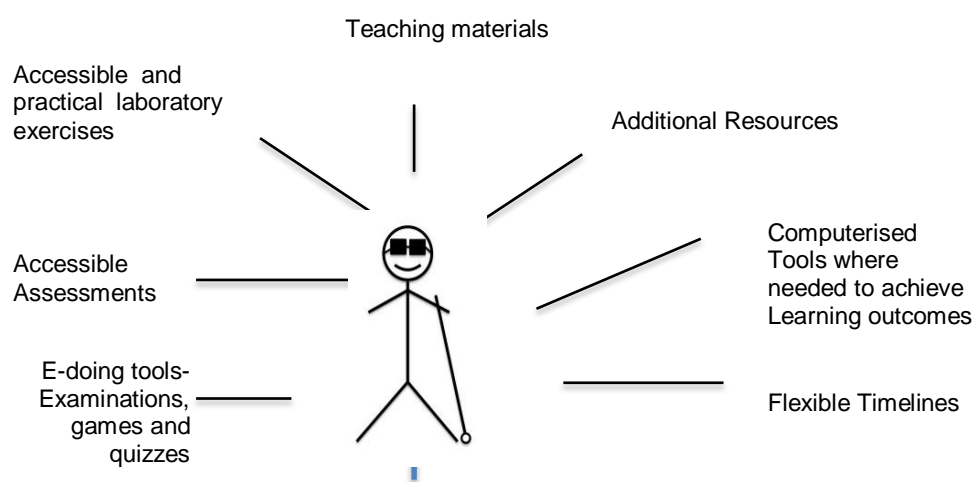


Figure 6.11: Accessible Curriculum and Teaching Materials

Teaching Materials

All teaching materials need to be presented in accessible formats. Accessible materials should have file types such as MS Word documents or accessible PDFs. In addition, all functionality must be available from the keyboard for minimum workarounds. Standard formatting of Web pages and accessible Web pages with short text descriptions applied for non-text content such as images and materials presented via interactive media, should be available.

HTML and Word text documents should use recognised formatting elements such as lists, paragraphs and headings to format content. The use of accessibility standards and guidelines can assist in the design and development of the teaching materials, and testing by vision impaired students using a range of assistive technologies is recommended for the evaluation of the teaching products.

Accessible and Practical Laboratory Exercises

The practical exercises required in an IT education environment invariably require the use of laboratory equipment. In many cases practical exercises will be able to be carried out on the learner's personal computer. All practical exercises will need to be fully accessible and available to be repeated a number of times as most vision impaired learners prefer to attempt learning activities numerous times to concrete their understanding and hone their skills in the given area. Use of the accessibility guidelines and standards is necessary in the design and development of such activities and testing of the exercises by vision impaired individuals within the learning environment configuration is recommended in order to eliminate problems arising from different platforms and assistive technology operations.

Where practical exercise equipment needs to be shared a booking system for access will provide an equitable allocation of time for learners to use the equipment. Access to any specialist equipment could be designed as a group activity so that the learners can learn from each other's understanding as they progress through the activity. The observations undertaken reinforced the vision impaired learners' tendency to work together on problems and share their knowledge. This approach can still be taken where the learners must complete assessments individually; they can work together on investigating the problems and solutions posed, but complete the writing of their assessment items alone.

Accessible Assessments

In considering forms of assessment teachers are not expected to lower standards to accommodate learners with a disability but are required to give them a reasonable opportunity to demonstrate what they have learned. Once teachers have a clear picture of how a learner's disability impacts on learning they can consider alternative assessment strategies for their vision impaired learners.

Vision impaired learners may need particular changes to assessment activities. These include changing assignment deadlines and extensions of time if the task involves extensive reading. The task can also be modified so that the vision impaired learners work on a few selected texts instead of reading an extended list of texts.

For examinations, the question papers may need to be enlarged or transcribed into Braille with tactile diagrams and maps. It may be necessary to provide heavy lined paper or special writing implements. Some learners may undertake examinations using a personal computer with assistive technologies installed. Some may need other assessment accommodations such as a reader, an oral examination or extra space may be required for equipment and specific assistive personnel such as a scribe. A separate venue is needed if the noise from equipment being used by other sighted or vision impaired learners proves to be distracting.

Some vision impaired learners will require double time for examinations so time for rest breaks will also be necessary.

E-doing tools, games and quizzes (non assessed)

Games, quizzes and electronic exercises can assist the vision impaired learners to easily determine their understanding of key learning concepts. This type of non-assessed learning activity provides confirmation to both the teacher and the learner of mastery of the curriculum items. Where such tools are employed, the teacher can change the time setting of these e-doing tools, games and quizzes for individual learners. If one learner needs extra time on a multiple choice task the time can be extended just for this individual.

Any e-doing tools, games and quizzes included in the curriculum must be specifically designed for learners with vision disabilities, ensuring all images have full textual descriptions where diagrams and images form part of the learning materials. Learners must be able to revise their answers before submission and sufficient time must be allowed for completion. In addition, sufficient time to absorb new materials and complete learning tasks is also required. The environment should permit sufficient time for the learners to investigate and understand the role of e-doing tools, games and quizzes in the learning process. Flexibility in timelines is a vital element for successful learning for the vision impaired.

Additional Resources

Additional resources may be needed to help learners access extra support. Teachers may need to develop additional teaching aids for learners with a particular learning need or learners may have customised assistive technologies that require an adjustment of teaching methods or a different format of learning materials.

Flexible timelines

Flexible timelines may be arranged for vision impaired learners to study either independently or as part of the group. This enables learners to manage their learning to fit in with their own schedules and responsibilities.

6.1.4 Learning Outcomes

Module learning outcomes are directly linked to the learning outcomes for the associated course and ultimately to the learning outcomes for the entire program within which the module sits. The module learning outcomes become the focus for individual classes and clearly state what the learners will be able to achieve at the end of each class.

Learning outcomes are focused on the learner rather than the teacher or learning environment. Learners must demonstrate they have achieved each learning outcome, and some form of assessment will measure achievement of tasks linked to the learning outcomes. The stated learning outcomes therefore, should reflect the core competencies that the learner must master for the qualification standard.

The learning outcomes are also dependent upon the institution's own guidelines. University degree program learning outcomes will be based upon national regulations and undergraduates in Bachelor degrees in Australia are required to exercise critical thinking and judgement in identifying and solving problems with intellectual independence at the program level (AQF, 2011). The learning outcomes for vision impaired learners should be the same as those for sighted learners to ensure an equal level of skills development and knowledge is obtained (see Figure 6.12).

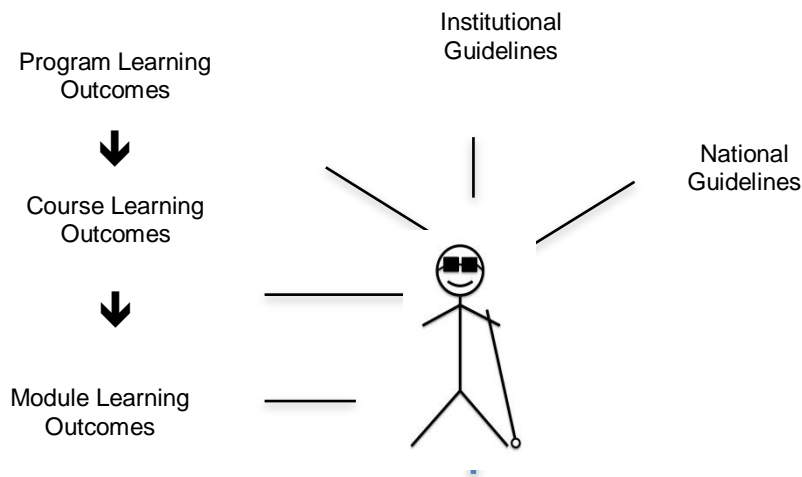


Figure 6.12: Learning Outcomes

6.1.5 Learner Characteristics

Building self-confidence is an important part of the learning process and the employment of qualified vision impaired teachers provides encouragement for success. The environment must ensure the learners feel part of a learning community and are able to share learning experiences, sources of information, inspiration and knowledge relating to the curriculum topics.

In order to achieve accessible individual learning experience, it is necessary to consider the individual's specific needs, background, geographic and cultural factors.

The learner's skills and abilities in the use of computers and assistive technologies are important characteristics to consider. Unless the learner displays confidence in these areas and has appropriate supportive technologies success may be jeopardised. Learners with minimal experience in IT may be required to complete a skills update before enrolling in a specific program.

The vision level and type of vision impairment are also significant learner characteristics as they impact upon the modifications which may need to be made to course materials. Added to these considerations, it is also necessary to consider the location in which the learner is studying. Access to fast Internet is a definite requirement for most courses and if this is not available the vision impaired learner may be disadvantaged.

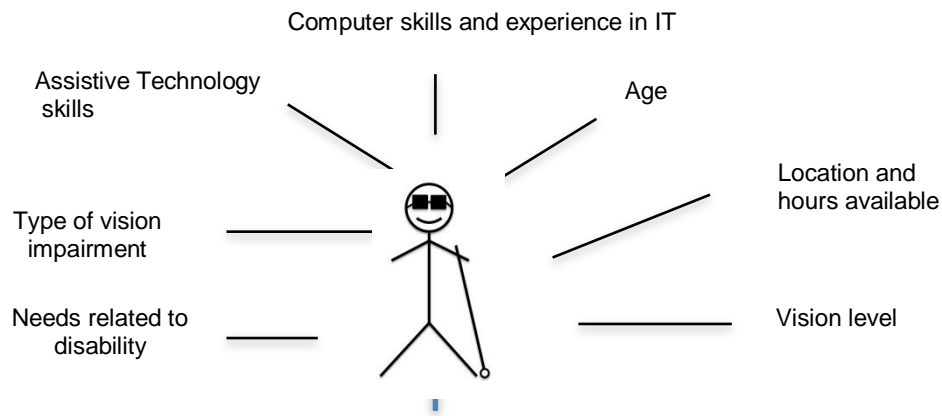


Figure 6.13: Learner Characteristic

The analysis showed that knowledge of the characteristics and specific needs of learners were found to be essential when developing an e-learning environment. Whilst individuals have specialised needs, it was possible to deduce several broad principles which are applicable to vision impaired learners and which can be used as general guidelines when designing and developing e-learning environments. Figure 6.13 illustrates the learner characteristics which must be considered.

Many vision impaired learners new to study may not have sufficient skills in the use of assistive technologies employed to assist their learning endeavours. A set proficiency level for AT skills is recommended in order to enrol in IT studies. Training in AT is commonly provided by disability supporting organisations and government bodies, frequently at no cost to the learner if they have a registered vision disability. Depending on the level of IT studies being undertaken, it may also be necessary to set a minimum proficiency level for computing skills. A bridging course may be required in order to bring the learner up to the required entry level. If minimum levels are not set then there is a risk that vision impaired learners will lag behind as they spend time developing basic competencies that should be pre-requisite to their enrolled course.

Age can be an important consideration when designing and delivering accessible programs. Many learners aged from approximately forty and upward have learned and used Braille, as this was the predominant tool for translating text into an accessible medium for those who are blind. The observations and interviews have shown that younger vision impaired learners have not learned Braille as screen reading applications on computers have provided the needed accessibility at primary

and secondary education levels. It was also noticed that older learners do not absorb new concepts as quickly as the younger vision impaired learners, particularly if they have been away from study for an extended period.

Location and hours available will affect the learner's ability to attend classes, either physically or virtually. Having recordings of lectures and tutorials available for learners to access at any time is advisable and provides a resource that can be accessed for review in preparation for assessments.

The learner's level of vision, type of vision impairment and their needs in relation to their disability will guide the teachers in their delivery of teaching materials and use of teaching aids. These will also dictate the type of assistive technologies used by the learners. Knowing details of the vision disability allows the teachers to more fully comprehend the problems that could be faced by the learners and enables them to devise solutions beforehand.

The analysis of the data and the observations in the research generated an acknowledgement and understanding of the importance of social elements for the vision impaired learner. The inclusion of this area in a holistic theoretical model for the design and development of e-learning environments is a significant addition to previous theoretical models and therefore increases the scope and depth of the design and development base.

The term social elements in this research refers to the ways in which information can assist the learners to communicate, understand, feel part of the group, build respect and share their knowledge. These activities result in the building of self confidence in themselves and their ability and this plays a significant part in successful learning.

6.1.6 Social Elements

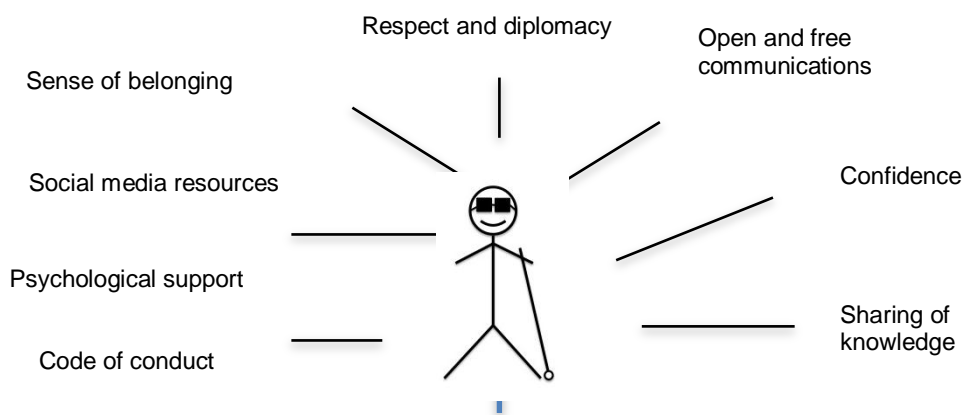


Figure 6.14: Social Elements

Being able to communicate with teachers and other learners in a real-time and online environment via a virtual classroom is essential. Applications such as Ventrilo provide a virtual classroom environment where teachers can broadcast lectures, take questions during the broadcast, and encourage student participation and discussion. In addition to classroom communications, the vision impaired learners need to be able to communicate with their tutor and other learners on a one-to-one or group basis using free communication methods such as e-mail, Skype and social networking sites such as Facebook and MySpace.

A sense of belonging is the feeling of being connected and accepted within a group, family and community. It is important for healthy human development. A sense of belonging can include feeling recognised, secure and able to participate comfortably in a group. Many vision impaired individuals spend much of their lives in physical isolation, and the nature of their disability means that they also lack the interaction sighted people have with their environment. Feeling as if they belong to the group is important for their self identity and confidence.

The sharing of knowledge is an activity through which information, skills, or expertise is exchanged among people or members of a group or community. It provides an avenue for problem solving through discussion and the exchange of experiences. The observations indicated that vision impaired learners are willing to share their knowledge in a quest to assist other vision impaired fellow learners. By giving assistance to others, they become confident in requesting assistance from

others at another time. It was also noted that once learners had successfully completed an individual assessment or exercise they would join together as a small group and assist those who were having difficulty in order to keep the group progressing at a similar pace. In many circumstances the entire class would rally around a learner with a more serious disability to explain concepts and demonstrate activities instead of individually moving forward to the next learning module. This occurred not only in the physical classroom but also with those learners who were located in other parts of the world.

Respect and diplomacy must be encouraged and supported. This contributes to the building of trust and ensures all learners are treated with deference and feel valued. Vision impaired learners may need to be encouraged to attempt new tasks they have not faced before. During the interviews it was noticeable that the vision impaired learners liked to take on new challenges provided they had sufficient support. Encouragement from colleagues provided an impetus to start new tasks. It was observed that confidence levels increased as learners successfully completed even small tasks at the beginning of their learning. Psychological support to assist the learners cope with their disability and the problems they face as they attempt to complete the course is essential. All learners, both able bodied and disabled, face problems during their normal lives and these problems can affect their ability to complete the course. Financial problems, other medical challenges and personal relations were factors that concerned many vision impaired learners.

Each member of the course should have access to open and free personal communications. This is essential for instant communication when and if problems or issues arise which require immediate attention. As the learners become more accepted by the group a bond of trust develops. Provided others have open communications with the newer learners, this is usually reciprocated.

