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Adapting Hands-On Science Programs for Students with Disabilities

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Abstract

The Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia's National Science Agency, has recognized that their hands-on science programming does not accommodate students with disabilities and seeks to make adjustments to existing programs. Present methods for teaching students with disabilities were investigated through a literature review and interviews with teachers at mainstream and specialist schools, special education coordinators, school administrators, visiting teachers, occupational therapists, teachers of the deaf, and Victorian Department of Education Officers. Additionally, several of the hands-on programs at the Victorian CSIRO Science Education Centre were observed to identify barriers for students with disabilities which are common in science programs. This information was used to develop a framework for adapting hands-on science education programs for students with visual, hearing, and mobility impairments. The framework contains a universal design section, as well as disability specific accommodations. The framework takes the form of a matrix pairing tasks with possible solutions for various degrees of the three disabilities which the framework focuses on.

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Nomenclature

- ADA - The Americans with Disabilities Act
- AD/HD - Attention Deficit and Hyperactivity Disorder
- ALS - Amyotrophic Lateral Sclerosis
- ASL – American Sign Language
- CATS – Coordinated and Thematic Science
- CSIR - Council for Scientific and Industrial Research
- CSIRO – Commonwealth Scientific and Industrial Research Organisation
- CSIROSEC - Commonwealth Scientific and Industrial Research Organisation Student Education Centre
- DO-IT - Disabilities, Opportunities, Internetworking, and Technology
- DDA Australia – Australia's Disability Discrimination Act
- DDA Britain – Great Britain's Disability Discrimination Act
- Disability - A condition that in some way hampers or hinders a person in terms of their ability to carry out day to day activities
- Education Provider – Educational authorities, educational institutions, and organizations whose purpose is to develop or accredit curricula or training courses used by other education providers (Australia)
- ESL – English as a Second Language
- Formal Education – The approach to teaching which is most common and historically prevalent, and which relies on traditional methods of presentation to communicate concepts to students (Smith, 2005)
- Handicap - When a disability hinders a person's activities of daily living
- IDEA – The Individuals with Disabilities Education Act (USA)
- IEP – Individualized Education Program (USA)
- ILP – Individualized Learning Plan (Australia)

- Impairment - Any loss or abnormality of a psychological, physical, or anatomical function
- Informal Education – Learning activities which are "voluntary and self-directed, life-long, and motivated mainly by intrinsic interests, curiosity, exploration, manipulation, fantasy, task completion, and social interaction." Other characteristics of informal learning include self-pacing and visual/object orientation (National Science Foundation, 2005)
- PSG – Parent Support Group (Australia)
- Reasonable Accommodation – An adjustment made in an effort to accommodate one with a disability (USA)
- RIDBC – Royal Institute for Deaf and Blind Children
- SAM – Student Accessibility Matrix
- STEM – Science, Technology, Engineering and Math
- Universal Design – A strategy used to design programs, buildings, and products in a way that makes them accessible to everyone, including those with disabilities
- Unjustifiable Hardship – An action that requires considerable difficulty or expense, which is not substantiated by the circumstances (Australia)
- VELS – Victorian Essential Learning Standards
- VAILS – Vision Australia Information Library Services

Executive Summary

The Commonwealth Scientific and Industrial Research Organization (CSIRO) is Australia's National Science Agency. CSIRO conducts scientific research with the focus of benefiting Australian industry and society. Another aspect of CSIRO is its Education Centre, whose mission is to inspire future scientists through hands-on science programs for school-aged children. The Melbourne CSIRO Science Education Centre (CSIROSEC) runs a range of science programs with an emphasis on the development and promotion of hands-on science education programs for students of all ages across Victoria. However, the Melbourne CSIROSEC was not proactively providing for all students because they did not have a formal plan for accommodating for students with disabilities. The project team was asked to adapt CSIRO programs for students with disabilities to ensure that their programs would be accessible to any student.

The main goal of this project was to develop a framework for adapting hands-on science programs to make them accessible to students with disabilities; more specifically, students with hearing, mobility, and visual impairments. This framework took the form of the Student Accessibility Matrix, SAM. A secondary goal of the project was to make suggestions to adapt a CSIRO Education program, known as Forensic Frenzy, using SAM to make it accessible to students with disabilities. These adaptations took the form of three case studies focusing on a student with no hearing who uses manual communication, a student with muscular dystrophy, and a student with low vision. The purpose of these case studies was to demonstrate how SAM can be used to make accommodations, as well as propose specific adaptations which can be implemented by CSIRO to modify their programming.

The goals of this project were accomplished by completing the following objectives: develop an understanding of the capabilities associated with different disabilities, determine current accommodations and methods of best practice to accommodate students with disabilities, evaluate and assess CSIRO Education programs, and develop a framework to be used for adapting hands-on science programs. In order to accomplish these objectives, the project team completed an extensive literature review to gain information regarding disability legislation, informal education, and background information on each type of disability. Interviews were conducted both in the United States and Australia with science teachers, specialist teachers, interpreters, teachers of the deaf, special education coordinators, school administration, and Officers of the Victorian Department of Education. From these interviews, the project group obtained valuable information regarding methods of best

practice, student support and aid, science specific adaptations, and the varying range of student abilities. The information gathered from the interviews was compiled and integrated into the accessibility framework.

CSIRO Education programs were observed to gain first hand experience with hands-on science education programs while also evaluating barriers present in CSIRO programs. For each program, an extensive barrier checklist was completed which identified tasks within each program which could potentially act as barriers for students with disabilities. Program observations assisted the team in identifying tasks to include in the framework and also gave the project team enough familiarity with the Forensic Frenzy program to make recommendations for the three case studies.

The main deliverable of this project was the Student Accessibility Matrix, SAM. SAM is a framework designed to help adapt hands-on science programs to be accessible to students with disabilities. SAM contains a universal design section as well as three disability-specific sections. The purpose of the universal design section is to outline changes which can be made in the classroom that benefit not only students with disabilities, but all students. By incorporating the modifications outlined in the universal design section, it is possible to take a proactive approach to making activities more accessible to students of all ability levels. Several subjects are addressed by the universal design section of SAM including presentation style, teaching methods, classroom setup, and multi-sensory learning. Within the universal design section of SAM, there is a numbered list of modifications followed by more detailed descriptions of each of the suggested modifications.

There are three disability specific sections of SAM which contain accommodations for students with auditory, mobility, and visual impairments. For each disability-specific section, a spectrum was outlined which presented different degrees of ability that are common among students. The auditory spectrum included students with partial hearing, no hearing, students who can verbalize orally, and students who use manual communication. For students with mobility impairments the spectrum included limited fine motor skills, limited gross motor skills, limited strength, and limited range of motion. Furthermore, students with visual impairments included students with colour-blindness, a limited visual field, low vision, and blindness.

Tasks which presented themselves as barriers to students were also identified in each section. A description of each task was provided, along with examples of the task which are commonly found in a hands-on science setting. Tasks ranged from targeting to observing physical changes, lifting objects, and accessing language. Information regarding the tasks was presented in the form of a matrix along with each spectrum of ability.

The tasks and spectrum were then organized in the form of a matrix. An excerpt from the Vision SAM is shown below in Figure 1. The top row of the matrix contains cells listing the spectrum of abilities and the first column lists tasks which were identified as barriers for each disability. In the row below the spectrum, general accommodations which can be made based on the degree of student ability are listed. These are accommodations that are common for students with the selected disability, regardless of the task being performed. Cells in the rest of the matrix contain solution codes which correspond to adaptations that should be made in order for the task to be accessible to students with the ability described in the spectrum. Solution codes may be used in more than one cell and are defined in a section after the matrix. For each solution, a short bulleted list outlining the main points of the adaptation is provided, as well as an expanded section which provides more detailed information regarding specific applications of the solution.

VISION SAM				
Task	Colour-blind	Limited Visual Field	Low Vision	Blind
ALL TASKS	V7, V16	V9, V16	V7, V8, V12, V16	V16
Targeting (Moving, Pouring, Assembling)			V5	V5
Measuring Using an Analogue Scale			V3	V3

Figure 1: Excerpt from Vision SAM Section

In order to gain insight about the usability and accuracy of SAM, feedback was generated from professionals in each disability specific field. The professionals were asked to provide information about the user-friendliness of SAM, feasibility of proposed adaptations, and areas of potential improvement. These suggestions were incorporated into the final draft of SAM.

Upon implementing SAM, CSIROSEC will become a leader in disability inclusion in Australia. Furthermore, CSIROSEC will also be compliant with new disability legislation outlined in Australia's Disability Discrimination Act (DDA). By complying with the DDA CSIRO will provide equal opportunities for all students, regardless of ability. Additionally, SAM is now a resource which is available to teachers, educators, and science outreach programs.

As a resource, SAM is user friendly and versatile. During development of SAM, it was recognized that SAM would be used by a variety of different groups including teachers, educators, outreach programs, and occupational therapists, among others. It was extremely important that SAM was easy to understand and that the adaptations proposed in the framework were feasible and kept in mind simplicity, cost, and time. SAM combines information regarding student capabilities, tasks commonly found in a science setting, and adaptations made to provide accessibility into one document which can be easily referenced. The universal design section of SAM shows general adaptations which can be made to enhance learning for all students. Each disability specific section of SAM incorporates methods of best practice to provide adaptations which are tailored to specific groups of students.

By implementing SAM, students with disabilities who have been underrepresented in science, math, and technology will now be afforded the opportunity to take part in science related activities. For a long time, students with disabilities have been faced with a glass ceiling as they are perceived as incapable of becoming scientists, mathematicians, and engineers. By implementing SAM, activities within these subject areas will be accessible to students with disabilities.

Additionally, of equal importance is the fact that SAM helps overcome misconceptions that teachers and outreach programs may have regarding the abilities of students with disabilities. In this regard, one of the most groundbreaking aspects of SAM shines through; SAM shifts the focus from a student's disability and increases awareness of student capability. By showing educators that students with disabilities are capable of performing activities, SAM presents students with disabilities the same opportunities as their classmates both now and in the future.

1 Introduction

A solid and engaging science education is very important for all students. Aside from learning fundamental and useful scientific concepts and facts, an education in the sciences allows children to develop skills that will help them succeed in all areas of life. Science education teaches students "how to observe, collect evidence, and draw conclusions," abilities that aid children in dealing with problems they encounter in everyday life (AAAS, 2003). Children must also be exposed to science to allow them to determine whether they would like to choose educational or career paths in science. In order to encourage children to pursue science, science education must be fun and engaging. Hands-on science education allows children to problem solve, process information based on their own inquiry, and interact with the concepts they are learning (McGiveney, 1999).

One specific area of concern in regards to hands-on science education is availability and accessibility for all children, including those with disabilities. Over three hundred thousand children in Australia have disabilities and there is a general consensus among educators that they should have the same access as their peers to hands-on science programs (ABS, 2007). Numerous Disability Acts have been put into place all around the world in order to ensure that those with disabilities are presented with equal opportunities in school, at work, and in the community at large. However, often times, catering to children with disabilities is not one of the primary objectives of educational programs. Often, children with disabilities are unable to participate fully in these programs and as a result, students with disabilities are greatly underrepresented in Science, Technology, Engineering and Math (STEM) fields (University of Washington, 2006).

Aside from a moral obligation to promote accessibility, modern societies also stand to gain significant tangible benefits from policies of inclusion. For example, numerous individuals with disabilities have made significant contributions to society. Beethoven was one of the most well-known composers of all time while being deaf and Stephen Hawking has made amazing advancements in the field of physics despite his almost complete paralysis. It is important to provide students with disabilities the necessary opportunities and resources to make similar accomplishments. Recognizing the importance of accommodating students with disabilities, the Commonwealth Scientific and Industrial Research Organization[1]

[1] For further information regarding CSIRO, please see Appendix A.

(CSIRO) is interested in exploring ways to improve the accessibility of its hands-on science outreach programs to accommodate students with vision impairments, hearing impairments, mobility impairments, and learning disabilities.

CSIRO recognizes that their current programming does not accommodate students with disabilities and seeks to make adjustments to existing programs. Standards for Education for students with disabilities in Australia were just recently released in 2005 in accordance with the Disability Discrimination Act of 1992 (HREOC, 2006). In working towards achieving compliance with the new legislature, CSIRO is taking the lead among organizations in Australia to incorporate inclusion of students with disabilities into their programming. The purpose of this project is to assist CSIRO in this endeavour.

While assisting CSIRO to adapt its programs, the overall goal of this project is develop a general framework that can be used in any educational context to make hands-on science education programs more accessible to students with vision impairments, hearing impairments, and mobility impairments. The group will review literature concerning each disability in order to gain a deeper understanding of the limitations imposed and examine current methods for teaching students with disabilities. The research will act as a supplement to information that will be obtained through interviews with science educators and staff at specialist schools, as well as experience gained through working with the hands-on programs at CSIRO. The framework will be implemented at CSIRO to adapt their existing programs and feedback based on its effectiveness will be used to refine the final version. The final product will be a set of guidelines to be used by CSIRO and other educators in the adaptation of hand-on science programs for students with vision impairments, hearing impairments, and mobility impairments.

2 Literature Review

Disability discrimination is something that has not been dealt with until relatively recently. All around the world, people are beginning to realize that disability discrimination exists and is apparent in all aspects of life, including education. This section gives some background on informal education, disability inclusion in education, specific disabilities, and special education for students with those disabilities. Additionally, this section seeks to define informal education, a more flexible approach to learning, which allows for interactivity and variance of presentation style to accommodate different learning styles (McGiveney, 1999). Examples of informal education include outreach programs, museums, and hands-on learning in the classroom. Hands-on learning programs are the focus of CSIRO Education and are used as a medium to excite and educate students about the sciences. The main difficulty with current hands-on science programs is that they are not fully accessible to students with disabilities. An understanding of the information provided in this section is essential to the successful modification of CSIRO's existing programming as well as developing a universal framework for adapting hands-on science programs for disability inclusion.

2.1 Informal Education

Informal learning is an important educational approach to learning which is used for all age groups. Informal education incorporates hands-on applications to supplement learning and understanding of material outlined in the curriculum. Informal learning occurs both inside and outside of the classroom through outreach programs, hands-on activities and museums. The benefits of hands-on learning, especially for children, will be investigated in this section.

2.1.1 Defining Informal Education

In order to understand informal education, it is first necessary to understand formal education. Formal education is the approach to teaching which is most common and historically prevalent. Formal education is very structured and often relies on traditional methods of presentation to communicate concepts to students. Within formal education, there is generally little variation between presentation methods to account for students with different learning requirements (Smith, 2005).

Informal education was developed as both a response to the shortcomings of formal education and a way of teaching to supplement material presented through formal education methods. The National Science Foundation defines informal education as learning activities which are “voluntary and self-directed, life-long, and motivated mainly by intrinsic interests, curiosity, exploration, manipulation, fantasy, task completion, and social interaction.” Other characteristics of informal learning include self-pacing and visual/object orientation (National Science Foundation, 2005). Students often achieve a better understanding of the material because informal learning accommodates for different learning styles.

Informal learning is an approach which focuses on interactions and how students learn. In informal education, students are exposed to different methods of problem solving and allowed to process information based on their own inquiries. Students are forced to identify challenges and make their own assumptions in order to navigate their way through a problem or task. Informal learning is also generally experimental, meaning that students make conclusions based on what they experience firsthand. Informal learning accommodates for different learning styles, as much of the learning is based on decisions the student makes during interaction instead of the manner in which the teacher presents the information (McGiveney, 1999).

As Digenti explains, a large majority of informal learning develops out of interactions between students in team projects. In this definition, Digenti explains that interactions between people are what give rise to informal learning. This type of knowledge is tactic knowledge. Tactic knowledge is knowledge gained through experience rather than knowledge which is presented to students in direct verbatim (Digenti, 2000).

Another asset of informal learning is what Ramey-Gassert refers to as the “flow” experience (Ramey-Gassert, 2007). This describes a level of engagement that learners develop from following an activity from beginning to end and overcoming obstacles on their own without direct step-by-step guidance from outside sources. In addition to the feelings of accomplishment associated with “flow experiences”, the ability of students to problem solve for themselves is another integral part of scientific learning. Such problem skills go beyond what can be taught from a textbook.

Regardless of whether informal learning is classroom or outreach based, one of the biggest benefits which accompanies informal learning is this method of education directly introduces and mirrors real life interactions students will face. With informal learning, students work in groups, face a wide range of different stimuli, and are able to make their own choices instead of being led step-by-step through the process by an instructor or teacher. Barriault discusses the three stages of learning a child will frequently exhibit during informal learning, which include initiation behaviors, transition behaviors, and breakthrough behaviors. In the first stage, the child is doing the activity with some interaction with other students as well as the instructor. In the next stage, the activity is repeated and there is a "positive emotional response" to the activity. In the final stage of behavior, the child will seek out and share information with others and make comparisons to information learned in class. This stage provides concept reinforcement which, along with repetition, is very important in childhood learning (Barriault, 2007).

2.1.2 Informal Education Programs

There are many approaches to informal education which include hands-on programming, group work, and outreach programs. A driving force behind informal education in the sciences in the United States is the push to place emphasis on STEM: science, technology, engineering, and math. One example of the effort to strengthen STEM education is the University of Massachusetts' STEM Education Institute which offers support in many different areas. Different STEM programming includes STEM Earth Central, the Nanotechnology Summer Institute, Saturday Seminars, STEM Education Institute Seminars, STEM adventures for scouts, STEM Research Academies for young scientists, and STEMTEC which seeks to better prepare K12 math and science teachers (Sternheim, 2006).

The division of the National Science Foundation which is dedicated to Informal Science Education (ISE) is primarily concerned with increasing interest and understanding of STEM. As such, the National Science Foundation ISE financially supports a wide variety of programming in this area. Different projects which received grants in the past year include "A Museum-based After-School Program Examining Amphibian Ecology", "Spring Watch Planning Grant", and "Hands-On Learning in Engineering" (National Science Foundation, 2006). The after-school museum program seeks to develop a traveling museum exhibition, a seminar series, and create science pod casts. The Spring Watch program focuses on planning a television mini-series with six installments that has viewers report back findings through a website. Lastly, The Hands-On Engineering program desires to expand programming at the Paleontological Research Institute to increase opportunities for visitors to find and identify fossils firsthand as well as serve as citizen-scientists who collect data for ongoing research

(National Science Foundation, 2006). Just from this short sampling of different informal education programs sponsored by the National Science Foundation, it is possible to see the wide variety of applications which exist for informal education.

Another extension of informal learning, which is independent from the National Science Foundation's ISE, is the NASA Education program. This program seeks to stimulate students in the areas of science, technology, engineering and math through media, exhibits, and programming throughout the community (NASA Education, 2006).

Science museums are an additional example of informal learning environments. Museums use interactive displays to communicate scientific principles. The main goal of museums is to engage their patrons while also educating them. An important point to note about museums is they must accommodate many different age groups, learning styles, and personal interests. As such, museums must find a medium that will allow them to excite and inform very diverse groups of people. Of science museums Wellington has the following to say, "students in science centres display interest, enthusiasm, motivation, alertness, and a general openness and eagerness to learn, characteristics that tend to be neglected in school science" (Ramey-Gassert, 2007).

Informal education in the sciences has been shown in studies to increase excitement about science courses as well as the pursuit of careers in science. A study conducted by the U.S. National Science Foundation evaluated student opinions after a one to seven year follow up period as to how their experience with science outreach programs affected their work in high school classes, involvement with summer science and research programs, and overall career goals. Previous research indicated that hands-on and laboratory oriented approaches to learning directly correlate to higher achievements and better understanding of the material (Markowitz, 2004). In 1998 the National Science Foundation (NSF) reported that people with scientific careers say that their initial interest was sparked by interactive science programs.

A separate investigation conducted by Resnick arrived at similar conclusions about informal learning, determining that informal learning substantially expanded on textbook learning. Textbook based learning did not incorporate team work and was "divorced from real-world experience" (Ramey-Gassert, 2007). Another benefit of informal education programs is they often encourage students to work in groups and focus on interactions instead of lecturing students to promote learning.

2.1.3 CSIRO Education

The Commonwealth Scientific and Industrial Research Organization[2] (CSIRO) is Australia's National Science Agency. Formed in 1926, CSIRO employs over 6,500 scientists and branches out into all fields of science including astronomy, farming, and communication technology. Beyond scientific research, CSIRO holds science education as one of its important secondary roles. Throughout Australia, CSIRO's educational outreach involves science programs for schools, science clubs, and community activities.

CSIRO has nine different science education centres throughout Australia. The Victoria Education Centre is located in Melbourne. The centre offers thirty-three science programs for all ages of children. The programs cover a wide range of subject areas from gene technology to sports science. Each program is tailored to different age groups and grade levels. One feature the Melbourne site has to offer is the "Lab on Legs" program which brings activities and workshops to classrooms throughout Victoria.

In designing programs, CSIRO must keep in mind the Victorian Essential Learning Standards (VELS) which outline requirements that the curricula in the schools must meet (See Appendix B). The main focus of CSIRO programming is on hands-on instruction to facilitate learning and science education. CSIRO Education's mission is to "engage, enthuse and educate students, teachers and the wider community about science and its applications" (CSIROa, 2005). The programs that CSIRO Education offers are in place to affect the community and establish an interest in science in hopes that these programs will spur scientific careers.

2.2 Disability Inclusion Rationale

People with disabilities are entitled to the same opportunities as those without disabilities. Several countries around the world have recognized disability rights, including Australia, the United States and Great Britain. In order to address disability rights, these governments have each passed their own legislation. Of equal importance to legislation is the underlying principle that those with disabilities can make valuable contributions to society.

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[2] For more information on CSIRO, see Appendix A

2.2.1 Legislation in Australia

Australia passed the Disability Discrimination Act (DDA) in 1992. The DDA encompasses all aspects of life for Australians with disabilities from employment and education to building accessibility. The DDA provides the Attorney General several options and possible courses of action for implementation. The DDA is enforced in Australia under the Criminal Act, with varying degrees of intent being recognized. The penalty for non-compliance can be up to 6 months imprisonment or $1000 AUS.

Since passage of the DDA, the Attorney General has been working to develop standards for education (Australia, DDA, 1992; HREOC, 2006). The Standards for Education were finalized and released on 18 August 2005, although many of the requirements established have yet to be implemented. It is important to note that the timeline for application of the standards is by the year 2010. One of the main objectives of the standards was to specify *who* is obliged to abide by the standards and what their responsibilities are. The standards create and define the term "education providers" to clarify who must abide by these standards. "Education provider" encompasses educational authorities, educational institutions public or private, ranging from preschool to higher education, and organizations which develop or accredit curricula that is used by other education providers.

The standards encompass areas such as enrollment, participation, curriculum development, accreditation and delivery, student support services, and harassment. An education provider must ensure that anyone with a disability has access to participate in activities or programs related to these six areas on the same basis as a person that is not disabled. The education provider is required to consult the student and discuss any reasonable adjustments that must be made to reach these goals. The standards define a reasonable adjustment as one that balances the interests of all parties involved, without causing unjustifiable hardship. Unjustifiable hardship occurs when an adjustment requires considerable difficulty or expense, which is not substantiated by the circumstances. Many times, the consultation with the student must be repeated over time because the needs of the student change (Australia, Standards for Education, 2005).

2.2.2 Legislation in the United States

The Americans with Disabilities Act (ADA) was passed in 1990 to prevent discrimination against persons with disabilities. The ADA establishes a framework to prevent discrimination in specific areas such as employment and the provision of public services; these areas include schools, restaurants, hotels, and other public buildings. The ADA clearly states that whatever opportunities and services are available to the general public must be accessible to those with disabilities through direct design or “reasonable accommodation”. A reasonable accommodation is an adjustment made to assist a person with a disability. An accommodation is considered reasonable as long as it does not produce undue hardship, with respect to the cost and difficulty of the accommodation. The ADA is relatively strictly enforced, with fines of up to US$100,000 for repeated violations. The ADA tries to ensure that those with disabilities can take full advantage of all the opportunities and services that are available to the general public (United States, ADA, 1990).

The Individuals with Disabilities Education Act (IDEA) was originally implemented in 1975 and was recently updated in 2004 (NICHCY, 2007). The IDEA is the main piece of legislation in the United States that deals with education of children with disabilities. The IDEA is meant to ensure that children with disabilities have the same public education available to them as their peers. For this to occur, the IDEA requires that an individual evaluation be done to determine the child’s level of functional performance, special modifications that must be made, and goals for the child. All of this information becomes part of the child’s Individualized Education Program (IEP), which ensures that the child is able to succeed in the curriculum that has been developed (United States, IDEA, 2004).

2.2.3 Legislation in Great Britain

Great Britain passed the Disability Discrimination Act (DDA) in 1995. It is very similar to the Australian DDA and the American ADA, covering discrimination in employment, access to premises, education, and public transport. Great Britain’s DDA establishes regulations and provides possible adjustments to prevent discrimination in certain areas. Similar to the two acts previously discussed, Great Britain’s DDA also requires reasonable accommodations. One area that Great Britain’s DDA doesn’t cover in much detail is education; it merely provides some wording changes to legislature that is already in place, such as the Education Act 1993 (Great Britain, DDA, 1995).

All aspects of schools including funding, attendance, and parts of the curriculum, are covered in the Education Act 1993. Part III is devoted to students with special educational needs. Part III was expanded to include not only those children with learning disabilities, but also children that are considered to be disabled according to Great Britain’s DDA. The Education Act requires that an assessment of each child with special educational needs be conducted and the specific special educational needs of that child be stated. It is then the responsibility of the school to ensure that these special accommodations are implemented and maintained (Great Britain, Education Act 1993, 1993).

2.2.4 Benefit to Society

People with disabilities can contribute to society just as much as those without disabilities; the fact that someone has a sensory or mobility impairment does not mean they have diminished cognitive ability and often times those with cognitive impairments are still intelligent, they just learn differently. Many notable people with disabilities have impacted the world through inventions, music, literature, and scientific breakthroughs. Thomas Edison was deaf by the age of twelve, yet he invented the light bulb and made other notable discoveries (ENHS, 2004). A more recent example of someone who has succeeded despite his disability is Stephen Hawking. Dr. Hawking has been fighting ALS for almost fifty years and is almost completely paralyzed. However, he has still made numerous ground breaking discoveries in the field of physics (Hawking, 2007). These are two examples of the enormous contributions that people with disabilities can make in society in spite of their impairments.

2.3 Disabilities Overview

There are many different types of disabilities, including physical, sensory and cognitive impairments. The Parliament of Australia defines disability as "a condition that in some way hampers or hinders a person in terms of their ability to carry out day to day activities" (Disability Support and Services in Australia, 2002). More specifically in this definition, the Australian Parliament recognizes that there are different levels of disabilities that can affect a person's life in varying ways involving mild to profound restrictions on their abilities. According to a study done by the Australian Bureau of Statistics, one out of every five Australians has some type of disability, which equates to about four million people (ABS, 2002).

This section of the Literature Review is meant to give some background information on the nature and range of disabilities that are most common among students. Vision impairments, hearing impairments, and mobility impairments will all be explored to provide information regarding the types of disabilities that commonly affect students.

2.3.1 Vision Impairment

Visual impairment afflicts people in all countries. In Australia, a person is considered legally blind if they can see at 6 metres what someone with normal vision can see at 60 metres or if they have a field of vision that is 20 degrees or less, compared to a normal person's field of vision of 180 degrees. On a more general scale, a person is considered to have a visual impairment if they have any degree of sight loss (Vision Australia, 2007).

In a study of Australian twelve year olds, researchers "documented a relatively low prevalence of visual impairment in [the] population of Australian children. Uncorrected astigmatism and amblyopia were the most frequent causes." (Robaei, 2006). This study also demonstrated that the majority of visual impairments in Australia were correctable. Many visual impairments can be lessened or corrected through the use of glasses, contact lenses, surgeries, and various other treatments. However, there are still many visual impairments that are not correctable, requiring some persons to seek special services and programs to compensate for their disability. Some causes of vision impairment in Australian children include genetic conditions, birth complications and extreme prematurity. Around the world, other causes of childhood blindness are cataract, trachoma, and Vitamin A deficiency. Vision impairment can range from partial vision and limited range of vision to total blindness; many children require text to be in alternate formats, such as a large print or Braille, to be able to read (RIDBCa, 2007).

Another study involving reanalysis of data from the Melbourne Visual Impairment Project and the Blue Mountains Eye Study, found that visual impairments are fairly prevalent within the general Australian population. The research found that in 2004 there were approximately 480,300 people with low vision and 50,600 people with blindness in Australia. Analysis also included projections for the number of people who will have low vision or blindness in the next twenty years. This projection estimated that the number of people with low vision and blindness will double by the year 2024 (Taylor, 2000). Worldwide, it is currently estimated that there are about 1.4 million children under the age of 15 that are blind (CBMI, 2006).

2.3.2 Hearing Impairment

Hearing impairment is very often thought of as being totally deaf; however, the definition incorporates a wider range of hearing capability, including diminished hearing and the inability to make out certain sounds. A person may be able to hear lower sounds such as “o” and “u” but have trouble hearing sounds like “s” and “f” (RIDBCb, 2007). The level of hearing impairment may be hard to diagnose and could impact a person’s social interaction, including class participation for children (Easterbrooks, 1999).

In general, the term deaf is reserved for those that have significant hearing loss which prevents them from using auditory cues as a means of gathering information. On the other hand, hearing impairment refers to someone with mild to moderate hearing loss that can still hear well enough to communicate to some extent (NAD, 2007). In Australia, there are over 10,000 children under the age of fifteen that have some degree of hearing loss (VicDeaf, 2005).

One type of hearing loss that is common in children is conductive loss, which is a physical problem with the outer or middle ear. In many cases, amplification of sound can resolve problems associated with conductive loss. Another type of hearing impairment is sensorineural loss, which involves damage to the inner ear or auditory nerve. Those with sensorineural loss are often able to hear lower sounds, but not higher ones (McGraw, 2005). Lastly, central auditory processing disorders also cause some form of hearing loss and stem from a problem with the neural system (Easterbrooks, 1997). This disorder is more difficult to diagnose because there is not a problem with the ear itself; the problem lies with the system that processes what is heard.

2.3.3 Mobility Impairments

There is a broad spectrum of mobility impairments, which range in severity from person to person. Mobility impairments encompass a wide range of disabilities that can be both permanent and temporary. Mobility impairments can be present at birth while others are the product of illnesses or physical injuries that occur later in life (University of South Carolina, 2005). The majority of the conditions that cause mobility impairments also affect range of motion and motor skills. Some impairments can affect gross motor skills, such as walking, and also fine motor skills, such as handling objects in one’s hand (University of Washington, 2006). Several conditions that cause mobility impairments in children include cerebral palsy, muscular dystrophy, spina bifida, spinal cord injuries, and other neurological or musculoskeletal disorders.

A condition that often causes a child to have some form of mobility impairment is cerebral palsy. Cerebral Palsy is a lifelong condition that affects muscle control, hindering a child’s ability to walk, talk, eat or play. For one in four students with this condition, a learning disability is also present, which may cause them to learn at a slower pace and require special learning assistance in school. Through occupational therapy, students can better learn how to control their movements and perform tasks that require fine motor skills (University of Virginia's Children's Hospital, 2003).

Muscular Dystrophy (MD) is another condition which causes mobility impairment. MD includes thirty genetic diseases, all of which cause progressive weakness and degeneration of the muscles that control movement. One common type of muscular dystrophy is Duchennes, which mostly affects boys and onsets in early childhood (Ault). The varying types of muscular dystrophy differ in level of muscle weakness, age of onset, and progression rate. As muscular dystrophy advances, the muscles further weaken, tendons shorten, and fixations develop in joints, which limits an individual's flexibility and mobility (Mayoclinic, 2006).

Spinal cord injuries may result in paralysis of various degrees. Persons with quadriplegia are paralyzed from the neck down and as a result have limited or no use of their legs and arms. This disability is often caused by an accident where a neck injury occurred. Paraplegia is another type of paralysis where the individual has no use of the legs, but still has full use of their arms. This type of paralysis can be caused by an accident where the injury occurred in the lower back.

Spina bifida is a condition which affects 1,500 to 2,000 babies in the United States every year. Spina bifida is a birth defect that occurs when the spinal cord or its covering does not fully develop (Alexander, 2005). The symptoms of this condition vary from person to person depending on the location of the malformation that is caused from the underdeveloped spinal cord. The symptoms can range from basic physical problems to more severe physical and mental disabilities (NINDS, 2007). Often, children with spina bifida are paralyzed and have loss of certain sensations in the body. Spina bifida usually causes students to have problems with motor skills, attention span, memory, organization skills, and hand-eye coordination (Lollar, 2001).

According to a study by the Australian Bureau of Statistics, one in every ten people with a disability uses a mobility aid. There are many different types of mobility aids that are used by persons with mobility impairments which include wheelchairs, canes, walking sticks, and crutches (ABS, 2002). Some of these devices may be used for a short period of time because the persons' disability is temporary, such as crutches in the case of surgical recovery. These devices are used to increase the opportunities for a person with mobility impairments and artificially enhance their mobility.

2.4 Special Education

Every form of disability requires special adaptations to the curriculum in order to allow students with disabilities to be actively involved in all educational opportunities. There are many different approaches associated with including students with certain types of disabilities and they will be discussed within this section.

2.4.1 For the Blind and Visually Impaired

Students with visual impairments cannot see at all or have difficulty seeing well and therefore have different ways of learning. The visually impaired do not respond to visual aids and stimuli, but have a heightened level of hearing and sense of touch. Therefore, these outlets can be used to connect students to what they are learning.

Visually impaired students respond well to sound and physical stimuli, which make hands-on science programs a valuable approach to their education. Many schools for the blind use a hands-on approach to their curriculum. These activities include hands-on science experiments and music associated lessons (Colourado School for the Deaf and the Blind 2007).

In the realm of science, there are many visual aspects to the majority of curricula such as lecture notes on chalkboards, power point presentations, and instructional videos where visual laboratory instruction is given. In laboratories, visual observations are often important to the scientific concept being taught, such as colour changes in chemical reactions, light refraction, and dissections. The visual aspects of science present obstacles for any teacher and require them to find new ways of communication and instruction which go beyond visual aids in order to include students with visual impairments.

The West Virginia school district began a program called Coordinated and Thematic Science (CATS) to enhance teachers' abilities to recognize ways to incorporate students with disabilities into their classroom. In this program, the teachers are taught how to relate with students with all types of disabilities and how to modify their existing curricula to achieve an equal-learning environment where all students get a solid education, regardless of their disabilities. Many blind students use Braille books or require assistance such as an aide or a text-reader when faced with textual material. These adaptations should be recognized by teachers when they are planning their curriculum or science program. For blind students, it is important that students are aware of what is going on through auditory reinforcement because audio communication is their primary form of contact. Especially in laboratory settings, it is important to describe what is being done so that a visually impaired student can follow along even though he or she cannot see the demonstration (Strategies for Teaching Students with Disabilities, West Virginia School District 2002).

Constant communication with the student involving their disability in general is another important aspect to a successful educational experience for a visually impaired student. The University of Newcastle in Australia has many general adaptations for their blind or visually impaired students, particularly the means through which information is transferred. The University website recommends that material be released to the visually impaired students several weeks in advance, giving the student time to convert the information into a format that is conducive to their learning style, such as Braille or audio files. In a classroom or laboratory setting, it is important that key points are repeated within lectures or instructions to emphasize their importance. Verbal communication is the primary mode for students with visual impairments to receive information, which requires that educators speak clearly. Another suggestion involves tape recording instructions or lectures and making them available to the students with disabilities as a resource (University of Newcastle, 2005).

The National Centre for the Blind Youth in Science has many hands-on programs to encourage blind students to pursue an education involving math and science. Realizing that hands-on learning is the most effective method of education, this centre has established several programs to address student needs. One of their most effective hands-on programs is called the Circle of Life session. In this session, the blind students will explore nature through touch and sound, rather than visually. This program is particularly important because it immerses the students in nature while catering to their specific needs. Rather than describing the stimuli to the students, the group facilitators encourage the students to explore the world around them through their stronger senses. For students without vision impairments, sight would be the primary stimulus from which they would learn about nature; however, while participating in the Circle of Life session, the visually impaired students are learning about life science through a different medium that caters to their abilities. The students are exposed to a broad range of science topics including chemistry and life science. Another program that immerses blind students in hands-on scientific learning is their rocket program, which allows blind students to work together to build a rocket and launch it (National Centre for the Blind Youth in Science, 2006). These are all important educational opportunities for blind students to encourage them to continue their pursuit of scientific knowledge.