For the course to be effective it should provide a safe and happy learning environment which meets the needs of learners at all levels. A Code of Conduct Policy for learners and teachers is advisable to regulate the learning environment and it should include:

- Rights and responsibilities of all staff
- Learners' and carers' rights and responsibilities

- Venue rules
- Expected learner and teacher behaviour
- Guidelines for dealing with unacceptable behaviour and
- The suspension and expulsion process.

Vision impaired learners are generally not able to ascertain clues from the environment which are easily recognised by their sighted peers. A Code of Conduct Policy which can be made available and accessible through the use of assistive technologies assists this group of learners in becoming aware of the rights and responsibilities expected of them thus providing guidelines for social interactions.

According to Kaplan and Haenlein (2010) the term “Social Media” refers to the use of Web-based and mobile technologies to shape communication into an interactive conversation. It allows the creation and exchange of user generated content. Social Media have changed the landscape of communication between individuals, organisations, and communities. Social Media have provided the benefits of social networking to people with disabilities and they rely on it heavily for personal and official communications. Social media are an increasingly important part of modern life and they support the human need for social interaction. The use of social media should be encouraged for the vision impaired learner group; not only does it provide a means of free communication, but it also assists in generating a sense of belonging and identity for each learner. It is up to the teachers, however, to use these tools to best advantage and also ensure the learners are cognisant of the risks and security features of the social media applications used.

6.1.7 Evaluate, Feedback and Enhancement

In order to maintain an appropriate and accessible online learning environment for the vision impaired, there is a need to ensure that the objectives of the environment continue to be met. This requires activities to evaluate how well the environment is operating in relation to the objectives, providing feedback on all sections of the environment and applying changes and enhancements to ensure the needs and objectives continue to be achieved.

The evaluation process should be carried out on all components of the learning environment: physical classroom, virtual classroom and delivery, accessible

curriculum, learning outcomes, social elements, learner characteristics and standards and guidelines. The following areas are suggested for inclusion in the evaluation. However, each environment will be different and the overall objectives must drive this evaluation.

1. Physical Classroom:

A. Classroom Layout

- (a) How well does the layout of the physical classroom meet the needs of the visually disabled students?
- (b) What aspects of the physical layout work well?
- (c) What aspects of the physical layout do not work well and what problems do they present?
- (d) How could the physical classroom be changed to more effectively meet the needs and objectives?

B. Physical Equipment

- (a) How well does the physical equipment meet the needs of the visually disabled students?
- (b) What aspects of the physical equipment work well?
- (c) What aspects of the physical equipment do not work well and what problems do they present?
- (d) How could the physical equipment be improved to better meet the needs and objectives?

C. Physical Work Space

- (a) How well does the physical workspace meet the needs of the visually disabled students?
- (b) What aspects of the physical workspace work well?
- (c) What aspects of the physical workspace do not work well and what problems do they present?
- (d) How could the physical workspace be changed to more effectively meet the needs and objectives?

2. Virtual Classroom and Delivery:

A. Teaching and Support staff

- (a) How well do the teaching and support staff meet the needs of the visually disabled students?
- (b) What aspects of the teaching and support staff work well?
- (c) What aspects of the teaching and support staff do not work well and what problems do they present?
- (d) How could the teaching and support staff act more effectively to meet the needs and objectives?

B. Software Components

- (a) How well do the software components meet the needs of the visually disabled students?
- (b) What aspects of the software components work well?
- (c) What aspects of the software components do not work well and what problems do they present?
- (d) How could the software components be improved to better meet the needs and objectives?

C. Assistive Technologies

- (a) How well do the assistive technologies meet the needs of the visually disabled students?
- (b) What aspects (or features) of the assistive technologies work well?
- (c) What aspects of the assistive technologies do not work well and what problems do they present?
- (d) How could the assistive technologies be improved to better meet the needs and objectives?

3. Accessible Curriculum:

A. Teaching Materials

- (a) How well do the teaching materials meet the needs of the visually disabled students?
- (b) What aspects of the teaching materials work well?

- (c) What aspects of the teaching materials do not work well and what problems do they present?
- (d) How could the teaching materials be improved to more effectively to meet the needs and objectives?

B. Practical Exercises

- (a) How well do practical exercises meet the needs of the visually disabled students?
- (b) What aspects of the practical exercises work well?
- (c) What aspects of the practical exercises do not work well and what problems do they present?
- (d) How could the practical exercises be improved to more effectively meet the needs and objectives?

C. Assessment

- (a) How well does the structure and quality of assessments meet the needs of the visually disabled students?
- (b) What aspects of the assessments work well?
- (c) What aspects of the assessments do not work well and what problems do they present?
- (d) How could the quality of assessments be improved to more effectively meet the needs and objectives?

D. Tools and Administration

- (a) How well do the tools and administration processes meet the needs of the visually disabled students?
- (b) What aspects of the tools and administration processes work well?
- (c) What aspects of the tools and administration processes do not work well and what problems do they present?
- (d) How could the tools and administration processes be improved to more effectively meet the needs and objectives?

4. Learning Outcomes:

Learning Outcomes are pre-set by the curriculum. The evaluation of this element of the model should determine how well those Learning Outcomes are being met and how the achievement of these should be improved.

A. Learning outcomes

- (a) How well do the learning outcomes meet the needs of the visually disabled students?
- (b) What aspects of the learning outcomes work well?
- (c) What aspects of the learning outcomes do not work well and what problems do they present?
- (d) How could the learning outcomes be improved to more effectively meet the needs and objectives?

B. Social Media tools

- (a) Which social media tools are used to communicate with other learners?
- (b) What aspects of these social media tools work well?
- (c) What aspects of these social media tools do not work well and what problems do they present?
- (d) How could the social media tools be improved to more effectively meet the needs and objectives?

The perspectives of both teachers and learners are important if both groups are to continue to work together harmoniously and profitably.

6.2 Learning Styles of the Vision Impaired

Research in the area of learning styles for vision impaired learners is still in its infancy when compared to the learning cycle for sighted learners.

It is generally recognised that there are three ways in which learning occurs. They are:

- by using a visual approach
- by using an auditory approach and
- through using a tactile approach, or kinesthetically.

Blind and vision impaired learners predominantly use the auditory and kinesthetic approaches. This group also relies on all of their previous experiences to make a connection with new materials. Teachers cannot assume that the vision impaired learner can relate to anything connected to space as their condition precludes past experience in the spatial logic area. The teachers need to provide verbal details and hands on activities to make learning meaningful and possible.

The term “less is more” should be applied when using a representation of a picture or drawing. Vision impaired learners become confused when presented with too much information and are unable to determine just exactly what they are required to “see”. It is therefore essential that the teaching and learning materials contain only the main information and that it be clearly and concisely described.

Tactile materials must be designed from the outside to the inside as this will assist in providing a more complete picture for the vision impaired learners. Initially, the vision impaired learners may need some physical assistance, but with practice vision impaired learners can become independent and competent using tactual graphics.

6.3 Conclusion

The VIVID model presents an approach to the design and delivery of an accessible e-learning environment for vision impaired learners enrolled in IT education courses. Its holistic nature includes components that reach across the social and technological boundaries and it includes psychological considerations that support learners with an acute disability. This model is not presented as a complete solution, but as a resource to provide guidance to those involved in providing effective learning environments for non-mainstream students who have vision disabilities. The model is based upon findings from the researcher’s immersion in two e-learning environments designed specifically for the vision impaired over a four year period. The researcher attended nearly all classes over the period of study, and built up profiles of each learner as they progressed through their courses. Attendance at physical classes as well as virtual classes and observing the learners as they worked constantly over this time provided a wealth of information that would not have emerged if limited time had been spent in the data gathering.

The next Chapter discusses how the model was evaluated by experts in the field of education for the vision impaired.

CHAPTER SEVEN

THE EVALUATION OF THE VIVID

7.1 Introduction

Evaluation of the model took the form of eight experts in the field evaluating how well the problems and issues identified in the initial definition of the problem space had been met and where improvements in the model could be made. The evaluation is discussed in more detail in this chapter.

7.2 Profile of the Experts

There were eight experts who were appropriate to be contacted and were willing to participate. All these experts had more than five years' experience in the design, development and delivery of e-learning for people with disabilities.

Below are details of the selected experts.

A male, with more than fifteen years' experience in the design, development and delivery of e-learning for the disabled with special focus on the vision impaired. He has a Doctorate of Philosophy Degree.

A female, with more than fifteen years' experience in teaching and delivering advanced IT courses for a variety of disabilities including vision impairments. Her Doctorate of Philosophy Degree is in the field of Information Systems.

A second male, an instructional designer specialising in computer science-learning and accessibility for all types of disabilities. His Doctorate of Philosophy Degree is in the field of Information Systems.

A second female, who specialises in assistive technologies through her work as an instructor and manager of a virtual classroom.

A third male, who is totally blind, with more than twenty years'

experience in assistive technologies with a Masters Degrees in Information Systems and Psychology.

A fourth male, who is vision impaired and who specialises in Internet usage and people with disabilities. His Doctorate of Philosophy Degree is in the field of Internet Studies. He has more than ten years' experience in the area.

A third female, who is legally blind and specialises in education for people with disabilities, particularly those with vision impairment. She has more than ten years' experience in an organisation which has direct contact with people who are legally blind.

A fourth female, who specialises in Computer Engineering and has spent the past five years working in a supporting role in an e-learning environment and laboratory for vision impaired learners.

All of the participants are still active in the area. Some are involved in research, some are participating in accessible media presentation, some are promoting the use of the Internet and some are creating accessible e-learning for the vision impaired.

All eight participants were provided with a description of the new model and completed a questionnaire giving feedback on its characteristics, strengths and weaknesses.

7.3 Evaluation Survey

The survey comprised ten questions and appears in Table 7.1. The first seven questions requested the experts to rank statements made about the model. The rating scale consisted of a Likert scale: Strongly Agree, Agree, Neutral, Disagree and Strongly Disagree. The remaining three questions related to the strengths and weaknesses of the model and how it could be improved, together with an opportunity to make additional open comments.

Table 7.1 Evaluation Survey for Experts

Number	Question as a Statement
1	The model incorporates ample considerations of the specific design of IT education courses for vision impaired learners
2	The model incorporates ample considerations of the vision impaired so they can achieve the same learning outcomes as sighted learners

3	The model incorporates ample considerations of assistive technologies used by vision impaired learners
4	The model incorporates ample considerations of social aspects for vision impaired learners
5	The model incorporates ample considerations of the individual characteristics of vision impaired learners
6	The model incorporates ample considerations of the physical teaching and learning environment for vision impaired learners
7	The model incorporates ample considerations of the limitations resulting from vision disabilities
8	Please comment on the strengths of the model
9	Please comment on the weaknesses of the model
10	Please make any other comments you think may be useful for this research

7.4 Experts responses to Questions one to ten

Questions one to ten were designed to collect feedback and comments on the VIVID model. Questions one to seven were designed to ascertain the responses from the eight experts using the criteria “totally agree” to “totally disagree”. The responses from the experts indicated that the model is highly acceptable and incorporates considerations of:

- the specific design of IT education courses for vision impaired learners
- the achievements of the same learning outcomes as sighted learners
- assistive technologies used by vision impaired learners
- social aspects for vision impaired learners
- the individual characteristics of vision impaired learners
- the physical teaching and learning environment for vision impaired learners and
- the limitations resulting from vision disabilities.

These are summarised in Table 7.2, demonstrating that overall the experts were satisfied with the VIDID model.

Table 7.2: Responses from Questions 1 to 7

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Question 1: The model incorporates ample considerations of the specific design of IT education courses for vision impaired learners.	2	6	-	-	-
Question 2: The model incorporates ample considerations of the vision impaired so they can achieve the same learning outcomes as sighted learners.	2	6	-	-	-
Question 3: The model incorporates ample considerations of assistive technologies used by vision impaired learners.	1	7	-	-	-
Question 4: The model incorporates ample considerations of social aspects for vision impaired learners.	4	4	-	-	-
Question 5: The model incorporates ample considerations of the individual characteristics of vision impaired learners.	3	4	1	-	-
Question 6: The model incorporates ample considerations of the physical teaching and learning environment for vision impaired learners.	5	3	-	-	-
Question 7: The model incorporates ample considerations of the limitations resulting from vision disabilities.	7	1	-	-	-

Questions eight to ten were designed to ascertain the responses from the eight experts using open-ended criteria. The responses from the experts are as follows:

Question 8: Please comment on the strengths of the model.

- The incorporation of ‘Learning Outcomes’, ‘Social Elements’, and ‘Learner Characteristics’ wrapped around the central and core teaching and learning mechanics that is contained within the ‘Standards & Guidelines’ and ‘Evaluation, Feedback & Enhancement’ framework appears to provide a simple solution to a complex problem.
- Although the engagements or relationships between the various model elements are not explicit there is a very clear implication that unless adopted holistically limitations would necessarily diminish the efficacy of the model’s intended purpose.
- Personally, that this model captures the absolute essence and delivers a seemingly obvious solution is an indication of the creator’s deep understanding of the subject, something many strive for but do not achieve.
- The holistic approach is a breath of fresh air; most concentrate only on the technical aspects of accessible online material.
- The model is broad but comprehensive. It includes considerations not evident in other e-learning and accessibility models. As a model specifically for the vision impaired, it addresses factors that consider the individual needs of the learner based upon their disability, current knowledge and expertise.
- The inclusion of social factors is a very important aspect of the model.
- A sense of belonging and confidence aids the learning experience of learners with physical disabilities.
- The virtual classroom aspects are very important to an effective e-learning environment. Vision impaired learners must have a place where they can electronically communicate with lecturers and other learners as if they were in a physical classroom together.
- The model appears to have a holistic approach to the learning needs of students with vision impairments.

- It appears to be well rounded and covers more than just the technical accessibility issues, unlike most other models that concentrate only on a single accessibility issue.
- The eight components of the model cover a lot of aspects related to the design of a Web-based IT e-learning model for vision impaired learners.
- The model successfully integrates an accessible curriculum with accessible teaching practice and the provision of assistive technology. This combination contributes to an effective learning environment and hence the model appears to be sound.

Question 9: Please comment on the weaknesses of the model.

- It is not clear how all the components fit together. How does one factor affect each of the other factors? Is it cyclical, and if so, how does the cycle move? Whilst the breadth of factors is good, there needs to be more explanation of how it could be implemented in the real world.
- It may be a little unclear as to how this model could be implemented.
- What procedures need to be put in place?
- I see no weakness in this model.
- Some of the components are social based, how are they going to be measured and how accurate will these measurements be?
- While it is addressed in the model, further information would be of interest regarding how students interact with each other in the virtual space. This appears to be well addressed in the student-teacher relationship but I am interested to learn more about how other educational aspects such as social media are integrated.
- I can however envisage one seeking deep specific clarifications when the model is intended to be viewed as a holistic high level model. If one is encouraged by this model to delve deeper it should be seen as a strength rather than a weakness.
- I am not certain of the use of assistive technology from studying the model.
- Do all students have access to adaptive technologies?

Question 10: Please make any other comments which you think may be useful for this research.

- I particularly like the emphasis on social interaction. In my experience the peer support offered by other students with similar access issues and difficulties is the key to a course being successful.
- The model will be extremely useful for educators looking to create a learning space for people with a vision impairment.
- Did you in your thesis include information on the psychological impact of blindness? I think this effects the way the blind might well interact with an e-learning environment. I am impressed that you thought of the congenital versus acquired blindness. Very few researchers discuss this because quite frankly I think they are afraid of the outcomes or results if they address this issue. Learning is a significant challenge for the totally blind and for the aged blind.
- How and when to complement the model?
- Perhaps it would be helpful to include some discussion on how universally accessible the model is. These days the push is for universal accessibility – one accessible model fits all disabilities. Discussion on the sections of the model that are specifically designed for the vision impaired needs to be included and justification as to why these are necessary. A separate section should talk about the universally accessible parts of the model.
- I understand that this model is intended for the vision impaired but because the selection of components and the manner of their interrelated engagements are modelled, I believe this model addresses achieving learning outcomes for all, not just those with some perceived disadvantage.
- Model might be employed to address achieving learning outcomes in remote and deprived environments such as Central Africa. The incorporation of ‘Social Elements’ permits inclusion of the underprivileged, or the cyber bullied as readily as the vision impaired. Likewise, ‘Learner Characteristics’ permits the inclusion of psychological, behavioural, and other attributes. This seemingly simple model appears capable of meeting desired teaching and learning outcomes no matter how diverse they may be.