2.4.2 For the Deaf and Hard of Hearing

Teaching students who are deaf or hearing impaired presents a unique problem because of the difficulty in communication, especially at early stages of development. Much of early schooling for the hearing impaired is focused on making sure the child develops a suitable form of language communication. One of the most popular approaches has children learning sign language first, in order to develop critical language skills that can later be applied to a second language, such as English (Strong & Prinz, 1997).

In actual schooling, hearing impaired children may either be mainstreamed or go to a specialist school. If they are mainstreamed, many different actions may be taken to ensure that they are able to succeed in the classroom. Easterbrooks (1998) has several suggestions that deal with both modifications to the learning environment and the acoustic environment. The latter pertains to making sure that the "signal to noise ratio" is kept at an acceptable level. The former is associated with the fact that a hearing impaired child can not properly listen to the teacher and take legible notes; many times there must be some sort of visual contact for the student to understand what is being said, i.e. lip reading or looking at an interpreter. In this case, the use of a note taker or an FM listening system may be necessary.

Recent research has shown that deaf children may have superior visual skills, just as blind children have increased hearing and tactile skills (Silva-Moreno, 2003). This reinforces the importance of visual communication in the education of deaf children and uncovers another possible avenue for education. For science labs, many times accommodations can be made to ensure that visual communication is possible. This includes preferential seating for the best view, written instructions which can be reviewed prior to the lab, and visual cues throughout the lab (Burghstaler, 2006). However, given their enhanced visual capabilities, there may be better adaptations that can be made for deaf children to get the most of out science labs.

In Australia, one agency that is dedicated to helping hearing impaired children is the Royal Institute for Deaf and Blind Children. They have many different programs for hearing impaired students, ranging from the operation of numerous specialized schools to support for children that have been mainstreamed. One very interesting approach that is incorporated into many of their specialized schools is "reverse integration". With reverse integration, children without hearing impairments also attend the school and serve as "language and play models" for the other children (RIDBCb, 2006).

In addition to the general methods that have been employed in the education of hearing impaired students, new technologies have also been developed to communicate with these audiences. One such technology that has been developed at the Rochester Institute of Technology is C-Print, which translates spoken words into text. C-Print can be linked to many different computers, so an instructor can have their speech captioned in front of several students. The captioning can later be printed out for students to use as notes. C-Print is now used across the United States to aid in the education of deaf and hard of hearing students (RIT, 2003).

2.4.3 For Students with Mobility Impairments

Rather than focusing on a student's disability, it is important to focus on their strengths and abilities. Instruction within the classroom should highlight a student's strengths, rather than work around their disability. Every student has an area in which they excel and it is important for students with mobility impairments to be encouraged in these areas, rather than constantly focusing on their physical impairment. For example, children with spina bifida often have poor motor skills and hand-eye coordination, making it difficult to perform tasks that require a lot of movement and manipulation of objects; therefore, activities which can be completed without use of these skills are ideal, allowing the student to participate. Also, students with spina bifida respond well to sensory stimulation, including smell, taste, and touch. The incorporation of these into any program will increase a student's level of understanding of what is being studied (Lollar, 2001).

Mobility impairments can inhibit a student in several different ways, depending on the type of impairment that they have. Some students may be paralyzed from the waist down, whereas, some students may be completely paralyzed and unable to move their arms or their legs. With this broad range of abilities, it is important to recognize that there are many different types of accommodations that are necessary for different students. For students that lack fine motor skills, an aide is often used to assist in tasks that require such skills. Beyond classroom modifications, many students with these types of disabilities may require different therapies outside of the classroom, including occupational therapy to learn how to further control their fine motor skills. Also, students with mobility impairments usually need some type of aid to walk, whether it be through the use of crutches, a cane, or a wheelchair (University of Virginia Children's Hospital, 2003).

One of the first consideration involving educational modifications for students with mobility impairments is the accessibility of the laboratory or classroom. There should be enough room for a person in a wheelchair to easily and comfortably move around the classroom. Also, the height of the desks and laboratory tables should be adjustable to accommodate for students in wheelchairs in order to ensure that the desk can be used universally by all students. The accessibility of all of the supplies and lab equipment is one of the most important accommodations for students with mobility impairments (The Open University, 2007).

At the University of South Carolina, professors are encouraged to assign a lab partner to help students with mobility impairments to ensure that the students are able to reach and obtain required lab materials. Peer assistance is an important aspect to accommodating for students with mobility impairments and should be considered by science teachers in other laboratory settings. It is important to keep all of the necessary equipment in a central location to allow for easier access (University of South Carolina, 2005).

2.5 Universal Design

Universal design is defined as "the design of products and environments to be usable by all persons, to the greatest extent possible, without the need for adaptation or specialized design." (Burgstahler, 2006). The idea of universal design stemmed from the movement in architecture and product design where buildings and consumer products were designed to accommodate users of all ages and levels of ability. Universal design is now being investigated as an approach to education; when incorporated into curriculum development, universal design takes a wide range of abilities into consideration and takes a proactive approach to accessibility.

According to the Centre for Applied Special Technology (CAST), Universal Design needs to satisfy various criteria in order to incorporate all learners. Universal design must present information through multiple avenues in order to allow students to access information through multiple sensory channels. An example of this would be including both detailed written and verbal instructions for assignments and lab experiments. In addition to presenting information in multiple ways, it is also important that teachers utilize more than one form of evaluation. When students are provided with multiple types of evaluation, such as written and oral, students who cannot respond in written form are still able demonstrate their knowledge. Programs should also be multisensory to allow for participation of students with different abilities. For example, programs which involve more than one of the senses can incorporate students with various sensory impairments. Through the different senses, students with visual, auditory, and mobility impairments can all be exposed to the concepts at the same time without further accommodations. An important point to make about universal design is that it not only makes programs more accessible to those with disabilities, it also makes them more engaging and educational for students without disabilities (CAST, 2007).

The University of Washington sponsors a program called DO-IT (Disabilities, Opportunities, Internetworking, and Technology). The goal of this program is to “increase the successful participation of individuals with disabilities in challenging academic programs and careers such as those in science, engineering, mathematics, and technology.” (University of Washington 2003). Through the DO-IT program, universally designed learning is emphasized and advertised to teachers. The program provides teachers with many different articles and guidelines regarding universal design incorporation into their classrooms. The articles contain information and strategies that can be incorporated into the classroom to make it more accessible for everyone. An excerpt from one such article is included in Appendix C.

Another program run through CAST is called Planning for All Learners (PAL) and is a program which aims to incorporate all students through advanced curriculum planning. This plan follows a four step procedure to ensure that universal design principles are being followed. The first step is setting a goal regarding what concepts need to be understood through the activity and ensuring the goal aligns with the curriculum standards. Once the goal is in place, CAST recommends that the ability levels within the class, current methods for assessments, and materials used in the classroom be investigated. Lessons and activities should be planned in accordance with universal design learning techniques, ensuring that all students are able to participate. The final step in the plan is to take part in an iterative process of teaching by revising the lesson to take into account universal design. CAST provides tutorials to teach instructors how to refine goals, identify possible barriers, and use universal design to eliminate those barriers. The tutorials serve to give teachers the skills to think about and use universal design in the classroom, as opposed to merely giving them accommodations to use (CAST, 2007).

Programs which focus on universal design, such as the CAST and DO-IT programs, provide several recommendations and guidelines for teachers to use to develop programs that include all students, regardless of ability. One such recommendation is for teachers to outline activities ahead of time so they are able to identify what concepts they want the students to learn. With a course outline, material can be modified if necessary before hand for the whole class, rather than specifically tailor separate worksheets for students with disabilities. Additionally, by preparing material in advance, it is possible to distribute the material to students to allow them to preview the material before it is taught in the classroom. This approach not only helps students with disabilities but also provides reinforcement of the material, helping all students to better grasp the material being presented (University of Washington 2003).

As universal design is meant to accommodate students regardless of level of ability, it is important to understand general accommodations made for students with various disabilities. Appendix C displays a breakdown of various accommodations made for different disabilities. By examining the lesson plan in conjunction with accommodations made for different disabilities, it is possible to establish a universal framework which satisfies the needs of all students in classroom learning.

2.6 Summary

There has been a considerable amount of progress in addressing the issue of disability discrimination, as is evident in many pieces of legislation including the ADA, Australian DDA, and British DDA. However, legislation alone is insufficient; effort must be put into implementing programs which ensure inclusion, especially in education. Informal education accommodates a wide variety of learning styles making it accessible to many students and a suitable starting point for developing a universal framework to adapt programming for students with special needs. It is important to look not at the limitations of those with disabilities, but what interests them and what can be done to allow them to reach their full potential (University of Washington, 2006). With this type of attitude, CSIRO Education can become a leader in disability inclusion for science education.

3 Methodology

The overall goal of this project was to develop a framework for adapting hands-on science education programs for students with disabilities. The primary deliverable was a framework, known as the Student Accessibility Matrix (SAM), which provides guidance about how to modify programs to accommodate as many students as possible. SAM focuses on universal design as a proactive approach to accessibility and individualized accommodations for students with auditory, mobility, and vision impairments. SAM was used to make specific recommendations about how some of the existing programs at the Melbourne CSIROSEC should be adapted to make them more accessible for students with disabilities. An approximate timeline of the project is included in Table 1.

The project team accomplished the following objectives:

- Developed an understanding of the capabilities and limitations associated with different disabilities;
- Determined how schools currently accommodate students with disabilities in a science setting;
- Evaluated and assessed existing CSIRO Education hands-on science programs to determine adaptations that could be made for students with disabilities;
- Developed a framework (SAM) for adapting hands-on science education for students with disabilities.

To accomplish these objectives the project team:

- Completed an extensive literature review;
- Interviewed teachers at both specialist and public schools to develop an understanding of their experiences working with students with disabilities in the classroom and how they accommodated students with special needs regarding hands-on science programs or labs;
- Interviewed school administrators and special education teachers to further develop an understanding of existing accommodations for students;
- Interviewed Victorian Department of Education Officers to gain an understanding of what accommodations schools are required to make, science programming throughout the region, funding for special education, and the different types of aid available to students with disabilities;

- Interviewed Melbourne CSIROSEC staff members to assess their previous experiences with students with disabilities in CSIRO Education programs, primary and secondary goals of CSIRO Education programs, how programs are evaluated, program barriers, and proposed solutions to program barriers;
- Observed CSIRO Education programs both at the Melbourne CSIROSEC and through the Lab on Legs program to observe how programs are currently run and identified aspects of the programs which would be barriers for students with disabilities; and,
- Investigated school standards to determine what schools are required to provide for students with disabilities (equivalent of Individualized Education Programs in United States).

Task	WEEK							
	PQP	1	2	3	4	5	6	7
		March 12	19-Mar	26-Mar	April 2	9-Apr	16-Apr	23-Apr
Literature Review								
Interviews								
CSIROSEC/School Observations								
Develop SAM								
CSIRO Program Recommendations								
SAM Feedback								
Finalize Report								

Table 1: Project Timeline

3.1 Interviews

As a supplement to the background research, the project team conducted many interviews to gain further knowledge and understanding of hands-on science education for students with disabilities. To obtain the maximum number of perspectives and level of expertise on this subject, the project team interviewed people from a wide range of disciplines both in the United States and in Australia.

Interviews of teachers at public and specialist schools were important sources of information and guidance throughout the project. School teachers were interviewed about their experience regarding students with disabilities in the classroom in order for the project team to develop a better understanding of the capabilities of students with different disabilities. As school teachers have first-hand experience in dealing with the range of abilities present with students, interviews provided significant insight about the strengths and weaknesses students have within the classroom.

As seen in Table 1, interviews were conducted at the end of the Project Preparation (PQP) in Worcester, Massachusetts and throughout the first few weeks in Australia. The interviews were semi-structured and two project team members took turns speaking while the third project team member took notes. When only two project team members were present, one generally spoke while the other took notes. The interviews ranged from fifteen minutes to an hour in length and were conducted both on the phone and in person. A general outline of the interview questions used for interviews conducted in the United States is included in Appendix D. The areas the project team investigated during these interviews include:

- The extent and nature of accommodation efforts;
- Capabilities of students with disabilities within the classroom;
- Modifications made to science programs; and,
- The success of the modifications incorporated into the science programs.

In the United States, all interviews had been arranged with individuals the project team was referred to by personal contacts and faculty advisors. In Australia, the group had no source of referrals to specialist teachers so to develop a list of contacts, online research was carried out to locate specialist schools throughout Australia. Following this, the list was further expanded by researching the Melbourne CSIROSEC's database to generate a larger list of specialist schools as well as a listing of larger mainstream schools throughout Victoria.

Schools were called and the project team generally spoke with a secretary unless another contact was discovered through research. For specialist schools, the project team first inquired as to what type of disabilities the school accommodated. If it was determined that the school only accommodated students with intellectual disabilities, a phone interview was not requested. For those specialist schools who enrolled students with visual, hearing, or mobility impairments, the project team requested to either speak with or get contact information for, a curriculum coordinator or science teacher. For mainstream schools, the project team had to first determine if the school had any students with disabilities. If students with disabilities were enrolled in the school, the project team requested to speak with a special education coordinator or the person in charge of program accessibility for a phone interview. A more detailed summary of the agenda used for investigatory phone calls can be found in Appendix E and Appendix F. Also contained in the agenda are interview questions which were used if the school accommodated for students with mobility impairments, vision impairments, or deaf students.

In interviews with teachers, the teachers were questioned about what they had done in the past to accommodate students with disabilities. In particular, the project team was interested in learning about what science teachers were doing to provide for students with disabilities. Similarly, teachers at specialist schools were questioned about what overall modifications they make for the larger number of students with disabilities present within their classrooms. It was important to note if teachers made alterations to the standard curriculum when performing hands-on science programs as such techniques were valuable to incorporate into the framework of this project.

Special Education teachers (in the US) and disability specialists (in Australia) were also interviewed in order to gain a better understanding of what adaptations should be made to best accommodate for students with disabilities. Special Education teachers have a broader experience with students with all types of disabilities. Additionally, at many mainstream schools, there were specific facilities within the school to accommodate students with disabilities and the people in charge of running these facilities had a detailed understanding of the procedures used to make programs accessible to the students with disabilities at the school. A more detailed description of questions asked during interviews of classroom teachers, special education teachers, and disability specialists can be found in Appendix D.

In a broader spectrum of the educational arena, school administrators were interviewed about their experience in providing for students with disabilities in a hands-on science setting. Overall, administrators had a broader knowledge about what was done across all of the classrooms within each institution. Questions asked during administrator interviews can be found in Appendix G.

In addition to interviews with teachers and administrators, Officers of the Victorian Department of Education were interviewed. The purpose of these interviews was to determine the requirements for disability accommodation in Victorian schools, the number of mainstream and specialist schools throughout Victoria, influence of the DDA on accessibility, funding for disability accommodations, the type of aid available to students with special needs, and the types of evaluation used to measure the success of disability accommodations. Interviews with Department of Education Officers all took place over the phone and were semi-structured. In general, the interviews lasted between ten and twenty minutes in length. Questions asked during interviews with Department of Education Officers can be found in Appendix H.

Physiotherapists (PTs) were another source of information regarding students with mobility impairments. PTs have experience making adaptations and are familiar with the capabilities of students with different types of mobility impairments. A detailed list of PT interview questions is included in Appendix I.

Further, Melbourne CSIROSEC staff was interviewed about what modifications have been made in the past to accommodate students with disabilities within their science programs. CSIROSEC does not have any formal programs that cater to students with disabilities; however, interaction with students with disabilities has occurred previously in general settings. From these interviews, the project team was able to determine what has been done in the past to accommodate students with disabilities, as well as what approaches were and were not successful. Interviews with Melbourne CSIROSEC staff also focused on barriers in current programming that had been identified by the project team, desired outcomes of programming, how the success of CSIROSEC programming is evaluated, and proposed solutions to eliminate program barriers. Interviews with Melbourne CSIROSEC staff were semi-structured and conducted throughout the duration of the project. A more detailed description containing Melbourne CSIROSEC staff interview questions can be found in Appendix J and notes from the interviews can be found in Appendix K.

After completing the interviews, notes and recordings were transcribed, analysed, and compared to the previously researched information. Once all of the information was gathered from the interviews, the relevant information was incorporated into SAM.

3.2 Assessment of Melbourne CSIROSEC Programming

To gain a better understanding of the areas of Melbourne CSIROSEC's programming which needed to be modified to include students with disabilities, the project team assessed some of the existing programs. The programs observed were selected in a manner such that the maximum number of different programs conducted by different presenters could be observed. Additionally, the project team arranged to see programs both at the Melbourne Education Centre and at schools to develop an understanding of how each type of program was run and set up.

The project team actively participated in and observed the programs that CSIROSEC conducts both at the Melbourne CSIROSEC and at schools through the Lab on Legs program.

The project team aided the CSIROSEC presenter in conducting the programs and identifying any difficulties the students had while partaking in them. This allowed the project team to gain some first hand insight on what the students were expected to do during the programs.

During observations, the project team took notes about what the presenter said, what questions were asked by the presenter, and a summary of how the program was run. Additionally, the group identified barriers found throughout the programs using a barrier checklist, which is included in Appendix L. The barrier checklist lists different tasks and a description of the barriers associated with the tasks. There is space in the checklist to indicate if the barrier is present in the activity as well as possible solutions. All notes taken during the observations were transcribed into electronic format

Additionally, a summary of the information obtained from all of the barrier checklists was compiled into one summary checklist which lists the different barriers and the programs in which they were found.

3.3 SAM Development and Evaluation

The overall goal of the project was to develop a framework, SAM, for adapting hands-on science education for students with disabilities. SAM contains a universally designed set of adaptations that can be applied to any hands-on science program, as well as a separate matrix for each of the three disabilities SAM focuses on. In this manner, the modifications create equal accessibility for all students, independent of disability. SAM allows students with disabilities to participate equally by emphasizing their strengths, rather than compensating for their weaknesses.

In developing SAM, the project team:

- Determined the range of disabilities SAM addresses;
- Determined what tasks may be barriers for students with the selected disabilities;
- Determined what accommodations should be classified as universal design;
- Determined the modifications specific to each disability;
- Determined what resources are available to students with each disability;
- Received feedback from experienced professionals in each field of disability.

The first step in creating SAM was to identify the range of disabilities SAM would address. SAM addresses three types of disabilities: deafness, vision impairments, and mobility impairments. Within each disability, there is a wide spectrum of ability regarding what students are capable of. It is recognized that intellectual disabilities are important to accommodate for in science; however, with the time allotted to the project, it was not feasible to make accommodations for intellectual disabilities. Additionally, incorporating hands-on activities is one of the best approaches for teaching students with intellectual disabilities, making intellectual disabilities less of a focus for this project.

Once the range of disabilities was established, it was important to identify what types of tasks would be difficult for students. These tasks were identified through interviews and program observations. As previously mentioned, during program observations, tasks were identified using the barrier checklist.

Accommodations made for students with disabilities were researched through the literature review and also investigated in interviews. Interviews with teachers, administrators, and Officers of the Victorian Department of Education provided factual information about current accommodations made for students with disabilities in the classroom. The outcome of these interviews was a combination of universal design principles and disability specific accommodations.

In addition to current programming done at schools for students with special needs, it was also essential to determine what resources were available to these students. Such resources included personal aides and teachers of the deaf. The purpose of investigating available resources was to determine the baseline level of assistance which SAM could assume.

To evaluate SAM, each disability specific section was reviewed by professionals in each disability field. The project team sought feedback on how user friendly SAM was, the appropriateness of the adaptations, and the completeness of the adaptations. Feedback from each reviewer was examined and suggestions were incorporated into the final version of SAM.

Several CSIROSEC programs were then evaluated and suggestions were made for adapting the Forensic Frenzy program. This program was selected to be adapted as it is Melbourne CSIROSEC’s most popular program and forensics is popular within modern culture. Additionally, there are a variety of different types of activities within the program. The program was reviewed, barriers were identified, and adaptations were suggested for specific disabilities using SAM. The project team completed three case studies by using SAM to propose adaptations for the Forensics Frenzy program to make it accessible to a blind student, a student who cannot hear and cannot verbalize orally, and a student with muscular dystrophy. These three case studies were selected to demonstrate how SAM may be applied to adapt programs for students with a range of disabilities. The adaptations were given to the Melbourne CSIROSEC to serve both as an example of how to use SAM and provide some adaptations for the program.

Ultimately, SAM serves the purpose of making hands-on science programming accessible to students with disabilities while also enhancing the educational experience of students without disabilities. In order to achieve this, SAM takes into account current programming in the classroom, barriers which are present in CSIROSEC programs and resources that can be assumed to be available to aid students with disabilities in the classroom. The approach SAM takes is a combination of universal design and specific accommodations tailored to each student's ability.

4 Findings

The main findings of this project regard education in Australia, disability barriers, disability accommodations, technology, and evaluation of student success. Information was collected through the form of interviews with classroom teachers, specialist teachers, school administrators, physiotherapists, and Officers of the Department of Education. From these sources, barriers that exist for students with disabilities were determined. Additionally, accommodations made in the classroom and science settings were investigated to determine methods of best practice for making hands-on science programs accessible. Technology used for students with disabilities was also examined. In addition, methods for assessing student understanding of material were also evaluated. Lastly, Melbourne CSIROSEC programs were also observed to identify barriers within programs as well as possible solutions.

4.1 Interview Results

A total of thirty interviews were conducted, eight in the United States and twenty-two in Australia. Teachers at mainstream and specialist schools, special education coordinators, school administrators, visiting teachers, physiotherapists, teachers of the deaf, and Victorian Department of Education Officers were all interviewed. In Australia, the project group spoke with nine specialist school staff members, nine mainstream school staff members, and three Department of Education Officers to gain a better understanding of different areas related to disability education.

The purpose of each interview varied depending on the interviewee. For teachers at mainstream and specialist schools, the project team sought to gather information regarding best practices for making science accessible to students. Special education coordinators provided the group with information regarding how accommodations are made for students with different types of disabilities in mainstream schools. School administrators provided the project team with an understanding of the general education structure in Australia. Additionally, it was found that assistant principals were often in charge of making disability accommodations at schools. Through speaking with visiting teachers, disability specific teachers who visit schools throughout Australia, the group gained an understanding of the different types and levels of external support students receive.

Outside of the school setting, physiotherapists and teachers of the deaf provided the project team with information regarding specific areas of concern in making programming accessible to students who have mobility impairments or are deaf. Officers of the Victorian

Department of Education supplied the group with information about accommodations schools are required to make, how funding is allocated for students with disabilities, and the type of aid students receive.

It is important to note that in the sampling of interviewees the group sought to gain an understanding of best practices for disability accommodation rather than a statistically significant sampling from different target groups. The outcome of the interviews was an understanding of student abilities and needs, modified assessment methods, and accommodations currently made for students with disabilities. Contact information for interviewees from the United States can be found in Appendix L and contact information for interviewees from Australia can be found in Appendix N. Transcribed notes from interviews conducted in the United States can be found in Appendix O and transcribed notes from interviews conducted in Australia can be found in Appendix P.

4.1.1 Education in Australia

In Victoria, there are two levels of schools: primary and secondary. Primary schools include "prep" to Year 6. There are private primary schools, which often have a religious affiliation, and public government primary schools, where the student will attend the nearest school in their neighborhood. The purpose of the primary schools is to provide the students with a solid foundation of knowledge and the necessary skills to successfully move forward with their education.

Secondary schools are for students in Year 7 through Year 12; however, Years 11 and 12 are optional. For Years 11 and 12, students study for the Victorian Certificate of Education (VCE) and are evaluated by outside exams and other academic assessments. If students do not wish to pursue higher education, they can get the Victorian Certificate of Applied Learning (VCAL). This option gives students the opportunity to get real world work experience in an area of their choosing. Some of the types of secondary schools include co-educational government secondary schools, private independent schools, and non-denominational schools (Baker).

4.1.1.1 Department of Education

The Department of Education in Victoria is divided up into nine regions. The regions are divided geographically and all follow the same basic guidelines for schools. The Departments of Education have a parallel structure in each region so it was possible to gain an understanding of the Victorian Education system and services provided by the Department of Education by speaking with Officers from one of the nine regions. The Department of Education provides a variety of resources for schools including guidelines for the schools to follow regarding disability inclusion, curriculum guidelines, and professional development for teachers (Schmidt).

Regarding disability inclusion, all schools are required to provide adaptations to their programs to include all students. There are no specific guidelines for schools to follow, but every school is expected to modify their programs to allow students with disabilities to participate. Although the types of accommodations provided vary between schools, the Department of Education will provide the necessary funding and additional resources students require. According to the student's disability, visiting teachers, teachers of the deaf, or integration officers may be provided to the school to use at their discretion (Schmidt, Baker, Bond).

The Department of Education provides funding for students with disabilities on a student by student basis. The seven categories of disabilities are physical disabilities, visual impairments, severe behaviour disorders, hearing impairments, intellectual disabilities, autism spectrum disorder, and severe language disorder/crucial educational needs. Student funding ranges from $3,000 to $30,000 per year based on the level of disability of the individual student. The funding is allocated to the school that the student attends and the people involved with the student's education make decisions on how to best distribute the funds. Schools in Australia are self-managing in the sense that they receive money without an outlined budget from the Department of Education; the school administration can spend the money on student support as they see fit. With this system, each school independently hires support staff for the student and as a result, staff and student accommodations vary from school to school (Bond).

4.1.1.2 Education for Students with Disabilities

In Australia, if a student has a disability the child's parents can choose to send the child to either a mainstream or specialist school. Some mainstream schools have an extra unit or facility to provide for students with disabilities, such as a hearing facility for deaf students. These facilities are usually subsets of the main school and provide supplemental educational support for students, while keeping the students in mainstream classrooms for the majority of their time at school (Geddes). Students with disabilities who attend a mainstream school without a specialized support facility have visiting teachers that come to the school to support students with disabilities (Bond).

Specialist schools specifically accommodate students with disabilities. Overall, the term "special school" is usually reserved for schools that cater mainly to intellectual disabilities; however, the students often have other types of disabilities that are accommodated for as well. Frequently, students with mobility impairments also have an intellectual disability and will attend a "special school"; otherwise, they attend mainstream schools. There are several hearing specialist schools that provide for students with hearing impairments in Victoria. Vision specialist schools are no longer very prevalent because most of the students with vision impairments have been integrated into mainstream schools. The Burwood Education Centre run by Vision Australia is an exception to this trend. This centre is an active vision specialist school which provides full-time school programs for visually impaired students and part-time programs for mainstreamed students.

4.1.1.2.1 Individualized Learning Plans

In Australia, each student with a disability has an individualized learning plan (ILP). The ILP is the Australian equivalent of the individualized education plan (IEP) in the United States. The ILP establishes individualized goals for each child in the areas of language, student progress, and development. It is difficult to implement time periods that goals must be achieved within as they are based more on students making progress than meeting deadlines. The ILP does take the Victorian Essential Learning Standards (VELS) into account; however, the VELS are used more as a guideline and not as strict goals which must be met (Baker, Bond, Schmidt).

An important component of ensuring the success of the ILP is the parent support group (PSG). The PSG is comprised of the student's parents, teacher, school principal, and integration officer. The responsibilities of the integration officer include coordinating services to accommodate the students learning and physical needs, encourage students to be independent, and act as a liaison between the student and external agencies. The PSG meets to set goals for the student and decide how best to achieve those goals. The ILP is designed specifically for the student and necessary support can include a combination of time with a visiting teacher, extended test time, and various assistive technologies (Baker, Bond, Schmidt).

4.1.1.2.2 Visiting Teachers

Each region of Victoria has one visiting teacher for each of the following areas: vision, hearing, and mobility. The visiting teacher provides support in many different areas for both the classroom teacher and the student. The visiting teacher makes suggestions about programming, appropriate materials, and adaptations to the curriculum for the classroom teacher to implement (Bond). The visiting teacher also provides support for the students by going over material with them, making sure they are on track with their ILPs, and ensuring assistive technology such as hearing aids are in working order. Unfortunately, visiting teachers are very limited in what they are able to do as they have a short time at each school and are responsible for providing support for both teachers and students. Generally, the visiting teacher will spend two hours at the school with each visit and is able to visit between one and three times a week (Department of Education Officers and teachers of the deaf).

4.1.1.2.3 Student Aides

In general, students can either receive additional support from an aide in the classroom, outside of the classroom, or both inside and outside of the classroom. In schools, there is often a special education coordinator or a well being coordinator who ensures necessary accommodations are provided for students. Not all students are provided with aides and the amount of time a student spends with the aide is based on the level of disability. Student aides have many titles including integration aides, communication aides, teachers of the deaf, and teacher's aides (Baker).

Deaf students generally have a teacher of the deaf or communication aide that works with them. Interpreters are defined as people who provide direct translations of spoken word. In Australian schools, communication aides or teachers of the deaf provide more than translation of the spoken language, but also change the wording to make concepts and ideas easier to understand. According to Erica Povey of the Ballarat Deaf Facility, most primary schools do not have a fulltime communication aide; however, secondary schools usually do employ teachers of the deaf or communication aides fulltime.

For visual activities, particularly science, blind students often have an aide who will act an observer. This requires training for the aide to develop skills required to be a competent observer for the student (Stinchcombe). Mobility impaired students will also have aides who work with them in co-activity where the aide acts as an extension of the student's body to help the student in tasks he or she cannot perform independently. This technique is sometimes preferred over the aide merely doing the activity for the student because it allows the student to have some interaction with the task at hand (LaClaude).

4.1.1.3 Science in Specialist Schools

The majority of special schools focus on education for students with intellectual disabilities. Most accommodations focus on ensuring the simplicity of science activities. Many special schools do not offer strong science programs, but rather incorporate science into other forms of moderated science such as kitchen science (Deering). These types of programs concentrate on the science involved with everyday activities that the students have experience with. For example, the transition between the solid phase and the liquid phase can be demonstrated through the melting of butter while cooking.

Science teachers within special schools also incorporate simple science experiments into their curricula. The main accommodation at special schools concentrates on visual stimulation as students with intellectual disabilities often learn best through visual demonstrations and hands-on educational activities. An example of such a demonstration includes a colour changing reaction. Other activities include the study of the mechanics of a bike, weather, and nature walks as well as environmental science and forensics (Specialist School Teachers and Administrators).

4.1.2 Disability Barriers

When activities are designed without students with disabilities in mind, barriers are often present. Although the barriers differ between activities, common trends can be observed. This section discusses some of the barriers present to students who are deaf, visually impaired, or mobility impaired.

4.1.2.1 Barriers for Students who are Deaf

The most prevalent barrier for deaf students is a language barrier, as English is very similar to a second language. Thus, the learning age of a deaf student may be a few years behind their chronological age. The English language also has a very different structure than ASL (American Sign Language) and Auslan. The language gap generally tends to increase as the student moves into higher grade levels because the terminology becomes more complex as the student advances through courses. Other problem areas for deaf students who communicate through sign include the uses of the letter ‘s’ at the end of a word, tenses in language, and new words (Teachers of the Deaf).

In terms of vocabulary, deaf students are not exposed to new words on television or in conversation as often as students with normal hearing who hear new words all the time. Furthermore, students with normal hearing will have had previous exposure to many words in conversation and create links between the words and the definition when a meaningful explanation is provided. Without the prior experience with the words, deaf students often have difficulty creating necessary links between words and meanings. As a result, deaf students require vocabulary to be given to them directly (Greaves, Saynor, Cantwell, Gillespie, Povey).

Communication with other students and teachers also presents itself as a difficulty for deaf students. During discussions in class, a deaf student may be able to hear the teacher through an FM system but when another student asks a question, it may not be audible to the deaf student and they may easily become lost in the discussion. Furthermore, it is a general trend that many deaf students learn to be complacent and will not answer a question even if they know the answer as they are conscious of speech and worry others won’t understand what they are saying. Also, a deaf student may know the answer but not be able to communicate it orally or through written language as they get overwhelmed with words and vocabulary (Fram, Gauthier).

It is important to note that for deaf students, reading the material is not the same as understanding it; that is, simply transcribing aural information to text does not ensure that the students comprehend the material. Reading comprehension can be a problem for any student, but it is often overlooked for deaf students as many people believe the only barrier deaf students face is hearing spoken language. However, if the student does not know the meaning of the words that are transcribed, the situation is similar to trying to read a foreign language and may have little or no meaning (Teachers of the Deaf).

Sensory overload should also be avoided with deaf students. Sensory overload is when more than one piece of information is being communicated through the same sensory channel at the same time. An example of this is when a student tries to watch an interpreter and an experiment or other demonstration at the same time. The student cannot focus on both simultaneously, which may cause him or her to miss important information. Also, background noise can contribute to sensory overload as it is another incoming auditory input which can interfere with information being presented.

Non-verbal sounds are also a barrier for deaf students in terms of access. Sounds such as clicking and beeping outputs from a metre or other scientific tools can be important but are not accessible to deaf students. Other important concepts such as tone and pitch can also not be detected if a student cannot hear them. An example of a scientific tool used is a Geiger counter which produces a clicking sound to indicate the presence of radiation (Ault). When a metre output is totally dependent on aural production, it is not accessible to deaf students.

4.1.2.2 Barriers for Students with Mobility Impairments

Mobility impairment may result in various levels of limitations in strength, range of motion, and motor skills. Barriers which involve strength include lifting, pushing, and pulling objects. These activities are especially prevalent in many physics labs that deal with force and movement. Activities which require repetition often cause fatigue for students with limited strength. Limited range of motion may cause a student to have difficulty lifting as well as reaching, rotating, and stooping. For students with limited fine motor skills, tasks like grasping objects or handles, writing, and targeting can be difficult. Lastly, for students with limited gross motor skills, moving objects, turning handles and cranks, lifting, pushing, and pulling can be difficult. Students with limited gross motor skills may have muscle spasticity, making muscle control and large scale movement difficult.

4.1.2.3 Barriers for Students with Vision Impairments

There are many different barriers for students with visual impairments, especially in a scientific setting where many of the activities are visually based. Students with visual impairments may have difficulties in this arena because they cannot always see small objects, labelled containers, or colour differences clearly. Students may also have difficulty seeing reactions or movements that occur during experiments. A reaction resulting in a colour change or gas release is a barrier for students with visual impairments because they cannot see the changes occur and there are not always multi-sensory cues, such as smell or touch, which can be associated with those phenomena. Sufficient colour contrast is also important for students with visual impairments to enable them to read printed material on worksheets, posters, and PowerPoint presentations. It is important to use a light background and dark text for visual displays (Ault).

Beyond colour contrast for textual documents, small text size is another barrier faced by those who are visually impaired. Often, the standard text size used for printed material is too small for visually impaired students to comfortably read. Generally, size 18 fonts are adequate for visually impaired students to read. Some students can read a smaller font size, but visual fatigue may set in, limiting the amount of time the student can read (Lavergne, Fraser, Stinchcombe).

Descriptors such as ‘up here’, ‘down there’, or ‘across there’ are barriers because such language does not actually reveal anything about location and students with visual impairments cannot see the gestures that accompany the descriptors. A student with low vision would also find this language confusing if the referenced objects were too small or did not have an appropriate colour contrast level for the student to see clearly (Stinchcombe).

Tactile diagrams are useful tools for students with vision impairments, but are not perfect because tactile diagrams are not always simple enough to explain different ideas and concepts efficiently. When using touch, it is only possible to feel what is directly under one’s fingertips at a certain time. This is comparable to trying to look at an image through a straw; while it is possible to see all of the parts of the picture, one can only see very small pieces at a time, making it very difficult to decipher the entire picture (Stinchcombe).

4.1.3 Accommodations

There are two types of accommodations that can be made for students with disabilities. The first type of accommodation is a general accommodation. General accommodations seek to make activities and material accessible to all students, without disability-specific modification being needed. General accommodations are an example of universal design as they are inclusive of all levels of ability. The second type of accommodation that can be made is a disability-specific accommodation. Disability-specific accommodations make activities and material accessible to students with specific disabilities, taking into account individual abilities and needs.