- The research looks good and I think is a valid research topic; anything that enhances learning opportunities and considers the adjustments required for learners with vision loss is valuable.

Discussion of Responses

Overall the responses to the model were positive from all but one of the experts participating in the review with all ratings to questions one to seven being either Strongly Agree or Agree. Particular strength was seen in the model's considerations of the needs of learners relating to vision disabilities with seven of the eight experts rating it very high. Considerations for the physical aspects were also rated highly as were the inclusion of social aspects and the importance of encouraging social interaction. Particular strengths of the model noted by the experts focussed on the social considerations included in the model, particularly in comparison with other research that concentrated on technical aspects. The holistic nature of the model and accessibility via the virtual classroom were also considered strengths.

Concerns highlighted by the experts related to implementation of the model and the procedures that need to be in place to support this. Provision of psychological support for the learners in relation to their disability was proposed as being an important consideration. The comment about universal accessibility of the model was highly pertinent. However, this was not the aim of the research, and this area has great potential for future research. Although the model in its current form can be used to guide the design and delivery of accessible learning for any disability, the specific purpose of the research was to meet the needs of vision impaired learners. The scope of universal accessibility is huge and would require substantial further study.

The emphasis in these responses indicates the need for modification of the VIVID model in the following areas:

- implementation of the VIVID model
- expandability to other disabilities
- information on the psychological impact of blindness
- measurements of characteristic and social based components and
- a need to consider institutional factors.

These evaluations were valuable to the research and additions and modifications to the model were developed. The next section will present the revised version of the VIVID model after careful considerations of the feedback and comments.

7.5 Revised VIVID Model

After the evaluation process, the comments and suggestions from the reviewers were incorporated into a revised version of the VIVID model (see Figure 7.1)

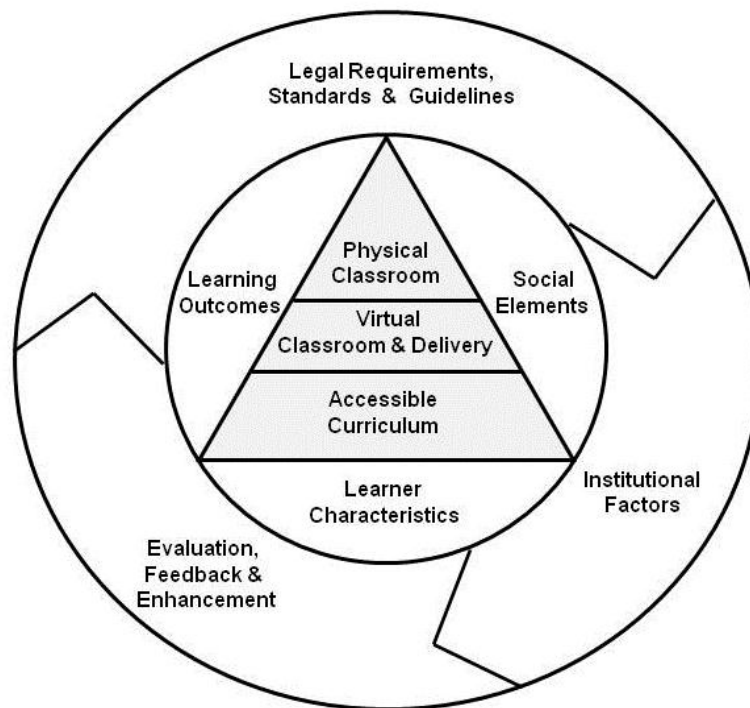


Figure 7.1: The Revised VIVID Model.

Following an analysis of the responses from the experts, two major modifications were made to the existing model. The first of these was that a new section was added to the model. Secondly, a brief outline for achieving optimum usage was included and a simulation of application of the model was described (see Chapter eight).

7.5.1 Institutional Factors

The new section added to the VIVID model is entitled “Institutional Factors”. The institutional factors in an e-learning environment consist of those elements of teaching and learning which are specific to individual institutions.

All institutions have their own strategies, policies, regulations and directive processes that will influence the delivery of educational courses and affect the environment in which they are delivered. The objectives of the institution will have a bearing upon these factors and will indirectly affect the accessible e-learning environment.

Large educational institutions, such as universities, are likely to have other support structures already in place. They may include:

- disability services
- e-learning resources and policies
- e-learning activities and
- e-learning and technologies which sustain the use of social media.

These four broad categories of institutional factors in e-learning environments play a major part in the success of the learners enrolled in the courses. The Academic Board of the institution will direct management through decisions made at an institutional level, and these must be considered when planning, designing, developing and delivering e-learning education to vision impaired learners (Permvattana, et al., 2012).

Disability Services

These should include:

- consideration of entry procedures if the vision impaired learner is not able to complete enrolment requirements
- specific and detailed orientation
- available access to assistive technologies
- an awareness of the National Disability Coordination Officer (NDCO) program in Australia.

Prospective learners should be advised that a full disclosure of their disability could result in additional funding to support them whilst they are enrolled. A Disability Services officer should be available at all institutions who should be contacted as early as possible in order to provide additional support and advice. This support will

ensure that learners with a disability realise their full academic potential despite their condition.

E-learning Resources and Policies

As e-learning can come in various modes, a great variety of e-learning resources should be available for both teachers and learners. One of the most important resources is e-pedagogy which includes the principles of teaching and learning in an online environment. It covers guidelines in learner engagement, self-centred learning, learning modes and e-learning activities.

E-pedagogy also outlines the learning theories that guide teachers into learner centred theory. These learning theories include the benefits of appropriate resource usage, suggested e-learning activities and design considerations. Samples of e-learning projects, reports, case studies and professional development workshops can also be found within existing e-pedagogy research.

The purpose of e-learning policies is to facilitate effective learner engagement through the provision of appropriate e-learning environments. Policy statements, unit outline policies and general principles and procedures can be included in e-learning resources. Comprehensive e-learning resources and policies can provide considerable benefits to learners and teachers.

E-learning Activities

E-learning activities provide the purpose and context for learners to make meaning from the content of a module or course. They are the vehicle through which learning occurs. Oliver (2001) believes that learning activities need to:

- be active and engaging
- encourage cooperation and collaboration and
- provide opportunities for reflection.

The ability to provide a wide range of challenging activities and interactions is a key feature of e-learning. E-learning activities can be divided into two groups as follows:

- recall and comprehend and
- apply and collaborate

(Australian Flexible Learning Framework, 2008).

Recall and Comprehend

This group of e-learning activities is based on building knowledge for the basic levels of e-learning. This type of learning activity requires learners to understand and remember information. These strategies are the most appropriate for self-paced learning tutorials and can be applied in compliance or product training. Examples of accessible activities are matching and sequencing, games, pronunciation and decision-making.

Apply and Collaborate

This group of e-learning activities is based on building skills and performance for competence. These activities are far more advanced levels of learning, where the activity requires learners to apply the knowledge, analyse the results and then transfer the learning to another situation. This group of performance based outcomes is required for vocational education and training courses in Australia. Some examples of accessible activities from this group are case studies, problem based learning, project based learning, research, role-plays, e-mail, discussions, debates, chat sessions, Web blogs, virtual classroom, virtual laboratories and chat sessions (Australian Flexible Learning Framework, 2008).

Learning Modes

The blended and mobile learning approaches contain underpinning principles that promote learners' achievement (MOBIlearn, 2003).

Blended learning is a term used to describe the combined use of face-to-face and e-learning environments (Bonk, Graham, & Cross, 2005).

Mobile learning, or m-learning, appears as learners become competent at transferring acquired knowledge across topics, space and time. This is often aided by the use of mobile technologies such as tablet computers and smartphones (Sharples, Taylor, & Vavoula, 2007). M-learning happens when the learner takes advantage of the learning opportunities opened by mobile technologies (MOBIlearn, 2003).

E-learning and Technologies

Technology in e-learning has opened up the opportunity to provide flexible, personalised and inclusive educational courses which break down the limitations of realistic learning experiences (Laurillard, 2008). Some examples of accessible technologies used in e-learning are social media tools, blogs, announcements, discussion boards, E-mail, Podcast, tests, Wiki, quizzes and surveys.

Social media is the tool that engages great interest among the learners. There are hundreds of different social media tools which are freely available to help teachers to engage and collaborate with learners. These tools also help learners interact with their fellow colleagues.

Below are the most popular social media tools in e-learning:

- Twitter: an online social networking service which allows the users to send and read 140 characters of text.
- Second Life: a free 3D virtual world where users can socialise and use free voice and text chat.
- Google Docs: the user can create and share work online and access documents from anywhere.
- Delicious: a popular social bookmarking service
- Flickr: a Web site for online photo and portfolio management.
- Posterous: an easy blogging tool via E-mail.
- SlideShare: offers users the ability to upload and share publicly or privately design Power Point presentations, Word documents and Adobe PDF files.
- Wigglio: a completely free, online toolkit that makes it easy to work in groups.
- Xtimeline: a free Web site that lets users create timelines and explore timelines about history, biography and more.
- YouTube: a place to find, watch, upload and share videos.

The factors above are dependent on the resources provided by individual institutions and therefore the availability of experienced teachers plays a significant role in the effectiveness of academic success for the vision impaired learners. Taking into account the institutional factors when designing and developing a course which will

be available to both sighted and non sighted learners is an essential element of a holistic model.

7.5.2 A Brief Outline for Optimum Usage

The model provides all the elements which should be considered for the successful design of an e-learning environment for the vision impaired. The central triangle names the three basic elements required for the development of any learning module. For vision impaired learners, the three elements in the inner circle must be consulted when planning and developing an e-learning environment. The three elements in the outer circle must also be considered to ensure full accessibility.

The section entitled legal requirements provides information about legislated obligations which are further defined in standards and guidelines.

Evaluation feedback and enhancement is the process of gathering information following the conclusion of a course so that improvement can be incorporated in the future.

The model is cyclical and iterative. All components rely on the inclusion of other components and, like any system, the exclusion of one will affect the operations of the others. The model components must be viewed and analysed as parts of an integrated whole, providing pre-, co- and post-requisite aspects that work together to form a cohesive entity.

7.6 Chapter Reflections and Conclusion

When the model was presented to the experts, it was accompanied by a shortened explanation of each of the components. The full explanation is found in Chapter six.

The many problems and issues faced by vision impaired learners are discussed in detail in Chapters two, four and five. The experts did not have access to these discussions because the amount of information could not be included in their explanatory notes. On reflection it would have been more valuable to hold a workshop for the experts to meet in person. Such an event would have permitted the researcher to explain the model in detail and answer questions from the participants. Discussion between the experts could have presented further ideas to incorporate into

the model and these interactions could have been captured in recordings of the meeting.

Ideally, an evaluation of the model would best occur from the physical implementation of the components and measurement of its success. This was not possible in the time frame, as during the greater part of the period of the study the researcher was immersed in the learning environments with the vision impaired learners, gathering information about their challenges and devising a more holistic approach to the entire learning setting. Although the type of review carried out is not able to provide a thorough evaluation of the model, the insights presented by the experts were of great value and have presented a more robust final model.

As a consequence of the comments gathered in the evaluation process, Chapter eight presents an example of the implementation of a course using the principles of the VIVID model.

CHAPTER EIGHT

EXAMPLE OF THE IMPLEMENTATION OF A COURSE USING THE PRINCIPLES OF THE VIVID MODEL

This chapter demonstrates one example of the simulated implementation of a course using the principles of the VIVID model (see Figure 8.1). A hypothetical course entitled an “Introduction to Web Design”, which is part of a Bachelor of Communications Degree, is used as the vehicle. The proposed course is Australian based and will be implemented using International and Australian Standards and regulations.

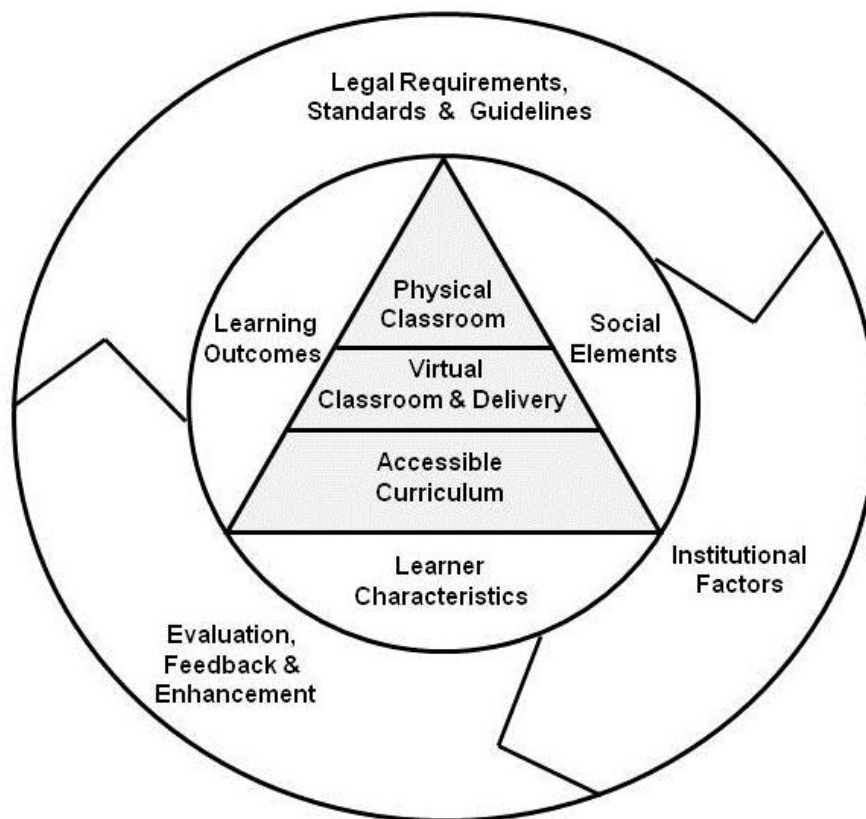


Figure 8.1: The VIVID (Vision Impaired using Virtual IT Discovery) model

The proposed course is a core requirement in a first year undergraduate program within a Bachelor of Communications Degree. The outcome of this course is to develop preliminary understandings of the principles involved in appropriate and accessible Web design. Learners enrolled in the course include mainstream learners as well as those with vision impairment.

All sections of the model are applied in the simulation:

- legal requirements, standards and guidelines to provide a baseline and guidance on minimum standards and best practise
- institutional factors to ensure the teaching and learning fits into the strategic directions and desired operations of the educational institution
- evaluation feedback and enhancement to provide guidance on potential problems and measure how well objectives are being met together with implementing adjustments designed to better meet objectives
- learning outcomes to align the skills and knowledge gained by the vision impaired with those of sighted learners and also contribute to the outcomes for the overall educational program
- learner characteristics which will provide information regarding the personal characteristics of the learners so that the specific difficulties they face in the learning environment related to their disability can be minimised
- social elements to ensure a sense of belonging and good social communications
- physical classroom (where applicable), providing appropriate physical learning space design and ensuring occupational health and safety requirements are met
- virtual classroom and delivery of learning materials which are appropriate to the learners' ability levels and provide a sound learning space for the generation of knowledge and skills, and
- accessible curriculum to ensure all parts of the curriculum are delivered in a manner which is accessible to those learners with a vision impairment.

The model is cyclical in nature and this is reflected in the integral nature of the three elements in the outer circle, the three elements in the inner circle and the three elements in the triangle. Each can interact with the other at any stage in the implementation process, thus providing strategic direction and best practice to the tactical and operational levels of the learning environment.

8.1 Legal Requirements, Standards and Guidelines

The educational institution's academic requirements are applied to this course. These are based on legislation in the areas of human rights, equal opportunity and social justice.

As the simulated environment is Australian, Guidelines on Information Access for Tertiary Students with Print Disabilities, published by the Australian Vice Chancellors' Committee (AVCC) in 2004 are used as a foundation. These national guidelines aim to assist individual institutions meet the needs of learners with print disabilities through strategies and arrangements which are appropriate to their local circumstances. Those with print disabilities include those with all types of acute vision impairment and also incorporate those other disabilities that do not permit learners access to printed materials. The guidelines relate to:

- provision of student assistance (administrative and academic aspects of university participation)
- teaching materials
- Internet access
- encouraging inclusivity
- equipment and technology
- practical classes and practicum placements and
- policy implementation.