4.1.3.1 General Accommodations

Usually, special accommodations are made for students with disabilities to ensure that assignments and activities are accessible to them. However, there are many general adaptations that can be made in the classroom and science settings to make programs more accessible not only for students with disabilities, but for all students. To further support this idea, many accommodations made by teachers and support staff for students with disabilities are actually adopted by the classroom teacher as these adaptations enhance the level of understanding for the entire class.

Preparatory material is one area that can be targeted to make information more accessible. When teachers are provided with preparatory material by outside sources such as CSIRO Education, they are able to prepare the information in the desired format, expose the students to new vocabulary, and give students the necessary background information to make the lesson meaningful. Furthermore, the classroom teacher can also give preparatory material to a student's aide or teacher of the deaf so that the student can get support outside of the classroom to prepare for what will be taught in class. Additionally, when information is distributed ahead of time, it is possible for the school or teacher to enlarge the font or transcribe the material into Braille, according to specific student needs (Geddes, Greaves, Stinchcombe).

It is also important to identify the primary and secondary goals of a lesson. By identifying these goals, it is possible to evaluate what portions of the program are necessary to understand the concepts being taught. For example, an activity may require cutting out shapes of organs and placing them on a large cut out of a human body to identify location of different organs. In this example, the actual cutting is not essential to understanding the concept and the student does not need to cut out the shapes to gain an understanding, making pre-cut paper organs a valuable accommodation by eliminating the need for fine motor skills in the activity. Using pre-cut or prepared parts also allots more time for teaching students various concepts (Fraser, Rosewarne).

Activities should be multi-sensory in nature, allowing students to access them through many different senses including vision, hearing, sight, smell, and taste when appropriate. By utilizing multiple senses, students are more engaged and those who have one or more senses that are impaired are still able to participate (All teachers).

Changing the wording of instructions and activities to make them more simple and easy to understand is an important accommodation. Students with disabilities often require basic step by step instructions that can be easily followed. Incorporating pictorial instructions to coincide with the textual instructions can be beneficial to students with various types of disabilities. When instructions are clear and concise, it is much more likely that the student will be able to complete an activity (Geddes, Cavanagh).

Moreover, it is also important to focus on student strengths. Each student has his or her own individual strengths and weaknesses and by utilizing each student's strengths in group work, it is possible for each student to contribute in their own way. By focusing on each student's strengths, as opposed to his or her weaknesses, it is possible to identify the maximum ability of the students and incorporate activities that they are all capable of into the curriculum (LaClaude).

Presentation style is another area that can be addressed to make learning more accessible for all students. It is important that presenters and teachers do not wander during presentations. By standing in one place, the teacher is less distracting and easier to see and hear. Standing in front of a bright light is also something which should be avoided, as in this situation it not possible for the students to see the teacher's face. Additionally, the teacher should always face the class when speaking in order to project his or her voice better and ensure students are able to lip read if necessary. Keeping all of these distractions in mind will make presentations more clear and easy to understand overall (Teachers of the Deaf).

Safety is also an important issue to keep in mind when focusing on general classroom adaptations. It is important to use suitable tools at all times to ensure safety, such as plastic beakers for measuring. Glassware in general should be avoided when possible in case equipment is dropped. Hazardous chemicals and sharps should be labelled and stored correctly. Making the classroom and lab environments safe for students with disabilities provides a safer classroom for all students (Marchilena).

4.1.3.2 Accommodations for Students who are Deaf

Accommodations for deaf students can be broken down into three main categories: accommodations made to enable the student to have access to spoken language, accommodations made to ensure that the language is simple and easy to understand, and accommodations made to make other non-verbal, but still important, sounds accessible. All three are very important in ensuring that a deaf child is able to get the most out of his or her education and participate fully in any setting.

4.1.3.2.1 Access to Spoken Language

Many different strategies are used to give deaf students access to spoken language. One approach is utilising technology; several pieces of personal technology are available to deaf students, the most common and well known being the hearing aid. All children in Australia with hearing loss are provided with hearing aids, which are paid for by the government. Hearing aids work by amplifying sound to help students hear better in many everyday situations. However, hearing aids are not perfect and they have several limitations. One common problem is that hearing aids amplify not only the language the student is trying to hear, but also all other sounds which include white noise and other background noise. The optimal working range of a hearing aid is only about one metre. This may work well for conversations but is not suitable for discussions with several people or noisy environments (Teachers of the Deaf).

Hearing at greater distances is partially remedied through the use of a personal FM system, which is another device that is paid for by the Australian government. An FM system consists of a small microphone with a wireless transmitter that the teacher wears and a small receiver that usually attaches to the student's hearing aid. The microphone will amplify the teacher's voice, making it easier to hear above other noise in the classroom. FM systems work well for students when all they have to pay attention to is the teacher; however, when there is classroom discussion or another student asking a question, the deaf student is left out because the sound is not picked up by the FM system. This can be resolved using general good teaching practices and repeating questions that are asked in class, allowing the deaf students to hear the question while also reinforcing it for other students (Teachers of the Deaf).

Proper classroom setup is very important for deaf children and can greatly enhance a student's ability to access spoken language. One of the most important factors is background noise, which must be kept to a minimum to ensure the student can hear what is important. A student's visual pathway to the teacher cannot be blocked by other students or objects because it is important for the student to see the teacher at all times. This ensures that the teacher's voice is clear and it is possible to read their lips at all times. Similarly, if a teacher of the deaf is in the front of the classroom, it is imperative that the student has a clear view of the teacher of the deaf. It is also very helpful if students are seated in a fashion that allows them to see each other, such as a semi circle. The semi-circle setup works especially well when there are discussions or interactions between the students, but can be beneficial in a regular classroom situation because other students may still ask questions. Being able to see the other students makes it easier for a deaf student to follow conversation. In lab areas, large centre facing benches are preferred to benches along the wall because they allow the student to see the teacher when conducting experiments (Marchilena).

Teachers of the deaf are used for many children who are profoundly deaf and their availability depends on the school. The teacher of the deaf may be available all the time or only for certain classes, playing different roles within each classroom. The first and most basic job of a teacher of the deaf is to translate spoken word into sign language; however, this is not always useful to deaf students because it does not account for the language gap. Therefore, teachers of the deaf go beyond mere translation of oral language into sign language by making decisions on what vocabulary will make the most sense to a child and incorporating that into their signing. For example, if language is used that the teacher of the deaf knows will be confusing to the deaf student, the teacher of the deaf will immediately modify the language in a way that the student will find easier to comprehend. Additionally, a teacher of the deaf can also offer assistance in helping the student communicate his or her own ideas with teachers and peers. If a student uses sign as their primary form of outgoing communication, the teacher of the deaf can translate into spoken word for the student so that those who do not sign can still understand what the student is saying (Teachers of the Deaf).

Preparatory material is especially important when making accommodations for deaf students. If the teacher of the deaf is able to preview the lesson plan, particularly for demonstrations, he or she can add cues that let the deaf student know to watch the classroom teacher at a particular moment. If this did not occur, it would be very easy for the student to miss a valuable part of the demonstration because they were looking at the teacher of the deaf, thus limiting their ability to pay attention to the demonstration (Teachers of the Deaf).

Also essential for deaf students is transcribing spoken word into written word. If video or other media is used, it should be closed captioned. Additionally, any verbal instructions should be available in print for deaf students. It is important that deaf students are able to access the same information as their peers (Teachers of the Deaf).

4.1.3.2.2 Language Gap

Simply transcribing spoken language into a written form does not ensure that a student is learning the material. A language gap exists for deaf students, making English similar to a second language. It only takes a few words that the student cannot comprehend for the student to get confused and render the text useless. Hence, it is imperative that the language be adapted so it is accessible for deaf students (Geddes, Cavanaugh, Greaves). It is important to remember that every student is different and there are varying degrees of proficiency in language among students of the same age; some may be at grade level while others may be far behind.

One strategy to minimize the language gap that exists for deaf students is to simplify the language used (Hall, Geddes). This must be done in a manner that does not make the material too simple because the students will know if what they are reading is below their level. It is also important to keep everything visual because deaf students are accustomed to gathering most of their information through the use of sight. Including pictures that are relevant to the discussion and show or reinforce the material that is being taught is an excellent strategy. Words describing concepts may be meaningless to the student, but allowing them to see pictures or visual displays which demonstrate concepts can help them comprehend the material more easily and effectively. When writing instructions for labs, the steps should be concise and include only information necessary to complete the lab so the text that must be deciphered is kept at a minimum. Pictures illustrating what is to be done in each step can also prove to be very useful in enabling the students to complete the labs on their own (Geary, Teachers of the Deaf).

4.1.3.2.3 Accommodations for Non-Verbal Sounds

Non-verbal sounds such as beeps, static, pitch, tone, animal vocalizations, and echoes are all common in a science setting. To make non-verbal sounds accessible to deaf students it is important to make the activity multi-sensory. Visual stimuli or something the student can touch or feel changing can be substituted for auditory cues. For example, a light turning on can indicate a change in sound or a student could feel an object vibrating instead of listening to the vibrations.

4.1.3.3 Accommodations for Students with Mobility Impairments

There are two main approaches to making accommodations for students with mobility impairments. One approach is to give students as much independence as possible. The second approach is more tailored to students with severe mobility impairments where an aide is used.

Often, to give students more independence when activities are taking place, materials are prepared ahead of time so steps may be skipped in the process, allowing students to complete the project independently. An example of this would be using pre-cut shapes so students did not have to use scissors as part of the activity (Rosewarne).

It is also possible to illustrate principles of movement by using a student's wheelchair. Rather than having the student physically move a model car, it is possible to move the student in their wheelchair to illustrate concepts such as velocity and acceleration. This technique helps by relating science concepts to the student's everyday experiences (Edgerton).

Additionally, evaluation is often done with either the use of a computer or note taker or completed orally to accommodate students who do not have fine motor skills. Picture essays are another form of assessment commonly used. By using picture essays students do not have to write out lengthy essays but rather can assemble pictures in order to illustrate the same point.

The most important thing to remember when making accommodations for students with mobility impairments is to look at what they are able to do, rather than what they cannot do. It may be easy to pick out areas where the student may not be able to participate, but each student has individual strengths which can be taken advantage of. The student may be able to participate in the activity, but he or she may have to go about it in a different way that is not apparent at first glance. A student may substitute one part of their body for another in order to complete an activity. For example, a foot pedal may be used to switch something on and off if the student does not have upper body mobility.

Schools will often use aides for students with mobility impairments when completing experiments. In these instances the teacher will be in front of the class teaching and an aide will act as an extension of the student's body. This is referred to as co-activity and the aide will move the student's hands or legs and help them in completing tasks or experiments. Co-activity is sometimes preferred over the aide just doing the entire activity because it allows the student to have some participation (LaClaude, Harrison).

4.1.3.4 Accommodations for Students with Visual Impairments

There are many different types of accommodations that can be made for students with visual impairments and blindness. Although these students may not be able to completely see a demonstration or all aspects of an activity, they can still participate and learn the material in a hands-on setting. The first accommodation that is made to most programs is the inclusion of multi-sensory components because they will stimulate the student through his or her stronger senses: hearing, touch, smell, and taste (All teachers). There are many other aspects that can be modified slightly to involve students with visual impairments across all areas of activities and experiments.

The first area of an activity that needs to be modified is the presentation of text-based information. Most of the time, lab instructions as well as other handouts and written material will require some changes depending on the student's level of visual impairment. Through experience with the student, the teacher will be familiar with what accommodations are necessary for each child; therefore, the teacher needs to be given the material ahead of time in order to prepare the material in the necessary way (Fraser, Lavergne, Stinchcombe).

For students with low vision, the font size of all printed instructions will need to be increased so that the student can comfortably read them. Blind students may require Braille worksheets. For students with more severe visual impairments, the instructions must be as simple as possible and key information should be repeated to emphasize its importance (Fraser, Lavergne, Stinchcombe).

Instructions will also need to be delivered in a manner the student can comprehend; for example, an activity should not be described by pointing to different areas of the room. It is essential to illustrate clearly and verbally what needs to be done. It can also be helpful to expose students to objects that will be used in the experiments beforehand so they may better understand the material when instructions are presented. Along with instructions, different forms of presentations are often used to portray material. If a whiteboard is going to be used, the presenter should write in large print and legible font so that students with visual impairments can see. It is also important to make sure that light backgrounds and dark text are used because strong contrast is best for students with low vision. Keeping the font size large and the pictures simple are two of the most important accommodations to keep in mind when using PowerPoint, posters, and white boards for presenting material to students who have visual impairments (Ault).

Worksheets are often incorporated into the programs as a way for students to record their findings and as a reference for questions later. For students with low vision, it is important to enlarge diagrams and the font size on worksheets or have them put into Braille form. In order to reproduce the material in the necessary form, worksheets should be in electronic format. If information is in electronic format, it can be manipulated and reproduced as required. Additionally, when information is presented in electronic format, other computer technology such as magnification programs and screen readers can also be used to assist with reading the material (Stinchcombe).

Braille is the form of written communication that is often associated with the visually impaired; however, it is estimated that only about five to ten percent of the legally blind population in Victoria use Braille; this is a very small portion of the visually impaired community. For specific subject areas, such as math and science, there are separate codes for different countries, which require more specialized training to read. Unfortunately, there are few training courses in Braille, making it a less prominent adaptation in Australia. The Vision Australia Information Library Service (VAILS) provides services to translate material into Braille form (Stinchcombe).

Magnification is another important tool used for students with visual impairments. Magnifying glasses can be used by students with visual impairments to see better what they are investigating or observing in science experiments. Video magnifiers can be used to enlarge images or objects for students. For example, if a student is participating in a dissection laboratory, the video magnifier can be placed over the animal being dissected so that the student can visually see the organs on a larger scale. This way, the student’s visual of the object is enhanced and he or she can actively participate with the other students. Connecting projectors or televisions to microscopes is another way to adapt life science labs for students with visual disabilities because they can see the small objects on a larger scale (Lavergne).

For more hands-on activities and explanations, tactile diagrams can be used for further explanation and reinforcement of the material being taught. A tactile diagram is a model of anything that can be touched. These diagrams can be made for any simple figure using a multitude of different supplies. Some teachers use craft supplies to make three-dimensional diagrams of different scientific concepts. A good example would be a diagram of a cell, complete with DNA and organelles, which allows the students to feel the different components. Some people use thermoform or Piaf paper. Thermoform paper can be placed over a raised surface and heated to conform to the surface. The thermoform paper can then be removed and used on its own. Piaf paper uses heat sensitivity to raise different areas based on greyscale shading, making the dark outlines of different diagrams three dimensional (Stinchcombe).

Another effective way to expose students with visual impairments to the world around them is through auditory cues. Incorporating sounds into the activities makes them more engaging. For example, adding a "click" noise at the end of a reaction will give the visually impaired student a confirmation that something has finished. Other uses of sound include using balls with a bell inside of them so that a student can track the ball movement using auditory input rather than visual input (Stinchcombe).

Additionally, preset syringes allow the student to draw up correct volumes of liquid without assistance. Organizational trays can be used to help students sort through the materials in the science activities. Various "speaking" measuring devices can be used as well because they can measure certain objects and announce the numerical value associated with the measurement (Fraser).

Verbal descriptions are very important and should be dealt with in a particular manner. Explanations should be simple and easy to understand. Lastly, peer helpers can be incorporated into programs to ensure that students with visual impairments have other students around to describe verbally what is happening around them (All teachers and administrators).

4.1.4 Technology

Technology has made it possible for students with disabilities to access information that would not have otherwise been available. Many technologies exist and this section serves to discuss specific technologies utilized by teachers who were interviewed by the project team, rather than provide an extensive list of available technologies.

4.1.4.1 Technology for Students who are Deaf

Hearing aids are a commonly used technology for deaf students. All Australian students with a hearing impairment are equipped with hearing aids as they are paid for by the government. Other assistive technology includes cochlear implants, FM technology, and Front Row Pro. With FM technology the teacher wears a microphone and the student wears a receiver, allowing the student to better hear what the teacher is saying. Front Row Pro is a new technology that has been developed by Phonic Ear. With this technology the teacher wears a microphone and there is a speaker in each corner of the classroom. The system amplifies the teacher's voice and because of the speaker placement, the student is closer to the sound regardless of where the student or teacher is located in the classroom (Teachers of the Deaf).

For deaf students, image creator programs are frequently used in the classroom. Such programs include Clicker 5 and Writing with Symbols which are used at St. Alban's East Deaf Facility. These programs allow teachers to search pictures lists by country for different pictures to illustrate concepts they are teaching in class (Fram).

4.1.4.2 Technology for Students with Mobility Impairments

Assistive technologies have also been developed to aid students with mobility impairments. These technologies include software which operates based on the student activating a switch to control a computer or device. Speech recognition software such as Dragon Dictate can be used to record the speech of a student who cannot communicate his or her ideas through writing or typing on a computer. Augmentative communication devices such as voice synthesizers may be used by students that are non-verbal. Also, computers with touch screens are in some instances easier for students to use than a keyboard or mouse. Mice also exist which operate based on eye or head movements for those that cannot operate a standard mouse. Also, head pointers can be used which allow students to turn pages as well as draw and paint. In addition to commercially developed technologies, many people develop their own technologies to suit personal needs.

4.1.4.3 Technology for Students with Visual Impairments

Many assistive technologies also exist for students with vision impairments. There are now pocket Braille readers with refresher displays such as the PAC Mate. Using these machines one can type in or record in Braille and also detach the refreshable display and connect it to a computer. This product is produced by Freedom Scientific and can interface with any Microsoft product; however, it is very expensive, costing around $12,000, making it an investment that not everyone can make (Stinchcombe).

The JAWS screen reader and voice synthesizer is also made by Freedom Scientific. This software reads the text on the computer screen aloud. To aid students in reading material on computer screens there are also screen magnifiers which enlarge information on the screen for students with less severe visual impairments. One drawback to screen magnifiers is some students may get motion sickness while looking at the screen because the display moves as different areas of the screen are magnified. It is worthwhile to note there are some websites which are not compatible with screen readers and screen magnifiers (Stinchcombe).