The most comprehensive international specifications and developers guidelines, the Web Accessibility Initiative (WAI) is a part of the World Wide Web Consortium (W3C) and its content is recognised by Australian Governments and national and international Web services organisations (full details of the WAI can be found at: www.w3c/wai.org). These guidelines form an essential foundation for the development and delivery of educational programs for those with accessibility issues. All accessibility guidelines in the WAI are applied in the Bachelor program under discussion. Regular evaluation of standards compliance is also undertaken on an ongoing basis to ensure new additions and updates are also incorporated into the e-learning environment.

Australian occupational health and safety legislation is also consulted and legally required safeguards together with institutional factors are incorporated across both physical and electronic environments to ensure the safety of all learners within the learning situation. Issues of importance from this legislation are:

- risk management guidelines
- emergency evacuation procedures clearly displayed
- processes for the reporting of hazards
- first aid provisions and visible fire extinguishers
- ergonomic considerations and
- signage for various assistant resources.

The above sources provide an outline of some of the legal requirements, standards and guidelines which are applied to the design, development and delivery of this course.

8.2 Institutional Factors

All institutions have individual policies, strategies and regulations which influence the educational courses offered and the environment in which they are delivered. The specific objectives of the institution will affect the accessible e-learning available to those enrolled in courses. In the simulated environment the following policies, strategies and regulations are examples of items for consideration and inclusion.

8.2.1 Policies

Institutional E-learning policies, which are a sub-section of the general policies, should include but are not limited to the provision of:

- appropriate Internet access
- suitable equipment
- expert academic staff
- technical support personnel and
- proper physical areas.

In this course, a large lecture room and four IT laboratories are available. These are all fully Internet accessible with other appropriate resources. Highly qualified

academic staff are available and technical assistance by qualified IT personnel is provided to support the learners and teachers.

8.2.2 Strategies

In this course, a variety of strategies are employed and these are dependent on the personal needs of each learner. All those listed below are easily accessible for those with vision impairments and they are also appropriate for sighted learners.

They include:

- virtual classrooms
- case studies
- blogs
- games
- chat sessions
- discussions
- debates
- demonstrations
- e-mail
- peer to peer collaboration
- problem based learning
- social networking
- Wikis and
- role play (online).

8.2.3 Regulations

There are several related pieces of administrative legislation that constitute or contain rights and allocate responsibilities in e-learning environments for the vision impaired. The regulations regarding disability and education in Australia are contained in the Disability Discrimination Act (DDA), 1992 and the Disability Standards for Education and Guidance Notes, 2005, which provide greater detail in terms of those with vision impairment. (Full details can be found at <http://www.comlaw.gov.au/Details/C2005C00526> and <http://www.comlaw.gov.au/Series/F2005L00767>.)

The most important aspect of the DDA is that all learners must be treated equitably irrespective of any disability. In this course all learners who apply to enrol will be accepted providing that the educational and technical pre-requisites are met. Lecturers and the course coordinator will monitor individual requirements and provide whatever resources are necessary to ensure accessibility.

An example of a vision impaired learner enrolling in this course is Sarah. Sarah is a thirty seven year old Australian female whose eyesight is deteriorating rapidly. When Sarah first contacted the institution, in accordance with the institutional policies, she was referred to the Equity Officer who made arrangements to meet with her to gather information on her medical characteristics and assess her needs. Having seen the confirming medical documentation, the Equity Officer then ascertained further information from Sarah about the restrictions which resulted from her vision impairment. Sarah was then advised to agree to disclose her disability so that the course coordinator and lecturers would be fully aware of her individual resource needs. This she agreed to do which enabled the institution to apply to the Commonwealth Government for additional funding to provide the necessary assistive technologies. At the meeting it became obvious that Sarah needed the services of a guide dog since it accompanied her that day. From this meeting the Equity Officer was able to provide Sarah with the essential support to enable her to undertake the course.

8.3 Learning Outcomes

The learning outcomes of this course are closely linked to the learning outcomes of the Bachelor of Communications Degree. Figure 8.2 shows how the learning outcomes of the Introduction to Web Design course have been developed from the learning outcomes of the Bachelor of Communications Program. Successful learning outcomes in each module are developed from the course learning outcomes and they are also shown in Figure 8.2.

Bachelor of Communications			
Program Learning Outcomes (PLO)	PLO1 – Understand the principles involved in Web design PLO2 – Develop accessible Web pages using best practice principles PLO3 - Evaluate accessible Web pages using best practice principles PLO4 – Launch and promote the Web site		
Introduction to Web Design			
Course Learning Outcomes (CLO)	PLO1 CLO1 – demonstrate a knowledge of the concepts of Web Design PLO1 CLO2 – demonstrate an understanding of the principles of anatomy of Web pages PLO2 CLO3 – demonstrate an enhanced facility in writing for the Web PLO1,PLO2 CLO4 – demonstrate the ability to increase accessibility features already present in Web design and authoring tool products PLO2 CLO5 – demonstrate the successful creation of accessible Web pages and PLO3 CLO6 – demonstrate an appreciation of evaluation techniques.		
Module Learning Outcomes (MLO)	Module 1 - Principles of good Web Design MLO1.1 CLO1 – Explain the concept of web design MLO1.2 CLO2 – Describe the principles of good web design	Module 5 - Rules of Accessible Web Design MLO5.1 CLO4 – Explain the rules of accessibility in web page design MLO5.2 CLO4 – Demonstrate accessible web page navigation	Module 9 - Adding images, links and Web forms MLO9.1 CLO2 – Demonstrate an understanding of the principles of anatomy of Web pages MLO9.1 CLO3 - Demonstrate and enhanced facility in writing for the Web
	Module 2 - Anatomy of Web page MLO2.1 CLO2 – Describe the structure of a web page MLO2.2 CLO4 – Identify and explain accessibility features in web page anatomy	Module 6 - Writing for the Web MLO6.1 CLO3 – Write advanced web page contents	Module 10 - Testing, Evaluating and Enhancement MLO10.1 CLO6. Understand testing and evaluation methods MLO10.2 CLO6. Understand enhancement techniques
	Module 3 - Web Design and Planning MLO3.1 CLO2 – Plan the web page structure MLO3.2 CLO4 – Plan accessibility features	Module 7 - Understanding the audience MLO7.1 CLO1 - Demonstrate a knowledge of the concepts of Web Design MLO7.2 CLO5 - Demonstrate the successful creation of accessible Web pages	Module 11 - Launching and Promoting the Web site MLO11.1 CLO5 – Demonstrate the successful creation of accessible Web pages
	Module 4 - Building the Web site MLO4.1 CLO5 – Develop the web page MLO4.2 CLO4 – Develop accessible web page features	Module 8 - Designing Web Navigation MLO8.1 CLO2 – Plan the Web page structure	

Figure 8.2: Learning Outcomes

These outcomes require each student to develop minimum defined levels of expertise in computer literacy and in the use of assistive technologies. There is, therefore, a prerequisite for enrolment. This allows the modules to develop and extend basic expertise which assists in ensuring success in achieving stated outcomes.

These modules are planned to enable learners to design and develop Web sites. The learning modules are as follows:

- Principles of good Web Design
- Anatomy of Web page
- Web Design and Planning
- Building the Web site
- Rules of Accessible Web Design
- Understanding the Audience
- Writing for the Web
- Designing Web Navigation
- Adding images and links
- Adding Web Forms
- Testing, Evaluating and Enhancement and
- Launching and Promoting the Web site.

Other learning outcomes, which are institutional, are also part of many courses. Graduates must demonstrate evidence, appropriate to their disciplines, of the following skills and qualities:

- apply discipline knowledge, principles and concepts
- think critically, creatively and reflectively
- access, evaluate and synthesise information
- communicate effectively
- use technologies appropriately
- utilise lifelong learning skills
- recognise and apply international perspectives
- demonstrate cultural awareness and understanding and
- apply professional skills.

Learning outcomes in a course using the VIVID model principles take into account the vision disability of the learners and instructional designers need to be cognisant that although learning outcomes will be the same as for sighted learners, the course delivery, assignments and tasks may need to be adjusted. An outcome that requires learners to perform an action using specific tools or an approach that is inaccessible is not a valid learning outcome in this environment. The investigation underlying this research has shown that in the process of achieving learning outcomes, the focus is frequently on the methods required to achieve the outcome rather than the outcome itself. Accessible learning outcomes must reflect that vision impaired learners can achieve the same learning outcomes as sighted learners as a result of successfully completing accessible IT e-learning courses. Accessible learning outcomes must integrate fully with accessible learning content, delivery and infrastructure in order to present a holistic learning environment. It is important, therefore, that the design of the e-learning environment is planned and developed with accessible learning outcomes as a foundation.

At this point, Sarah needs to meet with the lecturer to confirm that the outcomes achieved by her will be the same as those for sighted learners. However, modifications may need to be made in the format and presentation of printed materials to ensure that she can access them with the help of assistive technologies. It is also probable that Sarah will require extensions for some of her assignments and it is important that the lecturers and tutors are aware of her situation and can comply with her requests.

8.4 Learner Characteristics

In order to achieve an accessible individual learning experience, it is necessary to consider the individual's specific needs, background, demographics and cultural factors. These factors will affect their ability to perform in an appropriate learning environment. They include the type and degree of vision impairment, age, educational level and physical requirements. Background information, obtained after enrolment, includes the individual's basic IT skills and knowledge, knowledge and experience of Web design, knowledge and experience of assistive technologies and quality of Internet connection.

In this course lecturers can implement all of the following as their knowledge and understanding of each learner's personal needs develops. They can:

- provide adequate orientation in the physical and virtual classrooms
- design and develop suitable induction strategies
- ensure appropriate assistive technologies are available and
- modify and adjust materials to be presented.

Sarah has decided to enrol as an on campus student and therefore she needs extensive orientation. As a bona fide student, Sarah is able to access the services of a Mobility Trainer through local services for the vision impaired. This will assist her in organising travel arrangements and provide her with subsidised taxi vouchers.

8.5 Social Elements

The investigation underlying this research has shown that social interaction is an essential component for learners with vision impairment. Being able to communicate with teachers and other learners in a real-time and online environment via a virtual classroom promotes confidence, assists group learning, develops a sense of belonging and contributes to success. The Web design course environment will utilise Ventrilo or a similar product to provide a virtual classroom environment where teachers can broadcast lectures, take questions during the broadcast and encourage learner participation and discussion. Virtual classroom software applications can also enable learners to hear what other learners are saying and provide a forum for interactive discussion. In addition to classroom communications, the vision impaired learners will be able to communicate with their teachers and other learners on a one-to-one or group basis using free communication methods such as e-mail, Skype and social networking sites such as Facebook and MySpace. The building of a group identity in the Web design course is important to vision impaired learners who spend the majority of their lives in isolation, either physically or because of an inability to interact with their environment. The learning group enables them to form bonds and develop relationships of trust as they interact together either virtually or in a physical classroom to undertake the learning activities designed to meet the learning outcomes for the Web design course.

For this course the following measures will be implemented to ensure social interaction and the well being of the learners with vision impairment:

- regular social events such as group outings and lunches which will be held in cafes with appropriate ambience for those with vision impairments
- the use of a problem solving approach to difficulties where individuals and groups will be encouraged to consult and share ideas with their vision impaired colleagues
- team activities out of class to build Web sites to assist other disabled and disadvantaged groups and
- periodic contact with vision impaired teachers away from the formal classroom.

Sarah will need the support of her peers to succeed in the course. This will occur partly through the use of social media which she is able to access from home. By attending some of the social events on campus, Sarah will also develop relationships with fellow learners and teachers. This will lead to increased trust and self confidence. Sarah will be part of a friendly and supportive group where the members can work together to solve problems. The opportunity for Sarah to assist in the development of Web sites for other disadvantaged groups will give her a sense of contribution to her community.

8.6 Accessible Physical Classroom (where applicable)

In many circumstances e-learning environments incorporate physical classrooms that support the Web-based learning materials. Even distance learners with vision impairments require an appropriate physical learning space. The analysis has demonstrated that the requirement for an accessible physical classroom for vision impaired learners should include considerations to ensure the physical environment is safe and accessible. There should be:

- appropriate computer desks and workspaces which allow adequate room for assistive technologies
- ergonomic chairs to provide long term support for class sessions
- personal computers and laptops which are equipped with assistive technologies based on individual needs

- microphones which are always housed in the same location
- printers located at the most physically accessible place
- electronic USB whiteboards where information can be transferred to individual computers so that the user can make necessary adjustments for their vision impairment
- accessible teaching aids which can be stored closed by and are easily retrieved and
- an effective and safe classroom layout, preferably U-shaped which provides enough space for guide dogs, assistive technologies and individual supervision by the teachers (see Figure 8.3).

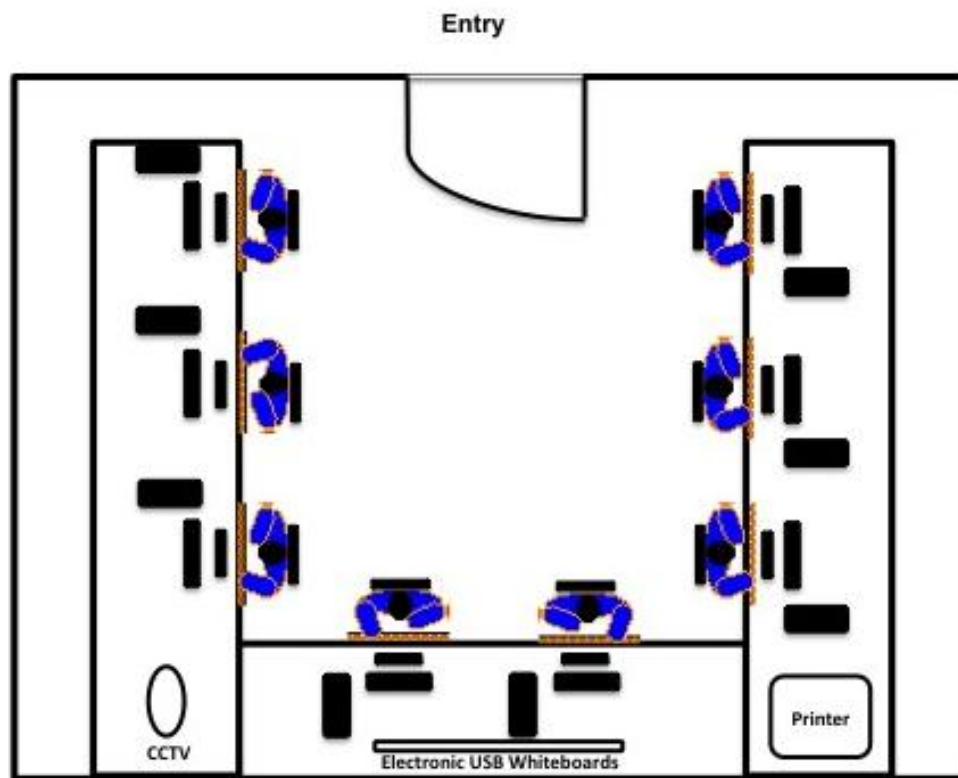


Figure 8.3: Simulated Accessible Physical Classroom

Sarah's needs include consideration for the wellbeing of her guide dog which accompanies her at all times. It is therefore essential that the physical classroom is on the ground floor so that Sarah can be seated near an exit to a garden area which allows her to walk her dog as required. Because Sarah's dog must sit either close to her or under her desk, it may be necessary to ensure that there is a suitable gap between Sarah's desk and the adjoining desk.

Since Sarah needs to use a screen reader the institution's technical staff will need to install the appropriate software on the computer that Sarah will be using.

8.7 Accessible Virtual Classroom

Virtual classroom refers to a learning environment where teachers and learners are separated by space or time or both, and the teacher provides course content through the use of methods such as electronic course management applications, multimedia resources, the Internet, video recorded lectures, tutorials and case studies. Learners receive the contents and communicate with the teachers via the same technologies and skills through using assistive technologies, such as a screen reader or a screen magnifier. These are a pre-requisite for vision impaired learners who will require a sound working knowledge of these tools and their limitations.