Other assistive technologies for visually impaired students include talking calculators, rulers, scales, and colour readers. The talking instruments take the output of the calculation or measurement and report it in a verbal output. In the same manner, colour readers determine the colour of an object and report that verbally (Fraser).

4.1.5 Evaluation and Measuring Student Success

It is often necessary to develop alternative forms of assessment for students with disabilities. Such disabilities include the inability to write manually as a result of limited fine motor skills or the inability to see what one is writing on the paper. In instances where students are visually or mobility impaired, teachers will often have students choose an answer to a question rather than formulate the answer; this generally consists of having students match answers to questions. John Geddes of the Sunshine Deaf Facility says the most difficult aspect of assessing deaf students is trying to devise a way to test the ideas and concepts the students have learned, while not relying on the English language. Different forms of assessment include pictures, videos of students signing, oral language, photo stories, and written language. For example, a blind student may be able to report their answers orally instead of putting them in written form (Marchilena).

Regardless of the type of evaluation, it is essential that the students demonstrate knowledge and understanding. Different ways of measuring student knowledge and understanding include evaluating what the students retain, having students recall data from experiments or the steps of a process, and having students report results. If the student has met the basic goals of the activity, then the activity is considered successful. At some schools long term evaluation of student success is recorded by using a teacher checklist to determine what concepts the student has grasped. Overall, productivity is tracked and checked against the goals established for the student in their ILP (All teachers).

4.2 Observation of Melbourne CSIROSEC Programs

In an effort to determine barriers that are common to Melbourne CSIROSEC programs and hands on science programs in general, the project team observed several of the Melbourne CSIROSEC's programs. The intention was to observe as many different programs conducted by as many different presenters as possible, both at the CSIROSEC and through the Labs on Legs program. A summary of all of the programs observed, along with the presenter, location, and grade level for each program is included in Table 2. A total of thirteen observations were conducted, covering eight different programs and four different presenters. Seven programs were observed at the Melbourne CSIROSEC and six were observed via the Labs on Legs program at schools in the Melbourne area.

Program	Presenter	Location	Grade Level
Air and Weather	Simon	CSIROSEC	4-6
Driving Innovations	Sean	John Paul College	8
Energy	Caitlin	CSIROSEC	3-4
Energy	Merrin	CSIROSEC	3-4
Force and Movement	Simon	CSIROSEC	3-4
Forensic Frenzy	Simon	CSIROSEC	10
Forensic Frenzy	Karina	Bellarine Secondary College	10
Gene Technology	Karina	Mount Waverley Secondary	10
Gene Technology	Karina/Sean	Broadmeadows Secondary	10
Gene Technology	Kane	CSIROSEC	10
Natural Disasters	Simon	CSIROSEC	4-6
Natural Disasters	Merrin	Strathmore Primary School	5-6
Thinking Scientifically	Caitlin	Niddrie Secondary School	7

Table 2: Summary of Observed CSIRO Education Programs

The notes from the observations are in included in Appendix Q. After observing several of the programs, conclusions were drawn. The first was that the programs are fairly consistent between presenters. They do not vary much beyond personal presentation styles and personalities. Programs followed a general structure which began with a preliminary introduction to CSIRO, discussion of relevant material to the program, and an overview of the experiments where presenters walked students through each experiment explaining the steps. The students then completed the different activities in groups of two or three. Each activity was accompanied by an instruction sheet that reiterated instructions previously covered by the CSIROSEC presenter. Worksheets accompanied most programs and students filled them out individually as they completed the activities. Each program concluded with a summary and review session where conclusions were drawn and concepts were reinforced. Overall the programs were very interactive and there was a lot of communication between the presenter and students, as well as between students within individual groups.

The most important outcome of the observations was a list of barriers which were identified within each CSIROSEC program. It is important to note that the barriers were program specific and did not vary between presenters. An initial barrier checklist was developed which identified common barriers found in hands-on science programs. This checklist evolved as observations progressed because new barriers were detected during program observations. The barrier checklist was divided up by type of disability (visual, auditory, or mobility) and categorized by different tasks.

During program observations, tasks were identified that were barriers in the program. An example of this would be in the Gene Technology program for the task of pipetting, it would be difficult for a student who lacked fine motor skills to pick up and manipulate the pipette. Another example of a task with barriers was reading a container label for students with visual impairments.

The complete barrier checklist used to evaluate CSIROSEC programs is included in Appendix L. This checklist lists tasks and CSIROSEC programs which contain the listed barriers. This barrier checklist was very important because it served as the starting point for the development SAM. An excerpt from the checklist can be seen below in Figure 2.

VISION Barrier Checklist			
Task	***Barrier Present?***	***Barrier***	***Possible Solutions***
Moving liquid or powder			
Moving powder from one container to another		Measuring proper amount of powder, getting powder in potential narrow opening	
Moving a liquid from one container to another		Pouring Liquid, accuracy of pouring liquid	

Figure 2: Excerpt from Barrier Checklist Used During Program Observations

On this chart, it is possible to see a listing of different tasks and the barriers present within each task. The task column is meant to serve as a broad category used to identify different aspects of classroom activities, while the barrier column specifies what is difficult for the student to do. The last column was used to write possible solutions to barriers found in the activity.

Additionally, information from the barrier checklists from all program observations was compiled to form the summary checklist. An excerpt from the summary checklist can be seen below in Figure 3. The summary checklist contains tasks and barriers, as well as the programs that were found to contain them. The complete summary checklist can be found in Appendix R.

VISION Summary Checklist		
Task	***Barrier***	***Programs with Barrier Present***
Moving liquid or powder		
Moving powder from one container to another	Measuring proper amount of powder, getting powder in potential narrow opening	Forensic Frenzy Thinking Scientifically
Moving a liquid from one container to another	Pouring Liquid, accuracy of pouring liquid	Forensic Frenzy Natural Disasters Thinking Scientifically

Figure 3: Excerpt from Summary Checklist

5 SAM Development

To transition from the barrier checklist to SAM, the project team focused on finding common themes in tasks listed in the barrier checklist. One example of this is combining the tasks of pipetting, pouring a liquid, and moving a powder into the category of targeting. It was important to categorize the tasks so the matrix was manageable in size. Additionally, a spectrum was established for each disability outlining different abilities present within each disability. The degrees of each disability were developed as a result of literature research and information gathered from interviews. The spectrum was necessary to account for the broad range of abilities between students.

It was determined that the best form for the framework was that of a matrix with each column containing a different degree of ability and each row outlining a different task that is a barrier for students. The first row of each matrix outlines general accommodations for all tasks. In the matrix, each cell provides a solution based on the task and degree of disability as defined by the row and column of the cell. To prevent the matrix from becoming oversized, cells contain solution codes which refer users to a written section of the framework, explaining each solution. In the written section, basic principles of the solution are bulleted. Below the bulleted list is a short paragraph explaining the solution in more detail. This setup was chosen because it allowed each matrix to be easily condensed into a smaller, pamphlet sized version including only the basic principles. An excerpt from one section of SAM can be seen on the next page in Figure 4.

VISION SAM				
Task	Colour-blind	Limited Visual Field	Low Vision	Blind
ALL TASKS	V7, V16	V9, V16	V7, V8, V12, V16	V16
Targeting (Moving, Pouring, Assembling)			V5	V5
Measuring Using an Analogue Scale			V3	V3

Figure 4: Excerpt from Vision SAM Section

In addition to the disability specific sections, there is also a section of SAM focused on universal design which emphasizes best practices teachers should use in all classroom and science settings. The universal design section is meant to be utilized before applying one of the disability specific matrices.

6 SAM

The final version of SAM is included in the sections below. SAM consists of universal design, auditory, mobility, and vision sections. The universal design section is meant to provide techniques that should be incorporated into all classrooms. Each disability specific section includes:

- An explanation of the spectrum used for the disability;
- Tasks identified as barriers, along with an explanation and examples of each task;
- A matrix linking the spectrum and tasks to solutions; and,
- A further explanation of each solution.

6.1 SAM Universal Design

Special accommodations are often made for students with disabilities to ensure that assignments and activities are accessible. To begin making the classroom and science settings accessible to students with any disability, there are many general good teaching practices that should be followed. Good teaching techniques have been shown to make information more accessible and easier to understand for all students, regardless of disability. This approach is further supported by the fact that many of the accommodations made by teachers and support staff for students with disabilities are actually incorporated into the general classroom to enhance the level of understanding for the entire class. The following list includes several universal design techniques that should be incorporated into all classrooms and activities before attempting to modify them for students with disabilities. This is followed by a list, containing more details for each universal design principle.

The universal design principles are as follows:

1. Provide preparatory material to students and/or support staff
2. Determine which activities are necessary to achieve learning goals
3. Integrate multi-sensory activities into daily classroom learning
4. Simplify instructions
5. Utilize activities which allow students to work in groups
6. Focus on student strengths
7. Use good presentation style

8. Ensure all equipment is within student reach
9. Use suitable equipment at all times to ensure safety
10. Allow students extra time if needed

A more detailed description of the universal design strategies follows:

1. Preparatory material is important as it introduces students to concepts and allows them to familiarize themselves with the material before it is introduced in a formal classroom setting. When teachers or support staff are provided with information, such as worksheets ahead of time, it is possible to convert the text to alternative formats. These alternate formats depend on the student's needs and can include enlarged font or Braille. Repetition is also important for all students in learning because the more times information is introduced through different mechanisms, the more likely the student will gain an understanding of the material being taught.

2. By identifying the primary and secondary goals of an activity it is possible to identify which areas of a program or lesson need to be adapted. For example, if the main objective of an activity is to observe a chemical reaction resulting from the mixture of two chemicals, then measuring the volume of liquid to mix is not essential to the concepts associated with the activity. Rather, students could be given preset volumes to mix, removing the barrier associated with the task. Another benefit of removing non-essential tasks is there is more class time to complete other activities.

3. Multi-sensory activities are integral to classroom learning to help reinforce concepts and allow students to access material through different mediums. By allowing students to experience material through multiple channels, students are able to capitalize on their abilities and utilize their stronger senses. Additionally, multi-sensory activities allow students to access material through different mechanisms and keep all students more engaged in the activity.

4. Simplifying instructions so that they are clear and concise allows all students to complete activities more independently. Additionally, breaking down instructions into steps and accompanying them with pictures makes them easier to follow. Students who have difficulty with language and vocabulary, such as deaf students, will also be able to better understand simpler instructions.

5. Activities which allow students to work in groups can accommodate students of many different abilities. If students are not able to do a certain part of the activity, a different member of the group may be able to do it or aid the student in completing the activity. When each student is able to take advantage of his or her own strengths, group work is much more effective, productive, and individually satisfying for all students.

6. Focusing on student strengths makes it possible to incorporate activities students are capable of completing into the curriculum. Fewer adaptations are required if programs are created with a broad range of student abilities in mind. Keeping student strengths in mind will make the curriculum more accessible for all students, regardless of whether or not a disability is present.

7. Several steps can be taken to ensure presentation style lends itself to being accessible to all students. Presenters should avoid wandering back and forth while talking and face the students being addressed rather than facing a presentation screen, chalkboard, or experiment. Presenters should also not stand in front of bright lights as it may make it difficult to see their face. These techniques ensure that the presenter's voice is always projected towards the class and face is always visible, which is especially important for deaf students to hear and lip read. It also makes it easier for all students to hear the presenter, allowing them to concentrate on understanding what is being said, rather than trying to decipher it.

8. There should not be any equipment that is out of the reach of students. Equipment and activities should be based at a level which can be easily and safely accessed by students, including tabletop activities. This can easily be achieved by using adjustable tables and workstations. These modifications allow all students to comfortably complete experiments while accommodating for students in wheelchairs who may require a higher desk or a lower lab bench top.

9. Safety should always be a primary concern and suitable tools, such as plastic beakers instead of glass beakers, should be used to ensure safety. Other safety measures

include properly storing and labelling hazardous chemicals and sharps. Creating safe laboratory environments makes classrooms safer for all students.

10. It is important to realize that there is a wide range of student abilities in the classroom. Allowing students more time to complete tasks if necessary is very important. If students feel rushed, they may not be able to do their best or get the proper experience from an activity. This is particularly important for students with disabilities, as they may require extra time to complete tasks because it may take them longer to read material, move objects, and follow instructions step by step. Some students may also require repetition to learn concepts concretely.

6.2 Auditory SAM

6.2.1 Auditory Spectrum

There is a large spectrum of hearing abilities among deaf students. This spectrum ranges from slight hearing loss to profound deafness. In order to provide the most appropriate accommodations for all levels of hearing loss, the spectrum has been divided into categories defined by a student's level of hearing loss as well as a student's form of communication. Therefore, the spectrum has been broken down into four categories: Partial Hearing and Can Verbalize Orally, Partial Hearing and Use Manual Communication, No Hearing and Can Verbalize Orally, and No Hearing and Use Manual Communication. Below is a brief description about the different levels contained in the spectrum.

How students receive incoming auditory information:

Partial Hearing: Students grouped under "partial hearing" are those that still have some usable residual hearing. Many times with amplification, these students can access auditory information, whether it is speech or a non-verbal sound. It should be noted that being able to hear with amplification does not mean that the students can adequately process the information.

No Hearing: Students grouped under "no hearing" are severely or profoundly deaf and are not able to hear much or any incoming auditory stimuli, even with amplification. These students have no usable hearing and as a result they depend solely on lip reading or sign to receive verbal information and cannot hear other non verbal cues or sounds.

How students communicate with others:

Can Verbalize Orally: Students in the "can verbalize orally" category are able to communicate to those around them using spoken language. These students have enough confidence in their ability and knowledge of the English language that they can verbally communicate to others.

Use Manual Communication: Students who use manual communication do not communicate through the use of spoken language. The student may not have adequate knowledge or skill to communicate using English or the student may not have enough confidence in their ability to form words to speak out loud to others. Either case may result in a student not verbally communicating with others through spoken word. Two examples of manual communication are ASL and Auslan.

6.2.2 Auditory Tasks/Barriers

In order to best provide solutions for barriers posed in hands-on activities, tasks were identified which can be difficult for students with hearing loss. The tasks have been broken down into related categories and are further described below.

The following five tasks are identified in SAM as barriers for deaf students:

- Student Accessing Incoming Language
- Student Accessing Non-Verbal Sounds
- Student Comprehending Incoming Language
- Student Expression through English
- Others Accessing Student's Language

The following are descriptions for each task that SAM identifies as a barrier:

<u>Student Accessing Incoming Language</u>

Accessing incoming language is defined as a student being able to gain access to information in a form that they are able understand whether it is oral, written, or signed. There are many types of language students may need to access to including:

- Verbal Instructions from the teacher or presenter
- Lecture material from the teacher or presenter
- Classroom discussion
- Answers and questions posed by the student's peers
- Discussion with peers in group work
- Films and documentaries

Student Accessing Non-Verbal Sounds

Non-verbal sounds are very common in science settings and can include beeps, static, pitch, tone, vocalizations produced by animals, echoes, explosions, and many others.

Student Comprehending Incoming Language

Language comprehension assumes a student has access to information and focuses on a student's ability to understand the information. It is important to note that while a student may be able to read, hear, or receive visual input, this does not mean the student understands the material being presented. Understanding can be measured in terms of:

- Understanding new and abstract vocabulary
- Understanding new concepts and scientific principles
- Understanding the goal of the task

Student Expression through English

Students need to communicate what they are thinking by demonstrating what they have learned. A language barrier exists which makes English a second language for deaf students. Communication can be difficult, including tasks such as:

- Writing observations
- Completing worksheets
- Compiling lab reports
- Completing homework assignments
- Taking notes

Others Accessing Student's Language

Students need to communicate with each other in order to actively participate in classroom activities. Other parties which may need to access student language include classroom teachers and presenters. The form of communication style depends on a student's ability and can include sign language, speech which may or may not be clearly understood by others, or written language.

6.2.3 Auditory SAM Accommodations

The Auditory Matrix is shown on the next page in Figure 5. Tasks that have been identified as barriers for deaf students are listed in the left hand column. The spectrum of the disability is found in the top row of the matrix. The second row of the matrix includes accommodations that can be made for all tasks to make them more accessible for students with auditory impairments; these solutions should be considered before the rest of the matrix is consulted. The middle cells of the matrix contain solution codes which correspond to adaptations that can be made to accommodate deaf students. The coded list of solutions is found below the matrix. It should be noted that the auditory specific accommodations are meant to supplement the universal design section; they assume that the general strategies in the universal design section have been implemented.

AUDITORY SAM				
Tasks	- Partial Hearing - Can Verbalize Orally	- Partial Hearing - Uses Manual Communication (ASL or Auslan)	- No Hearing - Can Verbalize Orally	- No Hearing - Uses Manual Communication (ASL or Auslan)
ALL TASKS	A3, A4, A5, A7	A3, A4, A5, A7	A4, A5, A7	A4, A5, A7
Student Access to Incoming Language			A8	A8
Language Comprehension	A6, A9, A10	A6, A9, A10	A6, A9, A10	A6, A9, A10
Non-Verbal Sound	A1	A1	A1	A1
Others Accessing the Student's Language		A8		A8
Expression through English	A2	A2	A2	A2

Figure 5: Auditory SAM Matrix

Auditory Solution Key

A1 - Alternate Access to Non-Verbal Sounds
A2- Alternative Forms of Assessment
A3- Amplification and Minimizing Background Noise
A4- Classroom Setup
A5- Converting Verbal Information to Written Format
A6- Repetition and Preparatory Material
A7- Sensory Overload

A8- Signing Through Third Party
A9- Simplifying language
A10- Visual Substitutes for Oral and Written Communication

A1

Alternate Access to Non-Verbal Sounds

- Use visual representations
- Use vibrations

Especially in science, many sounds which are not linked to language can be important. Besides amplification, there are several other ways to adapt such sounds so deaf students can access them. The first strategy is to adapt them visually. If sounds such as the clicking or beeping of a metre are important, adding a blinking light can allow deaf students to use the instrument. More complex sounds can be visualized using an oscilloscope. Another adaptation is to use vibrations so non-verbal sounds can be accessed through tactile means. The vibrate function on mobile phones is an excellent example of such an adaptation. Getting the attention of students is another area that needs adaptation for deaf students. Instead of clapping, shouting, or whistling to get the attention of the class, it is often useful to flick the lights on and off once slowly, or stomp on the floor to get all of the students to look up.