An accessible virtual classroom and the delivery tools for this Introduction to Web Design course include:

- assistive technologies, such as JAWS for screen reading and ZoomText for screen magnification based upon the needs of individual learners
- vision impaired teachers who understand the needs of vision impaired learners because they have experienced the difficulties themselves
- Voice over Internet Protocol (VoIP) or equivalent
- accessible manuals for virtual classroom operations which include information about the learning resources, “quick fix lists” so that learners can attempt to solve problems themselves and contact details for the staff at the institution
- sighted teachers to manage the entire environment so that Occupational Health and Safety regulations are appropriately followed and
- assistive technology technicians to help the vision impaired learners with problems related to hardware and software.

As Sarah completes some of the early modules of her course, she will gain the skills and knowledge that will allow her to access the virtual classroom. This will enable her to converse with lecturers and other learners as if they are all in the same room. Once she is confident in the use of the virtual classroom facilities, she can complete

the remaining modules either from her own home or she can continue to attend classes on the campus.

8.8 Accessible Curriculum

Learning materials will be broadcast by VoIP applications and these will be recorded live for future use and reference. This will allow teachers and learners to interact during lectures and tutorials thus providing instant feedback and immediate answers to questions.

The learning materials forming the basis of the course must be fully accessible. Two accessible teaching aids for the “Designing Web Navigation” module consist of firstly, different sized blocks, which are used to demonstrate the level of each Web page and secondly, different sized magnetised felt shapes representing various Web page elements which can be physically placed on a wooden board replicating the shape of the Web page.

Whilst universal design principles will provide a sound basis for accessibility, the teaching and learning materials need to be specifically accessible to the vision impaired, and this usually requires additional accessibility considerations. Many vision impaired learners cannot access images in formats such as bitmap, JPEG, GIF and Flash diagrams because they are not translatable by screen readers unless accompany by text descriptions. Therefore all learning materials in this course will have text descriptions included. Many interactive tools are not identifiable or translatable by currently available assistive technologies and alternatives to these tools that are fully accessible will be used.

The majority of problems faced by vision impaired learners are related to inaccessible curriculum and learning materials. These include:

- learning materials
- practical laboratory exercises
- assessments
- e-doing tools
- games and quizzes
- any additional teaching resources and

- computerised tools such as simulations operating systems.

Sarah requires considerable assistance in order to access teaching and learning materials. She requires a raised line drawing where the content of the graphic is presented in a form that can be felt. On occasions, she needs a scribe, specifically at examination times.

Sarah also requires more time to complete learning tasks and assessments. During this research it was found that vision impaired learners require at least double the amount of time to complete set tasks due to the additional time taken by the use of assistive technologies. Unlike sighted learners, Sarah takes longer to assimilate knowledge and familiarity of learning content as she has to memorise much of the information presented.

Assessment

In this course there are three assessment tasks which the learners are given in week one (See Table 8.1). Each task must be successfully completed prior to the commencement of the next assignment. Learners are given three days to make amendments if their task does not meet the required standards. Tasks are sent to the teacher in an electronic form and must be received by the due date.

Sarah cannot complete the tasks in the time provided and therefore she is able to apply for an extension and this is granted because of her vision impairment.

Table 8.1: Course Assessment Tasks

Outcomes Assessed	Task	Weighting	Due date
<ul style="list-style-type: none"> • Understand good Web design • Anatomy of Web page • Web design and planning • Building the Web site • The rules of accessible Web design • Understanding the audience 	Project one: Create a Home page	25%	Week 4
All outcomes above plus: <ul style="list-style-type: none"> • Writing for the Web • Designing Web navigation 	Project two: Develop ten Web pages	35%	Week 8

Outcomes Assessed	Task	Weighting	Due date
<ul style="list-style-type: none"> • Adding images and links • Adding Web forms 			
All outcomes above plus: <ul style="list-style-type: none"> • Testing, Evaluating and Enhancement • Launching and Promoting the Web site. 	Final Project: Design and launch twenty Web pages	40%	Week 12

8.9 Evaluation Feedback and Enhancement

In order to maintain an appropriate and accessible IT e-learning environment for the vision impaired, the meeting of objectives of the learning outcomes to a predefined level of acceptance must be evaluated every semester. The results of such feedback not only ascertain how well the environment is complying with guidelines and standards and achieving in relation to the objectives, but they also provide feedback which can enhance future course delivery. Evaluation will be carried out by a survey completed by the learners in addition to a review of the content and process of the environment by the lecturers and education manager.

Feedback

Feedback from learners provides useful information for further improving course delivery. All learners are asked to complete a survey by the University's Department of Teaching and Learning and the course coordinator receives an edited result table. However, individuals are not named. From this information, the course content is modified and redesigned if necessary to ensure the needs of future learners will be met.

Whilst this is useful information, a more detailed survey of the course can provide specific information from which further changes and enhancement can be made.

Student Survey

Question 1: Learning outcomes were clear.

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

Question 2: Learning outcomes were achievable.

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

Question 3: The social elements provided support and assistance for your studies.

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

Question 4: The characteristics of your personal requirements and learning styles were adequately met.

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

Question 5: The curriculum was fully accessible.

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

Question 6: The physical classroom layout was appropriate for your personal needs.

(only if applicable)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

Question 7: The virtual classroom was fully accessible.

(only if applicable)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

Question 8: The curriculum content was fully accessible.

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

The analysis of the data gathered above will determine whether the components of the course were successful and useful in ensuring e-learning accessibility for the vision impaired and they can be used for modification and enhancement.

8.10 Conclusion

This chapter has presented a simulated application of the VIVID model to an introductory Web design course. The VIVID model has been developed as a theory building project based upon detailed analyses of two large IT e-learning environments designed specifically for vision impaired learners. Whilst the model does not aim to be universally accessible, it does include universal accessibility foundations and considerations. The model is yet to be fully applied into a new e-

learning environment and such an exercise will undoubtedly highlight changes, additions and enhancements which will add value to the research already carried out .

The following Chapter describes the limitations of the study and concludes with recommendations for further research.

CHAPTER NINE

CONCLUSIONS, LIMITATIONS AND FUTURE RESEARCH

9.1 Conclusions

One of the most common problems faced by vision impaired learners is the inaccessibility of learning materials and Web sites. A second problem revolves around their different learning needs due to their disability. However, the most prominent problem is that e-learning courses are not designed specifically for vision impaired learners. E-learning models are commonly designed for sighted learners and do not incorporate considerations for those with disabilities, particularly those with vision impairments. A further challenge is that vision impaired learners are often isolated by their disability and e-learning models seldom include considerations of social elements. A final concern is that teachers seldom understand the needs of vision impaired learners and the barriers to learning these learners face (Permvattana, et al., 2012).

An increase of the use of e-learning and Web-based learning environments is becoming commonplace. The addressing of the inequity in education for the vision impaired has commenced but it has a long way to go before those with vision disabilities are able to achieve equivalent educational qualifications to those who are sighted.

As a result of the analysis undertaken as part of this research, a new holistic model was developed specifically for e-learning environments for the vision impaired. The model was progressively developed over the term of the research based upon relevant literature and past research in the area. An in-depth study of two e-learning environments for the vision impaired, the TruVision and the Cisco Academy for the Vision Impaired, were undertaken and analyses of the observations, questionnaires and interviews of both vision impaired teachers and learners as well as sighted teachers provided relevant input. The new model, VIVID (Vision Impaired using Virtual IT Discovery) incorporates aspects from past models in differing degrees, and integrates aspects which emerged strongly from the observations and interviews with the vision impaired learners and teachers.

The VIVID model provides nine areas which are necessary to create accessible e-learning environments that include complex visual information, interactive activities and simulations. Once the model is fully applied during the design and development of a new e-learning environment for the vision impaired learner, modifications, additions and enhancements will result and these should increase its usability and application.

The cyclic nature and interactive structure of the VIVID model is designed to be integrative and reflective for course development, thus allowing modification based on experience. This will result in vision impaired learners achieving identical learning outcomes to their sighted peers. A key factor in this is the recognition that a flexible delivery timeline is necessary for the completion of learning tasks due to the differing nature of each individual learner's disability. Reading speed, cognition and physical access methods (such as vision impaired with upper body motor disability) require variable time lines for completion of tasks so that the identical standard of learning outcomes to sighted learners is achieved. Use of this model will facilitate employment and social inclusion through educational programs that include the peer support and networking opportunities currently enjoyed by sighted learners in mainstream education.

9.2 Limitations and Reflections

One of the limitations of this research is the small number of case studies. Research in this area is so new and specialised that only a small number of environments were available to be studied. More case studies would have provided more data and given a broader view of the problems and potential solutions. More case studies may also have enabled a greater utility and applicability of solutions. Although generalisation was not an aim of the research there are common elements that can be transferred to other learning and disability environments.

A second limitation is the small number of participants interviewed. The early parts of the research involved many hours of observation, particularly in the TruVision learning environment. However, data collection from this source ceased when lack of adequate funding to upgrade teaching materials resulted in course content becoming out dated. However, the data collected from the CAVI participants was rich and reinforced the observation data gathered in both case study environments.

A further limitation is the inability to apply the model in a live environment. The model is very comprehensive and would take an extended period of time to implement and evaluate in detail. Finding an institution that would be willing to invest heavily in the time and cost to test the model was also a drawback. The CAVI environment was developed over a four year period prior to being studied in this research and continues to operate fully. This opens up an area for future research for organisations that may be seeking to trial a model for the development of e-learning environments for the vision impaired.

9.3 Reflections on Content and Process

It would have been helpful to have been able to interview a much larger group of participants as this would have broadened the data base and perhaps provided different perspectives, characteristics and needs. However, as Lazar, Feng and Hochheiser (2010) state, the small number of respondents did fall within acceptable research principles for the domain under study.

The researcher had not anticipated the considerable amount of time and effort which would be required to develop relationships with the participants and thus gain their trust. By the end of the research period, friendships had developed which could have enhanced data collection if they had been established before the research began.

An overseas visit to the CAVI environments, either in Sri Lanka or India, could have provided a totally different insight into the research. Financially, this was not feasible.

A more in-depth knowledge and understanding of accessible curriculum would have been extremely helpful. A closer examination of examples of tasks in learning materials and observations of how learners dealt with navigating Web sites and using AT to achieve outcomes would have provided additional information about difficulties. This would also have demonstrated the problem solving approaches used and allowed the researcher to note those areas which caused most frustration. A further outcome would have been observations of real examples of techniques used to make the curriculum content accessible.

In the research process, face to face interviews proved to be very time consuming in terms of making contact with each respondent and agreeing on a time and place to

meet. In a further project, the researcher would use group interviews with a maximum of five participants who already know each other. This would allow for a more relaxed atmosphere with a sharing of information which would enhance connectedness. The researcher is aware that using group interviews could result in one or more members being intimidated but believes that data collected in this way would be of great benefit. Further in-depth individual interviews could follow with willing participants if these were seen to contribute to the research objectives.

In terms of the questionnaire, the researcher would have included more questions about background information if a similar study was conducted in the future. Of particular interest would be the level of educational achievements of each participant and the length of time each had been vision impaired. Both these factors emerged as being quite significant in terms of achieving outcomes and more research into these aspects could provide additional knowledge and understanding of the components of a successful e-learning environment.

The researcher believes that a better preparation process undertaken before any physical visits to the e-learning environments would have been beneficial both in terms of time management and in terms of preparing learners for the participation process. By planning an introduction program for both teachers and learners, and ensuring all parties had a copy of the proposed meeting times, relationships would have been established prior to the research beginning.

9.4 Future Research

Previous research in this specific area is relatively limited and is summarised in Table 9.1. However, four significant models have been developed as discussed more fully in Chapter Two.

Lazar, in 2004, developed an Integrated Web Accessibility Model. This model was focussed on universal accessibility and centred upon Web accessibility. Although comprehensive in nature this model was not specifically designed for learners with a disability and is not able to be directly applied into an environment for vision impaired learners.

Kelly, in 2005, developed a holistic framework for e-learning. This model was the first holistic model of its kind, including considerations outside the mainstream

features of then current learning models. Sadly, this model was not detailed enough to demonstrate how each factor interacts with the others nor intuitive in its application.

Seale, in 2006, developed a contextualised model of accessible e-learning practice in higher education. This model is built around the many different stakeholders' views, providing a process model for higher education institutions considering the implementation of accessible courses. Although the model infers integration it reflects a physical and practical perspective rather than a holistic conceptual construct.

Prougestaporn, in 2010, developed the Web Accessibility for Visually Impaired People (WAVIP) model. Although reinforcing the need for more consideration for accessibility of learning materials for the vision impaired, the model is limited in its breadth and depth and takes little account of social elements, guidelines and learners' needs and the need to understand the learning environment at a bigger picture level.

Table 9.1 Development of Accessible E-learning Models

	Area 1 Universal Accessibility	Area 2 Models for e-learning Accessibility	Area 3 Web Accessibility	Area 4 Accessible e-learning for the Vision Impaired
Lazar (2004)	Web Accessibility Integration		Web Accessibility Integration	
Kelly (2005)		E-learning Accessibility		
Seale (2006)		Accessible e-learning in higher education		
Prougestaporn (2010)			Improving Web Accessibility for the Vision Impaired	
Permvattana (2012)		Accessible E-learning model based on the needs of Vision Impaired learners	Web Accessibility	Designed specifically for the Vision impaired

The researcher, following from the previous work of the above four researchers has presented the VIVID model which incorporates a set of integrative areas to holistically address the needs of vision impaired learners in today's e-learning and Web-based environments. The final row in Table 9.1 summarises the VIVID model's contribution to e-learning environments, providing a holistic suite of elements that contribute to more effectual design and development of e-learning and Web-based environments for adult vision impaired learners.

The VIVID model is a holistic model specifically devised for the design and development of e-learning environments for the vision impaired. At the time of writing, it has not been implemented.

Future research to test the practical applications and identify those considerations which may be missing would be highly valuable. Implementing the model in a higher education institution which has a large number of blind and vision impaired learners enrolled in IT courses, both in physical classrooms and in a virtual classroom, would be an ideal situation for detailed consideration and enhancement of the model. It is unlikely that this could be done in many locations due to insufficient enrolment numbers.

A further area of possible research would be to extend the model to the design and development of e-learning environments for those with multiple disabilities, particularly those with hearing and vision impairments. It may be possible to achieve this in many places; however, the number of participants in such research could again be small due to the small size of the total population related to the study.

The model, with minor modifications, could also be applied in a completely different disciplinary area, but still with those who are blind or vision impaired. This may be possible within any Bachelor Degree Programmes in numerous locations.

A final area of potential future research is to build a universal accessibility model that incorporates the features included in the VIVID model. Such an endeavour would require detailed investigation of the learning and physical needs of many different types of disability, but would provide a valuable resource to improve inclusion at all levels engendering greater participation in education and employment by those who are not able-bodied.

The research presented in this thesis is only a small contribution to the immense problem of inclusion for those with a vision disability. However, if this contribution is viewed as a piece of a much bigger picture, and many other researchers contribute pieces that relate to other parts of the disability and accessibility canvas, the pieces can be joined and the jigsaw puzzle can be solved.

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APPENDIX A: The Disability Services Act 1986

These details have been obtained from The Disability Services Act 1986 and some of the main objectives of the DSA 1986 (Australian Federal Government) Section 3 are as follows:

- (a) to replace provisions of the Handicapped Persons Assistance Act 1974, and of Part VIII of the Social Security Act 1947, with provisions that are more flexible and more responsive to the needs and aspirations of persons with disabilities;
- (b) to assist persons with disabilities to receive services necessary to enable them to work towards full participation as members of the community;
- (c) to promote services provided to persons with disabilities that:
 - (i) assist persons with disabilities to integrate in the community, and complement services available generally to persons in the community;
 - (ii) assist persons with disabilities to achieve positive outcomes, such as increased independence, employment opportunities and integration in the community; and
 - (iii) are provided in ways that promote in the community a positive image of persons with disabilities and enhance their self esteem;
- (d) to ensure that the outcomes achieved by persons with disabilities by the provision of services for them are taken into account in the granting of financial assistance for the provision of such services;
- (e) to encourage innovation in the provision of services for persons with disabilities; and

(Disability Services Act, 1986)

APPENDIX B: The Commonwealth Disability Strategy (CDS)

These details have been obtained from the Commonwealth Disability Strategy (CDS) and are as follows:

The CDS was implemented in recognition of the fact that government policy has a significant impact on the lives of people with disabilities who are more than normally dependent on government agencies and such policies must be implemented with great care. The CDS was refined in 1999 to have a more ongoing commitment.

The aims of the CDS are as follows:

- to provide information in accessible formats
- to employ people with disabilities
- to purchase accessible services
- to recognise people with disabilities as consumers of services and
- to consult with people with disabilities to find out what they need.

(Australian Department of Human Services and Health, 2004)

The Commonwealth Disability Strategy department ensures its workplace environment complies with Occupational Health and Safety legislation and also provides additional services beyond those requirements. Specific initiatives for people with disabilities which are either complete or under way, these include:

- ongoing accessibility and usability testing with users of assistive technology for every product
- adjustments to the workplace including ergonomic equipment and aids
- the development of a national DIAC 'reasonable adjustment' policy
- appointment of a senior manager to champion the inclusion of people with disabilities
- access to flexible working arrangements
- provision of access to a rehabilitation case manager for staff members who experience health issues affecting their ability to function at optimal capacity in the work environment. The case manager works with the staff member,

managers and appropriate support agencies to facilitate the employee's ongoing participation and contribution in the workplace.

APPENDIX C: WCAG 2.0 Quick Reference List

These details have been obtained from the WCAG 2.0 by W3C: Web Accessibility Guidelines and are as follows:

1.1 Text Alternatives: Provide text alternatives for any non-text content so that it can be changed into other forms people need, such as large print, braille, speech, symbols or simpler language.

1.2 Time-based Media: Provide alternatives for time-based media.

1.3 Adaptable: Create content that can be presented in different ways (for example simpler layout) without losing information or structure.

1.4 Distinguishable: Make it easier for users to see and hear content including separating foreground from background.

2.1 Keyboard Accessible: Make all functionality available from a keyboard.

2.2 Enough Time: Provide users enough time to read and use content.

2.3 Seizures: Do not design content in a way that is known to cause seizures.

2.4 Navigable: Provide ways to help users navigate, find content, and determine where they are.

3.1 Readable: Make text content readable and understandable.

3.2 Predictable: Make Web pages appear and operate in predictable ways.

3.3 Input Assistance: Help users avoid and correct mistakes.

4.1 Compatible: Maximize compatibility with current and future user agents, including assistive technologies.

(Web Accessibility Initiative, 2012)

APPENDIX D: A comparison and alignment of WACG 1.0 Guidelines and Access Board Section 508 Guidelines

Section 508 (US) Versus W3C WCAG (Australian)

“The US Access Board, who published the 508 rules, provided an analysis of the differences between 508 and W3C's Web Content Accessibility Guidelines (the most common reference in other legal systems), but it may be wrong in some important particulars.

There is another comparison between 508 and WCAG level A done by Jim Thatcher, formerly of IBM access - <http://www.jimthatcher.com/sidebyside.htm> - and a further one provided as part off the AccRepair Tool from HiSoftware (this is an expensive way to get a comparison). Note that this is different to comparing double-A or triple-A.

The important difference between the US and Australia is about how the legal framework itself is set up. In the US, Section 508 is a set of rules that must be met for anything purchased by the Federal government or with their money (i.e. grants to States). In Australia, the legal requirement is "not to discriminate against people because of their disability". So it is more broadly applicable, and there is no absolute set of rules. The current recommendation of the Human Rights and Equal Opportunities Commission (HREOC - <http://www.hreoc.gov.au/>) is to implement WCAG as far as possible, but the resolution process is complaint-based - if somebody has a problem, they make a complaint and the parties are brought together to work out how the problem can be fixed. Implementing WCAG to any level is not a guarantee, but implementing to level double-A is what I believe will avoid problems arising, and is in any case evidence of good faith (which is helpful, as shown by the results of the Sydney Olympics website case).

The situation in European countries is different again (and there is the European Parliament plus a number of national and local governments to complicate it), but in general the standard applied is WCAG, to level A or double-A. (There are also a number of US states who use WCAG rather than Section 508).”

(Nevile, 2002)

Side by Side WCAG vs. 508 (Thatcher, 2007).

The WCAG View

NOTE: Four WCAG Priority 1 checkpoints, 1.3, 4.1, 6.2 and 14.1, are listed as "not in 508" in the Comparison column of this table. If a web site is 508-compliant and its author wants to be Web Accessibility Initiative A-Compliant as well, these are the only four checkpoints he must address additionally.

Keywords	WCAG Priority 1	Comparison	Section 508
Text Equivalent	1.1 Provide a text equivalent for every non-text element (e.g., via "alt", "longdesc", or in element content). <i>This includes:</i> images, graphical representations of text (including symbols), image map regions, animations (e.g., animated GIFs), applets and programmatic objects, ascii art, frames, scripts, images used as list bullets, spacers, graphical buttons, sounds (played with or without user interaction), stand-alone audio files, audio tracks of video, and video.	Similar	1194.22 (a) A text equivalent for every non-text element shall be provided (e.g., via "alt", "longdesc", or in element content).
	<p>The Section 508 standard uses the exact language of WCAG Checkpoint 1.1 without "This includes" of WCAG 1.1. Given the decision of the Access Board to use the WCAG wording, it follows that the examples of "non-text elements" in WCAG 1.1 apply to Section 508 1194.22 (a) as well. This is further confirmed in the discussion that precedes the standards mentioning audio as an example on non-text elements.</p> <p>The Board also interprets this provision to require that when audio presentations are available on a web page, because audio is a non-textual element, text in the form of captioning must accompany the audio, to allow people who are deaf or hard of hearing to comprehend the content.</p> <p>It was an error to refer to captioning of audio in the final standards. The guides to the standards clarify this (see §1194.22(b)).</p> <p>If a website offers audio files with no video, do they have to be captioned?</p> <p>No, because it is not multimedia. However, since audio is a non-text element, a text equivalent, such as a transcript, must be available. Similarly, a (silent) web slide show presentation does not need to have an audio description accompanying it, but does require text alternatives to be associated with the graphics.</p> <p>For spacer images, those used for formatting output, the text equivalent is the empty string, alt="", and that is the alternative text that should be associated with those images.</p> <p>The issue of text equivalents for scripts, applets and programmatic objects is quite a different matter. It is rare that there is such a thing as a "text equivalent" for one of these programmatic objects. Such is often interpreted as a functional description of the</p>		

Keywords	WCAG Priority 1	Comparison	Section 508
	<p>object, as in "this applet provides an interface for logging in so as to view your 401K account."</p> <p>The picture is complicated by the role of such extensions to HTML in WCAG 1.0 compared to that in Section 508. For the former the pages must be usable with scripts and applets turned off or not supported. This makes the importance of the "text equivalent" much greater for WCAG compliance compared with Section 508. For section 508 these extensions must be accessible (see Paragraphs 1194.22 (l) and 1194.22 (m)).</p>		
Server-Side Image Maps	1.2 Provide redundant text links for each active region of a server-side image map.	The Same	1194.22 (e) Redundant text links shall be provided for each active region of a server-side image map.
Keywords	WCAG Priority 1	Comparison	Section 508
Auditory description	1.3 Until user agents can automatically read aloud the text equivalent of a visual track, provide an auditory description of the important information of the visual track of a multimedia presentation.	Not in 508	
	<p>By WCAG 1.1 and 1.4 (Section 508 1194.22 (a) and (b)) video must have a synchronized text equivalent. Given the web environment it is natural to assume that the synchronized text equivalent could be displayed in a window next to (or above or below) the video just like captions. The problem addressed by WCAG 1.3 is that blind users, for whom this is important, do not today have access to that text; their screen readers won't read the descriptions of the video. Until they do, WCAG 1.3 requires that the text description of the video be presented in audio.</p> <p>Video on the web which has text descriptions of important video information will conform to the Section 508 web standards.</p> <p>However, in the discussion of the standards, the Access Board specifically referred to the multi-media section of the standards:</p> <p>The Board did not adopt WCAG 1.0 Checkpoint 1.3 which provides that "[u]ntil user agents can automatically read aloud the text equivalent of a visual track, provide an auditory description of the important information of the visual track of a multimedia presentation...." Although the NPRM did not propose addressing this issue in the web section, there was a similar provision in the multi-media section of the NPRM.</p> <p>Indeed there is a similar provision in the final rule as well. Paragraph 1194.24 (d) of the multi-media section (cited above) requires that training and informational multi-media productions which support the agency's mission shall have audio descriptions.</p>		
Synchronized multi-media	1.4 For any time-based multi-media presentation (e.g., a movie or animation), synchronize equivalent alternatives (e.g., captions or auditory descriptions of the visual track) with the presentation.	The Same	1194.22 (b) Equivalent alternatives for any multi-media presentation shall be synchronized with the presentation.
Color	2.1 Ensure that all information	The Same	1194.22 (c) Web pages shall

Keywords	WCAG Priority 1	Comparison	Section 508
	conveyed with color is also available without color, for example from context or markup.		be designed so that all information conveyed with color is also available without color, for example from context or markup.
Keywords	WCAG Priority 1	Comparison	Section 508
Natural Language	4.1 Clearly identify changes in the natural language of a document's text and any text equivalents (e.g., captions).	Not in 508	
	<p>The Access Board determined that:</p> <ol style="list-style-type: none"> 1. The intent of 4.1 is to for web authors to indicate change in natural language with markup (lang="en"), not using in-line text, like "the following is in German." 2. Not many assistive technologies support language change markup. <p>Based on that determination, the Access Board decided not to include this checkpoint as a standard for Section 508.</p>		
Table Headers	5.1 For data tables, identify row and column headers.	The Same	1194.22 (g) Row and column headers shall be identified for data tables.
Complex Tables	5.2 For data tables that have two or more logical levels of row or column headers, use markup to associate data cells and header cells.	The Same	1194.22 (h) Markup shall be used to associate data cells and header cells for data tables that have two or more logical levels of row or column headers.
Style Sheets	6.1 Organize documents so they may be read without style sheets. For example, when an HTML document is rendered without associated style sheets, it must still be possible to read the document.	The Same	1194.22 (d) Documents shall be organized so they are readable without requiring an associated style sheet.
Dynamic Content	6.2 Ensure that equivalents for dynamic content are updated when the dynamic content changes.	Not in 508	
	<p>The Access board did not include this checkpoint in the Section 508 standards for web accessibility because it was deemed unclear.</p> <p>The purpose of Checkpoint 6.2 is to back up other checkpoints, like 6.3, that require text alternatives for dynamic content. Checkpoint 6.2 says the text alternatives must be kept up-to-date. The techniques document for this checkpoint (http://www.w3.org/TR/WCAG10-HTML-TECHS/#scripts-alt) gives an example of using the NOSCRIPT element displaying sports scores in a definition list while the script would present the scores in a "bill board." This checkpoint requires that these two presentations are displaying the same scores.</p>		

Keywords	WCAG Priority 1	Comparison	Section 508
	<p>Another example of this, my favorite, is a JavaScript function that displays the date the page was last updated at the bottom of a web page by querying the file date. This can ensure that the update information is current without having to change the update information every time the page is modified. But if you use the NOSCRIPT option as a text alternative to that dynamic content, the NOSCRIPT content would have to be updated every time the page was modified by this checkpoint, thereby nullifying the usefulness of the script.</p>		
Scripting	<p>6.3 Ensure that pages are usable when scripts, applets, or other programmatic objects are turned off or not supported. If this is not possible, provide equivalent information on an alternative accessible page.</p>	WCAG more restrictive	<p>1194.22 (l) When pages utilize scripting languages to display content, or to create interface elements, the information provided by the script shall be identified with functional text that can be read by assistive technology.</p> <p>1194.22 (m) When a web page requires that an applet, plug-in or other application be present on the client system to interpret page content, the page must provide a link to a plug-in or applet that complies with §1194.21(a) through (l).</p>
	<p>The WCAG checkpoint is much easier to interpret; your pages have to be usable when scripts, applets and other programmatic objects are turned off. If your page satisfies this checkpoint then it is likely that you also satisfy the corresponding Section 508 standards cited above.</p> <p>However, the presumption of the Section 508 standards is that scripting, applets and other programmatic objects will be turned on (and supported) and those all must be accessible. So, if your site uses scripting just for visual enhancements, like changing text attributes when the mouse moves over text, then the site satisfies both WCAG 6.3 and Paragraph 1194.22 (l).</p> <p>If you use "fly-over" menus implemented in JavaScript, and all the submenu items are available as normal text links, then the site satisfies both 6.3 and 1194.22 (l).</p> <p>However, if you use Document.write to place (important) text on your page while it is loading, then it will be functional text available to assistive technology. Assuming that the text is important, the site fails WCAG 6.3 but passes 1194.22 (l).</p>		
Flicker	<p>7.1 Until user agents allow users to control flickering, avoid causing the screen to flicker.</p>	508 More Specific	<p>1194.22 (j) Pages shall be designed to avoid causing the screen to flicker with a frequency greater than 2 Hz and lower than 55 Hz.</p>
	<p>The Section 508 standard 1194.22(j) is intended to be consistent with WCAG checkpoint 7.1 adding only a specific range of frequencies to be avoided. In particular, the Access Board stated in the final rule:</p> <p>Paragraphs (j) and (k) are meant to be consistent with similar provisions in the WCAG 1.0, however, the final rule uses language which is more consistent with enforceable</p>		

Keywords	WCAG Priority 1	Comparison	Section 508
	regulatory language. It can be argued that 1194.22(j) is actually more restrictive because most flickering can be controlled in the major browsers by pressing the Escape key.		
Client Side Image Maps	9.1 Provide client-side image maps instead of server-side image maps except where the regions cannot be defined with an available geometric shape.	The Same	1194.22 (f) Client-side image maps shall be provided instead of server-side image maps except where the regions cannot be defined with an available geometric shape.
Text only last resort	11.4 If, after best efforts, you cannot create an accessible page, provide a link to an alternative page that uses W3C technologies, is accessible, has equivalent information (or functionality), and is updated as often as the inaccessible (original) page.	The Same	1194.22 (k) A text-only page, with equivalent information or functionality, shall be provided to make a web site comply with the provisions of this part, when compliance cannot be accomplished in any other way. The content of the text-only page shall be updated whenever the primary page changes.
Frames	12.1 Title each frame to facilitate frame identification and navigation.	The Same	1194.22 (i) Frames shall be titled with text that facilitates frame identification and navigation.
	For both of these requirements, be sure to include meaningful name and title attributes on frame elements.		
Clear Language	14.1 Use the clearest and simplest language appropriate for a site's content.	Not in 508	
	The Access Board decided against including this checkpoint as a standard for web accessibility because it was deemed too difficult to enforce. The requirement to use clearest and simplest language can be very subjective.		

The Section 508 View

NOTE: If a Web site is WCAG A-Compliant and its author wants to be Section 508 compliant as well, these are the five standards he must address additionally. These are paragraphs 1194.22 (l), (m), (n), (o), and (p).