A2

Alternative Forms of Assessment

- Pictures
- Matching, multiple choice
- Allow students extra time
- Video tape signing

Assessment of student learning is often modified for deaf students. As a result of the language gap which often exists for deaf students, these students have difficulty communicating ideas through written or oral communication. Due to the language gap, it is important to design alternative forms of assessment which test the student's knowledge without dependence on the English language. Assessments are often modified such that students are able to use pictures or other alternative forms of expression. Examples of such strategies include picking a picture of a pipette to explain that they used a pipette rather than verbally explaining it. Additionally, matching and multiple choice questions can be used in place of open ended questions to limit the amount of information a student has to transcribe. Furthermore, short answer questions can also be used in place of questions which require a longer response. Extra time is another accommodation for deaf students as processing information from one language to another may take longer as a result of the language gap.

A3

Amplification and Minimizing Background Noise

- Hearing aids
- FM systems
- Minimize background and white noise
- Repeat questions

For students with usable residual hearing it is important that incoming auditory signals are amplified. Such signals include a teacher or peer talking, auditory output from a film or recording, and non-verbal sounds. A hearing aid is a commonly used technology which amplifies auditory input. It is important to recognize that a hearing aid not only amplifies what is meant to be heard, such as a teacher's voice, but also background noise. Hearing aids are best suited for enhancing short distance discussion as opposed to large scale classroom discussions. FM systems are a technology which assists the student in better hearing one auditory input. With an FM system the teacher or presenter will wear a microphone which has a wireless transmitter that amplifies the teacher's voice in the student's hearing aid.

Regardless of whether a technology is used to supplement student hearing, it is important to minimize background and white noise. Such noise can be a distraction and make hearing more difficult for all students. Furthermore, it is also important that teachers repeat questions and answers students provide in classroom discussion. This repetition helps reinforce concepts and ensure that a deaf student using an FM system can also hear the content of messages from other students as well as classroom discussions.

A4

Classroom Setup

- Clear visual pathway to speaker
- Adequate lighting in room
- Visible spot for interpreter or teacher of the deaf
- Semi-circle setup
- Centre facing lab benches

Classroom setup is an important point to consider in creating an accessible learning environment. First and foremost, it is important that students have a clear visual pathway to whoever is speaking if they lip read or to the teacher of the deaf or interpreter if sign is their primary means of language access. In addition to a clear visual pathway it also important the room has adequate lighting such that the teacher's face, interpreter, or teacher of the deaf can be seen. With this, the interpreter or teacher of the deaf must also have a place to situate themselves in the classroom so students are able to see them.

Visual pathways can be blocked by objects or other students and a general solution to this barrier is to seat deaf students closer to the front of the classroom so they have visual access to the classroom teacher and the teacher of the deaf. Moreover, to make a student's peers visible, as well as the teacher, a semi-circle seating arrangement is often used. Lab benches that face the wall prevent students from having visual access to the laboratory activity and the instructor simultaneously. Centre facing lab benches work much better than those that face the wall as they allow students to see each other as well as the instructor.

A5

Converting Verbal Information to Written Format

- Distribute hand-out of presentation notes
- Print out PowerPoint and overhead slides
- Closed Captioning

It is essential that verbal information is transcribed into written format for deaf students; this includes topics discussed in lectures and any verbal instructions given to students. By providing students with notes or a bulleted list of topics to be discussed, the student is aware of points when important topics are being discussed. By printing out copies of slides or notes, it possible for a deaf student to refer back to and review points which may have been confusing. Additionally, closed captioning is essential on all films which are shown so deaf students can access information which is provided in the film.

A6

Repetition and Preparatory Material

- Introduce and review new vocabulary ahead of time
- Use repetition to reinforce concepts
- Review concepts at the end of the activity
- Ask higher order thinking questions to ensure understanding and discourage complacency

It is important that when new vocabulary is introduced it is reviewed several times and students have an understanding of what new words mean. Preparing students ahead of time to deal with new vocabulary or abstract concepts allows them to spend time beforehand learning and understanding the concepts so when it comes time to do activities they are able to focus on the activity and not the concept or wording. Repetition is essential to reinforce concepts and continue to expose deaf students to new vocabulary. Often it is best to introduce an activity or concept, perform the activity, and then go through a summary or review of important concepts and what students have learned. To make certain that students understand new concepts and vocabulary it is important to ask questions to test student comprehension and prevent complacency on the part of the students. Additionally, questions should be higher order thinking questions as opposed to simple yes or no questions to better evaluate student learning and identify gaps in understanding.

A7

Sensory Overload

- Minimal note taking while the teacher is talking
- Not talking while a student is observing a demonstration
- Walk the teacher of the deaf or interpreter through activity first

Visual sensory overload is when multiple pieces of information are presented in a visual manner at one time. This should be avoided at all times. One area in which sensory overload is present is note taking. A hearing student taking notes is still able to access what the teacher is saying even though they are looking at their paper and not at the teacher. This is not feasible for deaf students as they do not have aural input, so they cannot take legible notes while lip reading or watching signs. To accommodate this, it is important to limit the amount of notes a student must take while the teacher is talking by either distributing hand-outs of notes and concepts to students or appointing a note taker for the deaf student.

Sensory overload can also occur during in-class demonstrations. For example, if a student is reading lips or watching the teacher of the deaf at the same time a demonstration is occurring, they may miss the demonstration. To accommodate this, talking should be done before or after the portion of the demonstration which requires the student's attention. Additionally, the teacher or presenter can walk the teacher of the deaf through an activity or experiment ahead of time so the teacher of the deaf knows when to stop signing so the student pays attention to the demonstration. It is important to note that by not talking and performing tasks at the same time, activities and experiments may take longer to perform and this should be taken into account when outlining lesson plans and planning programs.

A8

Signing Through Third Party

- Third party interpretation of material into an accessible form for the student
- Third party translates signed language to spoken language for teachers and peers

For students who use ASL or Auslan as their primary form of communication, it is important that they are able to have information translated into a form of language they can understand. A teacher of the deaf will translate spoken language using modified translations to ensure that the vocabulary used will be understood by the student. This may include the teacher of the deaf and the student creating non-traditional signs which they both understand to have a predetermined meaning.

The teacher of the deaf not only provides deaf students access to spoken language but also allows those who do not use ASL or Auslan to understand what a student is saying by converting ASL or Auslan back into spoken language.

A9

Simplifying language

- Use simple vocabulary
- Create non-traditional signs

Language gaps are the most prevalent barrier for deaf students. For deaf students who sign, English is a second language and deaf students face many of the same barriers confronting ESL students. To overcome this barrier, it is important to focus on what is being communicated and avoid complex vocabulary students are not familiar with. For complex concepts and vocabulary which do not have signs in ASL or Auslan, it is acceptable for the student and teacher of the deaf to create a new sign for their use.

A10

Visual Substitutes for Oral and Written Communication

- Pictures
- Diagrams
- Graphs

Deaf students face a language gap which often makes it difficult for them to understand written and verbal communication. To overcome this obstacle, visual substitutes such as diagrams, pictures and 3D models may be used. By illustrating the steps listed on an instruction sheet with pictures and minimal text, as opposed to many lines of text, it is easier for deaf students to follow directions and the students are less likely to get caught up in language and become confused. Graphs and other visual displays are another example of substitutes that can be used in place of oral or written communication. A graph provides a concise summary of information in a pictorial view. Diagrams and posters can also assist in presenting information in a manner which is easy to understand. An example would be a poster displaying the cycle rain water follows as a substitute for a chapter’s worth of text.

6.3 Mobility SAM

6.3.1 Mobility Spectrum

There are a wide variety of mobility impairments, each resulting in different student capabilities. Mobility impairments can be caused by certain conditions, such as cerebral palsy, muscular dystrophy, and spina bifida. Spinal cord injuries can also cause mobility impairments; however, the location of the injury or birth defect determines the severity of impairment with both spinal cord injuries and spina bifida.

Due to the wide ranging level of abilities among students with mobility impairments, the spectrum of accommodations focuses on various skills and abilities of students. Therefore, the disability specific matrix has been broken into four categories. The four categories used to distinguish between the necessary accommodations are: limited fine motor skills, limited gross motor skills, limited strength, and limited range of motion.

It is important to note that students with mobility impairments will have several different levels of the four spectrum categories. They may have trouble with one or many of the categories listed in the matrix. These categories are further described below:

Limited Fine Motor Skills: Fine motor skills involve controlling the smaller muscles of the body to perform tasks. The muscles associated with fine motor skills are found in the hands, feet, and head. More specifically, fine motor skills include small movements of fingers, hands, wrists, and feet. Tasks that require fine motor skills include writing, pushing buttons, and grasping objects. Students who have limited fine motor skills will find tasks that involve grasping, pinching, and manipulating objects difficult.

*Limited Gross Motor Skills***:** Gross motor skills are necessary for students to control large muscle activity. These skills are required to stand, walk, run, and sit. For students with limited gross motor skills, posture and balance may also be difficult. Often, spasticity is grouped with limited gross motor skills. Further, activities involving large scale movement will also act as barriers for students with limited gross motor skills.

Limited Strength: For students who have limited strength, there are many activities and tasks that they may find difficult. These tasks may include opening, closing, lifting, and twisting objects. Students may have different strength capabilities in different areas. For example, a student may be able to push but not pull or have more strength in one arm. Fatigue will often set in earlier for these students, making tasks that require repetition or prolonged periods of activity more difficult for them.

Limited Range of Motion: Students with a limited range of motion have a limited degree of movement with their arms, legs, and head. Therefore, these students may have difficulty lifting, moving, and reaching for objects. It is important to ensure that tasks and objects are located within a student's active range of mobility. Additionally, it should be noted that a student with a limited range of motion may have difficulties similar to students with low strength.

6.3.2 Mobility Tasks/Barriers

In order to provide solutions for barriers posed in hands-on activities, tasks were identified which can be difficult for students with mobility impairments. The tasks have been broken down into related categories and are further described below.

SAM identifies the following eleven tasks as barriers for mobility impaired students:

- Grasping/Squeezing/Pinching
- Lifting
- Pushing Buttons
- Pushing/Pulling
- Reaching
- Shaking/Stirring/Mixing
- Targeting
- Turning a Crank
- Twisting Dials/Caps
- Using Printed Materials
- Writing

The following are descriptions for each task that SAM identifies as a barrier:

<u>Grasping/Squeezing/Pinching</u>

Grasping can include tasks such as holding and using a handle or grabbing an object. Grasping is a task that can be incorporated into many different activities and requires fine motor skills and a certain level of strength. Grasping may be required to hold instruments or operate a handle on a piece of equipment. Squeezing is a task that is similar to grasping and would be used to expel liquids from bottles. Pinching is used to pick up small objects as well as operate forceps or tweezers. Tasks that require grasping, squeezing, and pinching include:

- Holding a handle
- Holding an object
- Squeezing a bottle
- Picking up small objects
- Handling forceps/tweezers

Lifting

Lifting objects is a barrier for students who do not have the strength to pick them up. Additionally, lifting can be difficult for students who do not have the range of motion and muscle control to lift objects upwards. Tasks which involve lifting include:

- Raising a beaker or flask to pour
- Elevating an object

Pushing Buttons

Targeting is one of the difficulties associated with pushing buttons: for this application refer to the task targeting. Additionally there are also problems which are unique to buttons. Some buttons do not provide enough resistance, while others may provide too much. If the button does not have a positive click, it may be difficult to determine when a button has been successfully activated. Examples of devices on which buttons can be found include:

- Calculators
- Electronic scales
- Any device with a on/off buttons
- Stop watches

Pushing/Pulling

Pushing and pulling are common tasks that a student must execute in order to complete an activity. While they may not be the main focus of the activity, pushing and pulling are often required to accomplish the goal outlined in the task. Pushing and pulling can be used in moving objects on the lab bench as well as rearranging objects during an activity.

Pushing and pulling can be difficult for students that are not strong enough to move the item, or do not have the range of motion or muscle control to move objects on their own. Examples of pushing and pulling include:

- Levers
- Sliding objects

Shaking/Stirring/Mixing:

Shaking, stirring, and mixing are all used for combining two substances together through a repetitive motion. Substances that are difficult to shake/stir/mix include:

- Highly viscous liquids
- Substances which do not dissolve quickly

Targeting

Targeting can be difficult for students with mobility impairments because they may not have the fine motor skills required to accurately aim at what they are trying to target. Additionally, the student may not have sufficient muscle control to properly aim or the target may be too far away for them to reach. Targeting involves tasks that require a student to move one object or substance from one place to another, requiring aim. Examples of such tasks are:

- Moving powder from one container to another
- Pipetting
- Pouring liquid into a small opening
- Assembly of small pieces

Turning a Crank

Cranks are used on some devices for energy generation or adjustment. Students with mobility impairments may have difficulty using cranks because of the grasping required, resistance of the crank, or the range of motion required to turn a crank. Examples of devices using cranks are:

- Manually powered torches

Twisting Dials/Caps

Dials are frequently used on various different instruments to adjust settings and threaded caps are often used on containers to provide a tight seal. Many dials and caps can be difficult to twist and act as a barrier for students with mobility impairments because they may not have the strength, fine motor skills, or control to properly turn dials or caps. Examples of devices that use dials or caps are:

- Jars
- Conical Tubes
- Voltmetres

Using Printed Materials

Printed materials may pose a barrier for students with mobility impairments if they are not able to manipulate the material used to print on. They may have problems turning pages or positioning the material in a suitable location for them to read it. Turning pages can be difficult because it requires the ability to separate individual pages as well as the range of motion to effectively turn the pages. Also, if a thick book is being used, the student may need strength to lift the book cover or multiple pages. Furthermore, coordination is also required to complete the movement needed to turn a page. Examples of printed materials include:

- Lab manual
- Instruction packet
- Information booklet
- Text Book
- Worksheets/examinations with multiple pages
- Flip books

Reaching

Reaching is a common task which is difficult for those who have a limited range of motion or who do not have the strength and coordination to raise a limb. A student may need to reach in order to:

- Access objects that are at an elevated or lowered level
- Raise a pendulum to release it

Writing

Writing is a common form of assessment used to evaluate students; however, writing can be difficult for students with mobility impairments if they do not have the required level of dexterity to write manually. Examples where students are required to write include:

- Recording observations

- Filling out worksheets
- Writing lab reports
- Completing homework assignments
- Taking notes
- Completing written evaluation and assessments

6.3.3 Mobility SAM Accommodations

The matrix for mobility accommodations is included on the next page in Figure 6. Tasks that have been identified as barriers for students with mobility impairments are listed in the left hand column. The spectrum of the disability is found in the top row of the matrix. The second row of the matrix includes accommodations that can be made for all tasks to make them more accessible for students with mobility impairments; these solutions should be considered before the rest of the matrix is consulted. The middle cells of the matrix contain solution codes which correspond to adaptations that can be made to accommodate students with mobility impairments. The coded list of solutions is found below the matrix. It should be noted that the mobility specific accommodations are meant to supplement the universal design section; they assume that the general strategies in the universal design section have been implemented.

MOBILITY SAM				
Task	**Limited Fine Motor Skills**	**Limited Gross Motor Skills**	**Limited Strength**	**Limited Range of Motion**
ALL TASKS	**M6, M8, M15, M17, M20**	**M6, M7, M15, M17**	**M6, M8, M15, M17, M18**	**M6, M9, M15, M17**
Targeting (Moving, Pouring, Assembling)	M2, M11	M2, M11		M11
Writing	M3	M3		
Using Printed Materials (Turning pages, positioning papers)	M4, M14	M4, M14	M4, M14	M4
Twisting Dials/Caps	M5, M19		M19	
Pushing Buttons	M5, M10	M10	M10	M10
Turning a Crank	M5, M10	M10, M12	M10, M12	
Grasping/Squeezing/ Pinching	M1, M5, M19		M1, M19	
Shaking/Stirring/ Mixing	M13	M13	M13	M13
Pushing/Pulling		M12	M12	M12
Lifting				
Reaching				

Figure 6: Mobility SAM Matrix

Mobility Solution Key

M1 - Aids and Alternatives to Grasping/Squeezing/Pinching
M2 - Aids for Targeting
M3 - Alternative Form of Recording Information
M4 - Computer Technology
M5- Enlarged Size
M6– Extended Time
M7– High Resistance
M8 - Low Resistance
M9- Position Task in Student Operating Range
M10- Positive Click
M11- Preset Amounts
M12- Provide a Push or Pull Option
M13- Shaking or Stirring Aid
M14- Tabbed Pages
M15- Teamwork and Co-Activity
M16– Use a Guide
M17 - Use Alternative Part of the Body
M18- Use Lightweight Objects
M19 - Use Surface with Enhanced Grip
M20– Warm Up Activities

M1

Aids and Alternatives to Grasping/Squeezing/Pinching

- Have the student use their hand like a socket on the knob/ball that is added
- Use vice grips
- Use a Velcro glove for the student and Velcro on the objects that the student needs to pick up
- Use an aid to attach the object to the person:
    - Velcro or fabric strap
    - Rubber band
    - Custom designed fixtures
- In place of squeeze bottles use pre-measured amounts of liquid
- Use haemostats as a substitute for tweezers/forceps

For students with mobility impairments, grasping objects can be difficult, particularly turning dials or caps and picking up objects. In order to make this easier, a knob or ball can be added at the end of the crank or dial so that the student has greater access to it. For example, a ball could be substituted for a handle, allowing a student to use their hand like a socket on the ball to move the crank. By substituting a ball for a handle, the need to grasp an object is avoided. Other aids such as vice grips allow the student to push or pull, also bypassing the need to grasp the object.

For students who have difficulty grasping, it can also be hard to pick up objects. To account for this, a Velcro glove can be worn by the student and Velcro applied to the objects that they need to pick up. Several other types of straps can be used in a similar fashion to secure the objects so that the student can have the maximum amount of control when using them. For example, Velcro or fabric straps, rubber bands, and custom designed fixtures can be used to attach tools to a student's hands if he or she has difficulty with fine motor skills.

Using squeeze bottles can be difficult for some students with limited fine motor skills and strength as they may not have the control or dexterity to properly complete the squeezing motion. To accommodate this, pre-measured amounts of liquid can be used in place of squeeze bottles.