Keywords	Section 508	Comparison	WCAG
Text Equivalent	1194.22 (a) A text equivalent for every non-text element shall be provided (e.g., via "alt", "longdesc", or in element content).	Similar	1.1 Provide a text equivalent for every non-text element (e.g., via "alt", "longdesc", or in element content). <i>This includes:</i> images, graphical representations of text (including symbols), image map

Keywords	Section 508	Comparison	WCAG
			regions, animations (e.g., animated GIFs), applets and programmatic objects, ascii art, frames, scripts, images used as list bullets, spacers, graphical buttons, sounds (played with or without user interaction), stand-alone audio files, audio tracks of video, and video.
	<p>The Section 508 standard uses the exact language of WCAG Checkpoint 1.1 without "This includes" of WCAG 1.1. Given the decision of the Access Board to use the WCAG wording, it follows that the examples of "non-text elements" in WCAG 1.1 apply to Section 508 1194.22 (a) as well. This is further confirmed in the discussion that precedes the standards mentioning audio as an example on non-text elements.</p> <p>The Board also interprets this provision to require that when audio presentations are available on a web page, because audio is a non-textual element, text in the form of captioning must accompany the audio, to allow people who are deaf or hard of hearing to comprehend the content.</p> <p>It was an error to refer to captioning of audio in the final standards. The guides to the standards clarify this (see 1194.22 (b))</p> <p>If a website offers audio files with no video, do they have to be captioned? No, because it is not multimedia. However, since audio is a non-text element, a text equivalent, such as a transcript, must be available. Similarly, a (silent) web slide show presentation does not need to have an audio description accompanying it, but does require text alternatives to be associated with the graphics.</p> <p>For spacer images, those used for formatting output, the text equivalent is the empty string, alt="", and that is the alternative text that should be associated with those images.</p> <p>The issue of text equivalents for scripts, applets and programmatic objects is quite a different matter. It is rare that there is such a thing as a "text equivalent" for one of these programmatic objects. Such is often interpreted as a functional description of the object, as in "this applet provides an interface for logging in so as to view your 401K account."</p> <p>The picture is complicated by the role of such extensions to HTML in WCAG 1.0 compared to that in Section 508. For the former the pages must be usable with scripts and applets turned off or not supported. This makes the importance of the "text equivalent" much greater for WCAG compliance compared with Section 508. For section 508 these extensions must be accessible (see Paragraphs 1194.22 (l) and 1194.22 (m)).</p>		
Synchronized multi-media	1194.22 (b) Equivalent alternatives for any multi-media presentation shall be synchronized with the presentation.	The Same	1.4 For any time-based multi-media presentation (e.g., a movie or animation), synchronize equivalent alternatives (e.g., captions or auditory descriptions of the visual track) with the presentation.
Color	1194.22 (c) Web pages shall be designed so that all	The Same	2.1 Ensure that all information conveyed with color is also

Keywords	Section 508	Comparison	WCAG
	information conveyed with color is also available without color, for example from context or markup.		available without color, for example from context or markup.
Style Sheets	1194.22 (d) Documents shall be organized so they are readable without requiring an associated style sheet.	The Same	6.1 Organize documents so they may be read without style sheets. For example, when an HTML document is rendered without associated style sheets, it must still be possible to read the document.
Server-Side Image Maps	1194.22 (e) Redundant text links shall be provided for each active region of a server-side image map.	The Same	1.2 Provide redundant text links for each active region of a server-side image map.
Client Side Image Maps	1194.22 (f) Client-side image maps shall be provided instead of server-side image maps except where the regions cannot be defined with an available geometric shape.	The Same	9.1 Provide client-side image maps instead of server-side image maps except where the regions cannot be defined with an available geometric shape.
Table Headers	1194.22 (g) Row and column headers shall be identified for data tables.	The Same	5.1 For data tables, identify row and column headers.
Complex Tables	1194.22 (h) Markup shall be used to associate data cells and header cells for data tables that have two or more logical levels of row or column headers.	The Same	5.2 For data tables that have two or more logical levels of row or column headers, use markup to associate data cells and header cells.
Frames	1194.22 (i) Frames shall be titled with text that facilitates frame identification and navigation.	The Same	12.1 Title each frame to facilitate frame identification and navigation.
Keywords	Section 508	Comparison	WCAG
Flicker	1194.22 (j) Pages shall be designed to avoid causing the screen to flicker with a frequency greater than 2 Hz and lower than 55 Hz.	508 More Specific	7.1 Until user agents allow users to control flickering, avoid causing the screen to flicker.
	<p>The Section 508 standard 1194.22(j) is intended to be consistent with WCAG checkpoint 7.1 adding only a specific range of frequencies to be avoided. In particular, the Access Board stated in the final rule:</p> <p>Paragraphs (j) and (k) are meant to be consistent with similar provisions in the WCAG 1.0, however, the final rule uses language which is more consistent with enforceable</p>		

Keywords	Section 508	Comparison	WCAG
	<p>regulatory language.</p> <p>It can be argued that 1194.22(j) is actually more restrictive because most flickering can be controlled in the major browsers by pressing the Escape key.</p>		
Text only last resort	1194.22 (k) A text-only page, with equivalent information or functionality, shall be provided to make a web site comply with the provisions of this part, when compliance cannot be accomplished in any other way. The content of the text-only page shall be updated whenever the primary page changes.	The Same	11.4 If, after best efforts, you cannot create an accessible page, provide a link to an alternative page that uses W3C technologies, is accessible, has equivalent information (or functionality), and is updated as often as the inaccessible (original) page.
Scripting	1194.22 (l) When pages utilize scripting languages to display content, or to create interface elements, the information provided by the script shall be identified with functional text that can be read by assistive technology.	WCAG more restrictive	<p>6.3 Ensure that pages are usable when scripts, applets, or other programmatic objects are turned off or not supported. If this is not possible, provide equivalent information on an alternative accessible page.</p> <p>6.4 For scripts and applets, ensure that event handlers are input device-independent. (Priority 2)</p> <p>8.1 Make programmatic elements such as scripts and applets directly accessible or compatible with assistive technologies [Priority 1 if functionality is important and not presented elsewhere, otherwise Priority 2.]</p> <p>9.3 For scripts, specify logical event handlers rather than device-dependent event handlers. (Priority 2)</p>
	<p>As discussed in "The WCAG View" table, if pages satisfy Checkpoint 6.3, it means that scripts are not involved with essential or important content (not conveying information) and thus would not require text that can be accessed by assistive technology. They would pass 1194.22(l).</p> <p>Two of the WCAG Priority 2 checkpoints (6.4 and 9.3) stress the need for accessibility of event handlers, primarily for keyboard access. This focus is not reflected in the Section 508 Web standards. Note that keyboard access is required in the software standards, 1194.21(a), but that does not apply to web content.</p> <p>The most important comparison between the Section 508 standard for scripts and the checkpoints of WCAG is the Priority 2/1 Checkpoint 8.1 which requires that scripts be directly accessible or compatible with assistive technology. My interpretation of "compatible with assistive technology," is that it is essentially that which Paragraph 1194.22 (l) requires. If Checkpoint 6.3 were not present, I would say that the</p>		

Keywords	Section 508	Comparison	WCAG
	<p>requirements on scripts from the Web Accessibility Initiative (including Priority 2) is similar to that from Section 508.</p> <p>However, there is a puzzling inconsistency in the WCAG checkpoints. Checkpoint 8.1 is listed with the Priority 2 items, yet for important functionality it is supposed to be Priority 1. On the other hand, checkpoint 6.3 (Priority 1) requires that pages be usable with scripts and applets turned off. It seems to me that Checkpoint 6.3 trumps Checkpoint 8.1 and important scripts are not allowed, whereas accessible scripts (those satisfying 8.1) are allowed by 1194.22 (l).</p>		
Applets and plug-ins	1194.22 (m) When a web page requires that an applet, plug-in or other application be present on the client system to interpret page content, the page must provide a link to a plug-in or applet that complies with §1194.21(a) through (l).	Similar	<p>6.3 Ensure that pages are usable when scripts, applets, or other programmatic objects are turned off or not supported. If this is not possible, provide equivalent information on an alternative accessible page. (Priority 1)</p> <p>6.4 For scripts and applets, ensure that event handlers are input device-independent. (Priority 2)</p> <p>8.1 Make programmatic elements such as scripts and applets directly accessible or compatible with assistive technologies [Priority 1 if functionality is important and not presented elsewhere, otherwise Priority 2.]</p>
	<p>The intent of the Section 508 software standards (§1194.21(a) through (l)) is to have specific requirements that will insure that software is directly accessible and/or compatible with assistive technology. Thus, if web sites satisfy 1194.22 (m) then they will comply with WCAG checkpoints 6.4 and 8.1. However, they will not necessarily comply with the Priority 1 WCAG checkpoint 6.3.</p>		
Forms	1194.22 (n) When electronic forms are designed to be completed on-line, the form shall allow people using assistive technology to access the information, field elements, and functionality required for completion and submission of the form, including all directions and cues.	Similar	<p>10.2 Until user agents support explicit associations between labels and form controls, for all form controls with implicitly associated labels, ensure that the label is properly positioned. (Priority 2)</p> <p>12.4 Associate labels explicitly with their controls. (Priority 2)</p> <p>9.3 For scripts, specify logical event handlers rather than device-dependent event handlers. (Priority 2)</p>
	<p>The key to accessible forms is for a person using assistive technology to be able to identify the purpose of any form control element and to be able to manipulate it. Knowing the intent of the input element is the purpose of WCAG Priority 2 checkpoints 10.2 and 12.4. WCAG checkpoint 9.3 would ensure that the form can be manipulated with the keyboard.</p>		
Skip	1194.22 (o) A method shall	Related to	13.5 Provide navigation bars to

Keywords	Section 508	Comparison	WCAG
Navigation	be provided that permits users to skip repetitive navigation links.	WCAG but Section 508 more specific	highlight and give access to the navigation mechanism. (Priority 3) 13.6 Group related links, identify the group (for user agents), and, until user agents do so, provide a way to bypass the group. (Priority 3)
	The "skip navigation" provision of the Section 508 Standards is related to a couple of Priority 3 WCAG checkpoints, but the Section 508 standard is specific and direct. The WCAG checkpoints assume technology not yet supported, like grouping and labeling links.		
Timed Responses	1194.22 (p) When a timed response is required, the user shall be alerted and given sufficient time to indicate more time is required.	Not in WCAG	
	There are not comparable checkpoints in the Web Content Accessibility Guidelines.		

Appendix E: The Interview Questions

E.1 Information Sheet for Vision Impaired Student Interviews

Project Title: Design of Accessible online IT learning Environments for the Vision Impaired

Project Description

You have been invited to participate in this study, which is part of a higher degree research study at School of Information Systems, Curtin University of Technology, Perth, Western Australia.

The purpose of this study is to investigate the best possible way to design accessible online IT learning environments for the vision impaired (VI). The particular focus of the research will be IT education for this group. To do this, it is necessary to identify not only the needs of the target group (the vision impaired) but also the critical accessibility characteristics of online learning environments. This research will identify the essential components and build a conceptual model and a set of guidelines to address the needs of learners with a visual impairment. The researcher will undertake interpretive qualitative research using the Design Science method.

The major methods of data collection will involve observation of online teaching environments, interviews with vision impaired learners and interviews with their instructors. This will be achieved through a study of:

1. The TruVision Project: a virtual (Web based) learning setting, which is for the Certificate I in Information Technology. The TruVision project is funded by Australian National Training Authority (ANTA).
2. Cisco Access for the Vision Impaired (CAVI), a joint project between Curtin, Cisco Systems and the Association for the blind (ABWA)
3. Vision Australia, Victoria

Aims of the project:

1. To investigate the features of effective and ineffective online learning environments for vision impaired learners
2. To build a conceptual model of an effective online learning environment in IT studies for the vision impaired appropriate to their disability

3. To develop a set of guidelines for the design and development of accessible online learning environments in IT for the vision impaired.

Participant Interaction:

Participants will be asked questions regarding their specific role and the role of the learner or teacher in relation to the use online IT learning Environments for vision impaired people. These questions will range from specific issues of features and services through to broader issues of social change and policies

Each interview will last approximately one hour.

Ethical approval:

This Doctoral study conforms to the National Statement on Ethical Conduct in Research Involving Humans and has been approved by the Ethics Committee at School of Information Systems, Curtin University of Technology.

Confidentiality and Security:

- All interviews will require the consent of the interviewee;
- The interviewee will have the right to refuse an interview or reject a previously consented interview at any time up to the publication of the thesis;
- To ensure that any potential misunderstandings of the subject material are resolved prior to the interview taking place through clear and concise explanations of the source material;
- All interviewees will be kept completely confidential unless permission has been given by the interviewee; and
- All questions are designed in a way to eliminate bias.

Risks:

Although some questions may be of a personal nature, there are no obvious safety issues that need to be addressed during the interview process.

Benefits: The aim of this research exercise is to provide benefits to the participants in the following areas:

Individual: The participants will contribute to the enhancement of the accessibility of online environments. It is an opportunity to voice concerns and opinions about the practical experience of working online.

The findings will provide a means to improve the accessibility of the online materials for the participants to help their learning.

Society: There are anticipated long term benefits for the design of the online IT learning environments for the vision impaired. From the research there will be a development of better design guidelines which should offer ease of access and easy user systems, so that there would be an increase in the number of online IT learners who have had previously difficulties with the online learning environments.

Inquiries: Any questions concerning the project entitled Design of accessible online IT learning environments for the Vision Impaired can be directed to Ruchi Permvattana (Principal Investigator) School of Information Systems, Curtin University of Technology e-mail: ruchi@permvattana.com

If you have any concerns about the project or would like to talk to an independent person, you may contact Dr Helen Armstrong (Supervisor) School of Information Systems, Curtin University of Technology e-mail:
Helen.Armstrong@cbs.curtin.edu.au

The project has been approved by Francesca Vallini, Coordinator for Human Research Ethics, School of Information Systems, Curtin University of Technology, Perth Western Australia. E-mail: Francesca.Vallini@cbs.curtin.edu.au

Approval Number IS 10_02

E.2 The Interview Questions

Ruchi Permvattana - Interview Questions to CAVI Students

Name: _____ Organisation _____ Date _____

Part 1: The characteristics/demographics and needs of the adult VI learner

1. What is your Gender?
 1. Male
 2. Female
2. What is your Age?
 1. 15-25
 2. 26-35
 3. 36-45
 4. 46-55
 5. 56-65
 6. over 66
3. I use a screen reader/screen magnifier
 1. All the time due to a disability
 2. Part of the time due to a disability
 3. Often, but do not have a disability that requires a screen reader/screen magnifier
 4. Occasionally to perform accessibility evaluation
 5. Other – please give details
4. What type of vision impairment do you have? (can be more than one answer)
 1. Optic Atrophy
 2. Nystagmus
 3. Macular Degeneration
 4. Glaucoma
 5. Diabetic Retinopathy (as a result of Diabetes)
 6. Cataracts
 7. Ocular Albinism
 8. Oculocutaneous
 9. Albinism
 10. Retinitis Pigmentosa (RP)
 11. Other - please give details
5. Congenitally Blind
 1. Yes
 2. No
6. What is your vision level?

1. 20/70 to 20/200 - moderate visual impairment, or low vision
 2. 20/200 to 20/400 - severe visual impairment, or severe low vision - legal blindness
 3. Less than 20/1,000 - near-total visual impairment, or near total blindness
 4. No Light Perception - considered total visual impairment, or total blindness
7. Please rate your computer proficiency
1. Expert
 2. Advanced
 3. Intermediate
 4. Beginner
 5. None
8. Please rate your Screen Reader Proficiency
1. Expert
 2. Advanced
 3. Intermediate
 4. Beginner
 5. None
9. What Screen Reader do you use?
1. JAWS
 2. Window-Eyes
 3. NVDA
 4. VoiceOver
 5. Other – please give details
10. What Screen Magnifier do you use?
1. ZoomText
 2. Zoom+
 3. Dolphin Lunar
 4. Magic
 5. DesktopZoom
 6. Other – please give details
11. How soon do you update your screen reader/screen magnifier after a new version is released?
1. Immediately
 2. Within 1 month
 3. Within 3 months
 4. First 6 months
 5. 6-12 months
 6. 1-2 years
 7. 2-3 years

8. 3+ years
 9. Other – please give details
12. How customized are your screen reader/screen magnifier settings? (e.g., changed verbosity, installed scripts, etc.)
1. Extensive
 2. A lot
 3. Somewhat
 4. Slightly
 5. Not at all
13. What types of hardware devices do you use? What features do you use on these devices?
1. Desktop
 2. Laptop
 3. Mobile phone
 4. Other - please give details
 5. None
14. What is your Internet connection type? Why?
1. Broadband
 2. Naked DSL
 3. Mobile Broadband
 4. Dialup
 5. WIFI Hotspots
 6. Other - please give details
 7. None
15. Which web browser(s) do you currently use with a screen reader/screen magnifier? Why?
1. IE6
 2. IE7
 3. IE8
 4. Firefox
 5. Safari
 6. Google Chrome
 7. Other - please give details
 8. None
16. Web page behavior - When first accessing a new, and unfamiliar web page, I'm most likely to...
1. Read through the home page
 2. Navigate through or listen to the links on the page
 3. Use the Search to find what I'm looking for
 4. Look for a site map or site index

5. Other - please give details

17. Access keys - I use Access keys:

1. Whenever it is available
2. Often
3. Sometimes
4. Seldom
5. Never

18. Headings - I navigate by headings

1. Whenever it is available
2. Often
3. Sometimes
4. Seldom
5. Never

19. Locating search - How do you usually try to locate the site search?

1. Read through the page content until the search form is encountered
2. Tab through page elements until the search form is encountered
3. Find the word "Search"
4. Jump to the first text/edit field on the page
5. Jump to the first button on a page and go back one element
6. Jump to the first form element in a page
7. Other - please give details

20. Site maps - If a site map is available, how often do you use it?

1. Whenever it is available
2. Often
3. Sometimes
4. Seldom
5. Never

21. Text only versions - If a text only version of a web site is available, how often do you use it?

1. Whenever it is available
2. Often
3. Sometimes
4. Seldom
5. Never

22. Pop – up windows - The pop – up windows I have used in this course are very accessible.

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

23. Images - If an image is used solely to enhance the meaning or feel of a Web page, I would prefer that the image:

1. Be described by my screen reader
2. Be ignored by my screen reader
3. Other - please give details
4. No opinion

24. Repeated links – I have no difficulty coping with different links with the same text repeated multiple times on the same page (e.g., "more", "add to cart", "details")

1. Strongly Disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

25. Multimedia Interactive content – The use of Flash helps to make the course content more accessible.

1. Strongly Disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

26. Acrobat/PDF – All of the PDF files in these online learning environments are accessible:

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree

5. Strongly agree

27. How long have you been enrolled in courses using online learning environments?

1. Less than 3 months
2. More than 3 months
3. More than 6 months
4. More than 1 year
5. More than 3 years

Part Two: The components of effective accessible Web-based online learning environments for IT training and education

28. Which courses do you find the easiest to learn? Why?

29. An online learning environment consists of the hardware, software, all the teaching materials and the methods of course delivery. What problems have you encountered whilst utilizing these online learning environments?

30. The online learning environment I have used are totally accessible. Please give examples.

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

31. Orientation is the position or the way in which page content is oriented - The orientation of these online learning environments is reliable and consistent. Please give examples.

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

32. Web site navigation systems are how you move around the online learning environments with a collection of links that might be images, text or Flash files

The navigation systems of these online learning environments is reliable and consistent. Please give examples.

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

33. Which components can you access easily? Why?

34. Which components do you have most difficulty accessing? Why?

35. What features seem to be the most accessible? Why?

36. You are satisfied with these online learning environments.

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

37. These online learning environments make all functionality available from a keyboard.

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

38. These online learning environments provide you enough time to read and use the contents.

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

39. These online learning environments make Web pages appear and operate in predictable ways.

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

40. The text content in these online learning environments is readable and understandable.

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

41. The online learning environments in this course help you avoid and correct mistakes. Please give examples.

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

42. Do these online learning environments provide text alternatives for any non-text content? (Can be more than one answer)

1. Provide short text alternative for non-text content
2. Provide a long description in text near the non-text content
3. Provide a long description in another location with a link to it
4. Other – please give details

43. Do you have any suggestions as to how these online learning environments can be improved?

44. What are your career goals for the future?

Additional questions:

45 Who have you approached for learning guidance regarding the curriculum in the past 6 months, and how often? (0= None, 1= Occasionally, 2 = Monthly, 3 = Weekly, 4 = Daily)

46 Who have you approached for technical advice regarding the equipment and technical issues in the past 6 months, how often?

(0= None, 1= Occasionally, 2 = Monthly, 3 = Weekly, 4 = Daily) Example of technical advice request: How do I do something in JAWS?

47 Who have you approached for advice on accessibility issues regarding Web sites, learning materials, etc. in the past 6 months, and how often? (0= None, 1= Occasionally, 2 = Monthly, 3 = Weekly, 4 = Daily)

48 Who have you gone to for advice for general matters in the past 6 months and how often? (0= None, 1= Occasionally, 2 = Monthly, 3 = Weekly, 4 = Daily) Example” Traveling and food, helpful Web sites, services, etc.

49 How often do you use the following communication methods to contact other students and instructors? (0= None, 1= Occasionally, 2 = Monthly, 3 = Weekly, 4 = Daily) Example of the methods as followed:

Skype

Ventrilo

Twitter

Facebook

MySpace

Email

Discussion Board or Other

50 What factors make the CAVI virtual learning environments a ‘place’ rather than a ‘space’? What makes it meaningful and enriching? What factors give you a sense of belonging, generate positive emotions and also give you direction?

End of interview questions. Thank you very much.

E.3 Consent Form

Project Title: Design of Accessible Online IT Learning Environments for the Vision Impaired

I _____ have read the information above and any questions I have asked have been answered to my satisfaction.

I agree to participate in this activity, realising that I may withdraw at any time.

I agree that the research data gathered for this study may be published provided

I am not identifiable.

Participant:

Date: _____

Investigator: Ruchi PERMVATTANA:

Date:

E.4 Information Sheet for The Evaluation of the VIVID

Information Sheet

Project Description

You have been invited to participate in this project, which is part of a higher degree by research at the School of Information Systems, Curtin University, Perth, Western Australia. The purpose of this project is to evaluate the new model for a holistic accessible e-learning environment for vision impaired students studying IT.

It is evident from both past research and the analysis conducted in this research that vision impaired adult learners require a different learning environment from sighted learners. This study presents a new model for the vision impaired, encompassing a Web based IT e-learning environment entitled the Vision Impaired using Virtual IT Discovery (VIVID) model.

The model was developed after considering:

- relevant literature and past research in this area
- study of the TruVision and the Cisco Academy for the Vision Impaired (CAVI), two e-learning environments and
- analyses of the observations, questionnaires and interviews of both vision impaired teachers and learners.

The VIVID Model

The research gathered data from interviews, questionnaires and observations from sighted and vision impaired teachers and learners to identify characteristics of a range of vision disabilities and the needs associated with these.

The data collected and analysed within this research have demonstrated the components needed for effective Web-based learning environments for vision impaired learners.

These components include:

- accessibility standards and guidelines
- accessible physical classroom
- accessible virtual classroom
- accessible curriculum and teaching materials
- social elements

- learning outcomes
- learner characteristics and
- evaluation, feedback and enhancement.

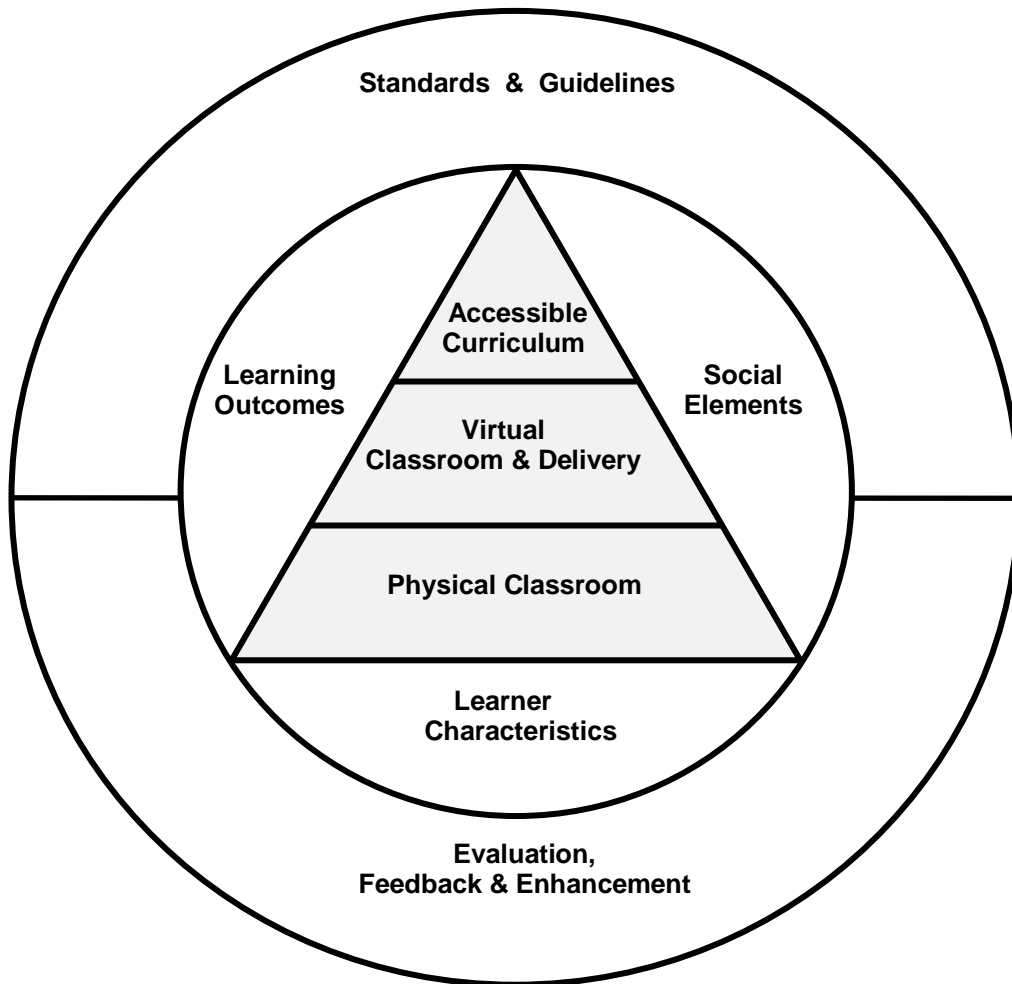


Figure: The Vision Impaired using Virtual IT Discovery (VIVID) model

An explanation of the VIVID Model

The VIVID Model is comprised of the eight components listed below.

1 Standards, Specifications and Guidelines

The specifications and guidelines such as Web Accessibility Initiative (WAI) from The World Wide Web Consortium (W3C) are recognised by governments and Web site agencies. A prospective Web designer and developer should refer to these for the design of learning environments for the vision impaired if accessibility is to be achieved.

The developer must choose which standards, specifications and guidelines are appropriate for the learning situation at hand and needs of the disabled learners. Regular evaluation of standards compliance is also recommended.

2 Accessible Physical Classroom

The analysis demonstrated that the requirement for an accessible physical classroom for vision impaired learners should include consideration of the physical elements. These elements include the following items that are specifically configured for the vision impaired to ensure accessibility:

- computer desks
- ergonomic chairs
- personal Computers (PC) and laptops
- microphones
- printers
- electronic USB Whiteboards
- accessible teaching aids and
- classroom layout.

3 Accessible Curriculum and Teaching Materials

The analysis demonstrated that the needs of accessible curriculum and teaching materials for vision impaired learners should include consideration of the following elements:

- accessible teaching materials
- accessible and practical laboratory exercises
- accessible assessments
- accessible E-doing tools, games and quizzes
- additional accessible resources
- accessible computerised tools and
- flexible timelines.

4 Accessible Virtual Classroom and Delivery

Virtual classroom refers to a learning environment where teachers and learners are separated by space or time or both, and the teacher provides course content through the use of methods such as course management applications, multimedia resources, the Internet, video recorded lectures, tutorials and case studies. Learners receive the contents and communicate with the teachers via the same technologies, skills in using assistive technologies, such as a screen reader or screen magnifier,

are a pre-requisite for vision impaired learners who will require a sound working knowledge of these tools and their limitations.

Designing Accessible Virtual Classroom and Delivery should include consideration of the following elements:

- assistive technologies
- vision impaired teachers
- Voice over Internet Protocol (VoIP) application
- accessible manuals for virtual classroom operations
- sighted teachers to manage entire environment and
- assistive technology technicians.

5 Social Elements

The term social elements in this research refers to the ways in which information can assist the learners communicate, understand, feel part of the group, belong, respect and share knowledge as part of a like learning community.

Being able to communicate with teachers and other learners in a real-time and online environment via a virtual classroom is essential. Applications such as Ventrilo can provide a virtual classroom environment where teachers can broadcast lectures, take questions during the broadcast, and encourage learner participation and discussion. In addition to classroom communications the vision impaired learners need to be able to communicate with their tutor and other learners on a one-to-one or group basis using free communication methods such as e-mail, Skype and social networking sites such as Facebook and MySpace.

6 Learner Characteristics

In order to achieve accessible individual learning experience, it is necessary to consider the individual's specific needs, background factors, demographic and cultural factors. The individual's needs with relation to their disability, such as level of vision, the age when the vision impairment occurred (i.e. congenitally blind or blindness through disease), any other medical issues and any other disability, will affect their needs in a learning environment. Background factors included the individual's age, gender, knowledge and experience of IT, knowledge and experience of the assistive technologies, quality of Internet connection, responsiveness of assistive technologies used, acceptance of new technologies and applications, and the behaviours of how they use web applications in general. Geographic and cultural factors will affect the way the individual connects to the

internet and applications within the learning environment and the way they communicate with instructors and other students.

7 Learning Outcomes

Learning outcomes are pre-set by the curriculum and instructional designers. Learning outcomes in the VIVID model are defined as being a statement identifying what vision impaired learners should have achieved as a result of successfully completing accessible IT e-learning course.

These learning outcomes need to ensure the vision impaired learners meet the same learning outcomes as sighted students. In order to achieve this objective all components of the model must integrate to ensure the learners are able to meet the stated learning outcomes in the newly designed e-learning environment. In fact the design of the learning environment must be built with the learning outcomes as a foundation.

8 Evaluation, Feedback and Enhancement

In order to maintain an appropriate and accessible IT e-learning environment for the vision impaired, there is a need to ensure that the objectives of the environment continue to be met so that the vision impaired learners can achieve the learning outcomes. This requires activities to evaluate how well the environment is operating in relation to the objectives, providing feedback on all sections of the environment and also applying changes and enhancements to ensure the needs and objectives are met.

Participant Interaction

Participants will be asked questions regarding evaluation of the VIVID model and give feedback on its strengths and weaknesses.

Risks

The questions asked in this survey present no risk to the participant. No personally identifiable information will be gathered.

Benefits

The aims of this research exercise are to provide benefits to the participants in the following areas:

Individual

The participants will contribute to the enhancement of the accessibility of e-learning environments. It is an opportunity to voice concerns, opinions and comments on the model based on your experience of working in the area.

The findings will provide a means to improve the accessibility of e-learning environments for the vision impaired.

Society

There are anticipated long term benefits for the design of IT e-learning environments for the vision impaired. E-learning environments developed utilizing the VIVID model as a base will aid vision impaired learners who have previously had difficulties with e-learning environments developed specifically for sighted students.

Inquiries

This study has been approved under Curtin University's process for lower-risk Studies (Approval Number IS_12_09). This process complies with the National Statement on Ethical Conduct in Human Research (Chapter 5.1.7 and Chapters 5.1.18-5.1.21).

For further information on this study contact the researcher Ruchi Permvattana by telephoning mobile 0402 832 837 or by emailing ruchi@permvattana.com. OR

The Curtin University Human Research Ethics Committee. c/- Office of Research and Development, Curtin University, GPO Box U1987, Perth 6845 or by telephoning 9266 9223 or by emailing hrec@curtin.edu.au.

E.5 The Questions for experts in e-learning environments for the vision impaired

The respondents acknowledge consent by returning the questionnaire.

1. The model incorporates ample considerations of the specific design of IT education courses for vision impaired students.

Strongly agree Agree Neutral Disagree Strongly Disagree

2. The model incorporates ample considerations of the vision impaired so they can achieve the same learning outcomes as sighted students.

Strongly agree Agree Neutral Disagree Strongly Disagree

3. The model incorporates ample considerations of assistive technologies used by vision impaired students.

Strongly agree Agree Neutral Disagree Strongly Disagree

4. The model incorporates ample considerations of social aspects for vision impaired students.

Strongly agree Agree Neutral Disagree Strongly Disagree

5. The model incorporates ample considerations of the individual characteristics of vision impaired students.

Strongly agree Agree Neutral Disagree Strongly Disagree

6. The model incorporates ample considerations of the physical teaching and learning environment for vision impaired students.

Strongly agree Agree Neutral Disagree Strongly Disagree

7. The model incorporates ample considerations of the limitations resulting from vision disabilities.

Strongly agree Agree Neutral Disagree Strongly Disagree

8. Please comment on the strengths of the model

9. Please comment on the weaknesses of the model

10. Please make any other comments which you think may be useful for this research.

Thank you for your participation.

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