Also, haemostats can be used as substitute for forceps or tweezers for students who have difficulty with a pinching motion. If a student cannot grasp tweezers or forceps, a haemostat can be used as they can be held in a similar manner to scissors which may be easier for some students to grasp who have limited fine motor skills.

M2

Aids for Targeting

- Use holes with a larger target area
- Use a funnel
- Add chamfers to holes

Students with mobility impairments may have difficulty pouring liquids or transporting objects into small openings. For pouring liquids and powders, an easy remedy is the use of a funnel, which widens the acceptable area for the student pour. Using a funnel to pour liquid into graduated cylinders, test tubes, and many other containers makes it much easier for the student.

Targeting is also an issue when assembling small pieces, such as fitting pegs into holes. Using larger pieces or adding a chamfer to holes may make it easier for students to assemble pieces because the target area is larger.

M3

Alternative Form of Recording Information

- Use stickers or stamps
- Use a modified pencil
- Use a computer
- Use a note taker

Many students with mobility impairments may have difficulty writing; therefore, normal forms of assessment or note taking may need to be altered. There are some resources available that can make writing easier for students, such as modified pencils. Modified worksheets may be necessary if the student cannot write at all. Worksheets utilizing multiple choice questions or a grid that can be marked off with a pencil, stickers or stamps can be very helpful. If the student is severely impaired, a note taker may be needed.

Students without the ability to manually record their answers or take notes may be able to input information into a computer. Assistive technologies including touch screens, modified keyboards and mice, and voice recognition software are available for use by students with mobility impairments. Generally if a student requires an adaptive technology, they will bring it with them. A simple modification that can be made is exchanging a standard mouse with a trackball-style mouse.

M4

Computer Technology

- Convert worksheets, instructions and overhead documents to electronic format so they can be viewed on a computer
- Record instructions as audio files on a computer so that students can refer back to them as they progress through activities

It is important that information can be read from a computer screen. Flimsy worksheets or instructions placed on tabletop can be difficult to access for students with mobility impairments. When the information is on a computer screen, the screen can be positioned such that the student can view the document and also manipulate it.

Additionally, students with mobility impairments often have to dedicate a significant amount of concentration to completing tasks as it often takes a lot of focus to control and move their bodies. As such, it is often difficult for them to listen to instructions and complete a task at the same time. Because of this, it is beneficial to record instructions such that students can access them as they are ready. Also, by allowing the students to access instructions at their own pace, the fact that not all students will be able to work at the same rate is accommodated.

M5

Enlarged Size

- Enlarge the size of push buttons
- Use larger handles
- Use keyboards and calculators that have larger keys
- Avoid using small objects or enlarge objects to allow for easier gripping

Small objects are much harder to hold and manipulate for a student with mobility impairments. Objects used should be slightly enlarged so that students can push or handle them more easily. If an activity requires students to push a button, enlarged buttons should be used so that the students who have poor targeting skills can access them. For example, calculators and keyboards with enlarged buttons can be used. Using larger handles can be helpful as well in assisting the student to push or pull objects independently.

M6

Extended Time

- Allow students extra time to complete the activities

Students with mobility impairments often take more time to complete certain activities. It is important to keep this in mind and allow them extra time on the proposed activities. The students may need to perform the task in several iterations to get the most understanding from it and will require more time to do so.

M7

High Resistance

- Use high resistance buttons
- Use high resistance cranks
- Use high resistance dials

Particularly for students with muscle spasticity, it is important to use objects that have high resistance. By using objects that have high resistance, unintentional contact will not disrupt the experiment. If a student is asked to turn a crank or push a button that has low resistance, they may turn it too far or unintentionally press the button. By using high resistance buttons, cranks, and dials it is possible to ensure the application of force to activate the device is deliberate.

M8

Low Resistance

- Use low resistance buttons
- Use low resistance cranks
- Use low resistance dials
- Use lower viscosity liquids when stirring is involved
- Use Pop-off or low resistance screw off type of caps
- Use surfaces that have less friction

Particularly for students with strength issues, it is important to use objects that have low resistance. If a student is asked to turn a crank or push a button that has a high resistance, they may not be able to complete that task independently; however, if low resistance buttons, cranks, and dials are used, the student will be able to better participate on their own. One strategy to aid with turning cranks is to use a larger arm, which makes it easier to turn. This approach can also be applied to dials by adding an arm, allowing it to be used like a crank.

With liquids, lower viscosity liquids should be used because they require less strength to mix and stir than thicker liquids. Bottles and containers that have “pop-off” style or low resistance threaded caps are available to accommodate for students who have limited strength. If something is required to be pushed or pulled along a surface, both the object and the surface should be smooth and low friction to make sure that the student will not have difficulty performing the desired task.

M9

Position Objects in Student Operating Range

- Student abilities may be dependent on the location of objects
- Objects may be placed closer or farther away from a student

Different students will have different capabilities in regards to their optimal working range. Some students may have fine motor skill capabilities at close range but not at a distance, as such requires the student be able to stabilize his or her arm. Furthermore, some students may be able to control their limbs in a certain operating range but once they are out of this range, they lose the capability. To best serve student capabilities it is important to ensure that the tasks the student is asked to complete are within operating range.

M10

Positive Click

- Use auditory or visual cues to denote that:
    - A button has successfully been pushed
    - A crank is being turned the correct way or has been rotated far enough
    - A connection has been made when assembling different pieces together
    - A switch has been successfully flipped

It is often hard to detect when a button has been successfully pushed if there is no visual or auditory cue to give feedback that the event has occurred. For students with physical disabilities who often have difficulty pushing buttons, it is important to provide feedback as to when they have successfully performed the task. This principle can also be applied to cranks, switches, and assembly pieces. When the crank or switch has been successfully been activated, a sound or visual cue will indicate when a task has been completed. For example, there could be a noise such as a click or beep to indicate that the crank has been turned far enough.

M11

Preset Amounts

- Have substance measured prior to activity
- Use automatic measuring device

Measuring a certain amount of liquid or solid during an experiment may be a barrier for some students with mobility impairments if it is difficult for them to use the measuring instrument. If the proper amount of substance is measured out beforehand in a container the students can utilize, the student can then concentrate on the other areas of the activity that are more important. Another option is to use devices that are designed to measure a specific amount, such as a preset pipette or syringe that holds the correct amount of liquid needed. With these adaptations, students can then take part in the act of measuring without having to worry about accuracy of the measurement.

M12

Provide a Push or Pull Option

- Allow students to either push or pull objects in order to complete an activity
    - Students may only be able to either push or pull objects
    - Some students may be able to push and pull but may be much stronger in one function

Depending on student ability and affected muscle groups, a student may be able to execute only the pushing or pulling function. Additionally, while some students may be able to both push and pull objects, one function may be significantly stronger than the other. To accommodate this, it is important to present the option of either pushing or pulling. Mechanisms to allow for the option to push or pull an object include incorporating a pulley or lever which changes the direction of applied force. Applications for providing alternative options include lifting or moving objects and turning a crank.

M13

Shaking or Stirring Aid

- Use a magnetic stir bar for stirring
- Use a closed container to shake or roll

Stirring or shaking can be a difficult task depending on the type of disability a student has. To make this task easier, magnetic stir bars can be used, which will stir the mixture without requiring a physical input from the student. Allowing a student to place the mixture into a closed container and shake it, rather than stir it can be easier for some students. Similarly, a mixture could be placed in a spherical container and rolled around. This mechanism mixes the solution while requiring less force and eliminating the need for the student to grasp the container while shaking.

M14

Tabbed Pages

- Add tabs to pages to make them easier to turn
- Label the pages to display the contents of the book

Adding tabs to pages in a book or worksheet packet can be a good way to help students with physical disabilities. With tabs, it is easier for a student to grab the desired page. Also, if the tabs are labelled, it is easier for the student to find what they need rather than having to go through the task of flipping through the pages.

M15

Teamwork or Co-Activity

- Partners can help students when needed
- Utilize disabled student's strengths
- Move student's limbs for them to complete the activity

Working in groups can be very helpful for students with mobility impairments. If students are grouped with students of different abilities, each student is able to get a better sense of accomplishment and participate to a greater extent. If a student is unable to do a certain part of the activity, another member of his or her team can do that portion of the activity. In this manner, each student can complete tasks they are capable of. For example, one student may be able to read measurements while another records them.

Another technique that is commonly used is called co-activity. With co-activity, the instructor or aide holds onto the student's body, moving their arms, legs, or other body parts to assist them in completing the task at hand. Many times, co-activity is used when the student cannot move their limbs independently. Through the use of co-activity, the student can still participate to a certain degree instead of having everything demonstrated for them.

M16

Use a Guide

- Guiding devices offer support and direction

A guide can also be used to aid in targeting to support and direct a student during an activity. The guide provides the necessary support for students that do not have the strength to do the activity independently. The guide also aids students with limited gross motor skills by providing direction and helping to control spasticity.

M17

Use Alternative Part of the Body

- Lower limbs can be used instead of upper limbs
- A left side limb can be used in place of a right side limb
- A joint or other part of the body can be used instead of a limb or hand

Alternative parts of the body and limbs can be used to complete tasks. When a task such as pushing a button or flicking a switch involves an upper limb, a lower limb can be used instead by operating a foot pedal or switch located on the floor. Also, while a student may have a mobility impairment on one side of their body, the other side of the body may not have an impairment and the stronger side of the body may be used instead. Also, different parts of the body may be substituted when completing tasks. For example, instead of using a finger to push a button, a student may use his or her elbow if the button is large enough to target easily (see M2).

M18

Use Lightweight Objects

- Weight should not restrict the student from lifting or moving objects
- Use lighter materials such as plastic in place of heavier materials like glass

If an object weight exceeds the strength of a student, the student will not be able to lift, push, pull, or move the object. In instances where the concept being taught does not rely on an object's weight, a lighter object should be used. When an activity focuses on comparing the weights of different objects, a lighter spectrum of weights should be used. Furthermore, lighter materials can be used to reduce the weight of an object. Plastic is lighter than glass and most lab materials like beakers, syringes, and containers are made in both plastic and glass.

M19

Use Surface with Enhanced Grip

- Enhanced grips on dials/caps
- Non-slip surfaces on table tops

Utilizing surfaces with adequate grip can make it easier for students with mobility impairments to complete activities. If the activity involves turning a dial or removing caps, it is important to ensure that the dial or cap surface has enough grip such that the student has to apply minimum pressure to avoid slipping. Non-slip mats on table tops and trays can help keep objects still while manipulating them. An added benefit of enhanced grip is that objects will not move as easily when the students are moving in their wheel chair, if they have one, or if things are on an angle.

M20

Warm Up Activities

- Perform warm up motions that mimic the intended activity with the students beforehand

In order to increase the capabilities of students with limited fine motor skill, it is valuable to do warm up exercises with them. During these warm up motions, the movement that will be required in the activity can be mimicked to give the student an understanding of what will happen. These activities include:

- Bending and straightening fingers
- Mimicking grasping
- Clapping hands

6.4 Vision SAM

6.4.1 Vision Spectrum

There is a large spectrum of vision impairments among students. This spectrum ranges from colour-blindness to totally blind. In order to provide the most appropriate accommodations for all levels of vision impairments, the spectrum has been divided into categories defined by a student's type or level of vision impairment. The spectrum has been broken down into four categories: Colour-blind, Limited Visual Field, Low Vision, and Blind. Below is a brief description of the different levels contained in the spectrum:

Colour-blind: Colour-blind encompasses students with many colour deficiencies. There are several different types of colour-blindness ranging from difficulty distinguishing between shades of one colour to the inability to see colours, which is very rare. Other students may have problems differentiating between specific colour combinations such as red and green or blue and yellow.

Limited Visual Field: Students with vision impairments may not only have difficulty seeing, but may also have a smaller field of vision than those with perfect sight. A full field of vision is approximately 180 degrees, while someone with vision impairment may have a field of vision that is 20 degrees or less.

Low Vision: Students with low vision still have some residual vision, although it may not be of much use. With magnification or large text, students with low vision are often able to make out what they are looking at well enough to figure out what image is, whether it be a picture or text. Without magnification, images will look blurry to students and small details may be indistinguishable.

Blind: Students who are blind have no residual vision. They may be able to make out areas of light and dark, but cannot see much beyond that. Blind students will gather much of their information through their other, stronger senses such as hearing and touch; these senses are many times more highly developed and more sensitive than people with normal vision.

6.4.2 Vision Tasks/Barriers

In order to provide solutions for barriers posed in hands-on activities, tasks were identified which can be difficult for students with vision impairments. The tasks have been broken down into related categories and are further described below.

SAM identifies the following eight tasks as barriers for visually impaired students:

- Measuring Using an Analogue Scale
- Observing Visual Change
- Observing Motion
- Reading Instruments with a Digital Output
- Reading Text
- Targeting
- Viewing Two Dimensional Diagrams or Visual Displays
- Writing

The following are descriptions for each task that SAM identifies as a barrier:

<u>Measuring Using an Analogue Scale</u>

Measuring with an analogue scale includes measuring using any device that does not provide a digital output. The difficulty which arises in using an analogue scale is that numbers and scale divisions which are not raised or enlarged cannot be accessed by students with vision impairments. Examples of analogue scales include:

- Rulers
- Protractors
- Graduated cylinders
- Thermometres

<u>Observing Motion</u>

Motion is a common topic covered in science classes and is a barrier for students with visual impairments because it is usually illustrated in a visual manner. Two common examples of motion are fluid motion and the movement of objects in space. Examples of principles and phenomena associated with motion include:

- Velocity
- Acceleration
- Gravity
- Displacement
- Waves
- Vortices

Observing Visual Change

There are several different types of changes which can be observed. These changes include physical, chemical, and colour changes. Physical and chemical changes are prevalent in many reactions and activities in science. Physical and chemical changes pose a barrier because they are usually observed in a visual manner and some changes are on a small scale, making them more difficult to see. Observing physical and chemical changes may also be a barrier because touch may not always be a suitable alternative for sight. In some instances, touch may disrupt the experiment or be unsafe. Examples of physical and chemical changes include:

- Colour change
- Gas release
- Phase change
- Precipitate formation
- Dissolving

Reading Instruments with a Digital Output

Digital outputs are now common with scientific instruments; however a digital output on a screen is completely inaccessible to a blind student and cannot be accessed by a student with low vision if the print is not large enough or does not have enough contrast for the student see it. Instruments with digital outputs include:

- Calculators
- Digital scales
- Stopwatches

- Voltmetres

Reading Text

Reading text can be a problem for students with visual impairments because the text can either be too small or in a format that is not accessible for the student. Texts that student must have access to include:

- Text on PowerPoint slides
- Text on posters or display boards
- Labels
- Keys/Legends
- Instruction sheets
- Worksheets

Targeting

Targeting involves tasks that require a student to move one object or substance from one place to another, requiring aim. Targeting may be a difficult task for students who are visually impaired as they either cannot see or have difficulty seeing targets. Examples of instances where targeting is involved include:

- Moving materials such as liquids, powders, and solid objects from one container to another
- Pipetting
- Assembly of small pieces

Viewing Two Dimensional Images

Two dimensional images are commonly used to illustrate scientific concepts. Two dimensional images may be inaccessible to students with vision impairments because they are not accessible through touch and may not be of sufficient size or contrast. Examples of two dimensional images are:

- Diagrams
- PowerPoint
- Posters

- Graphs
- Images from a microscope

Writing

Writing is a common medium used for evaluation. Writing can be difficult for blind students as they cannot see the paper. Examples in which students use writing to report include:

- Recording observations
- Filling out worksheets
- Completing lab reports
- Completing homework assignments
- Taking notes
- Completing written evaluation and assessments

6.4.3 Vision SAM Accommodations

The matrix for vision accommodations is included on the next page in Figure 7. Tasks that have been identified as barriers for student with visual impairments are listed in the left hand column. The spectrum of the disability is found in the top row of the matrix. The second row of the matrix includes accommodations that can be made for all tasks to make them more accessible for students with visual impairments; these solutions should be considered before the rest of the matrix is consulted. The middle cells of the matrix contain solution codes which correspond to adaptations that can be made to accommodate students with visual impairments. The coded list of solutions is found below the matrix. It should be noted that the vision specific accommodations are meant to supplement the universal design section; they assume that the general strategies in the universal design section have been implemented.

VISION SAM				
Task	**Colour-blind**	**Limited Visual Field**	**Low Vision**	**Blind**
ALL TASKS	**V7, V16**	**V9, V16**	**V7, V8, V12, V16**	**V16**
Targeting (Moving, Pouring, Assembling)			V5	V5
Measuring Using an Analogue Scale			V3	V3
Reading Instruments with a Digital Output			V3	V3
Reading Text			V4, V13, V15	V4, V6, V14, V15
Writing			V4, V17	V4, V6, V17
Viewing Two Dimensional Images	V11	V11	V1, V11	V1, V11
Observing Motion			V1, V2, V10	V1, V2, V10
Observing Changes (Physical, Chemical, Colour)			V1, V2	V1, V2

Figure 7: Vision SAM Matrix

Vision Solution Key

V1 - Access through Touch
V2 - Access through Sound/Smell
V3- Technology with Verbal Output
V4- Audio Recording
V5- Aids for Targeting
V6- Braille
V7- Increase Colour Contrast
V8- Enlarged Text
V9- Ensure Task or Demonstration is in Visual Field
V10- First Person Experience
V11- Good Keys and Legends
V12- Magnify/Enlarge
V13- Use Screen Magnifier
V14- Use Screen Reader
V15- Simplify
V16- Team Approach
V17 - Using Computers as a Writing Alternative

V1

Access through touch:

- Incorporate activities which have tactile elements in them
- Allow the student to touch/feel what is happening in different activities when it is safe to do so
- Make a three dimensional (tactile) diagram of the concept being taught

Students who are blind or visually impaired often have a more developed sense of touch as they have learned to use it more effectively. Different textures can be used to explain concepts and the differences between them. Students should be allowed feel different types of materials that are being talked about when it is safe to do so. Providing actual objects, as opposed to photos of the objects, will be a valuable addition for all students, especially students with visual impairments. During different reactions, allow students to feel what is happening. If an experiment involves dissolving a substance, let the student feel the mixture at the beginning, middle, and end of the process. This way the student has a connection with the material by touching it. If it is safe for a student to touch part of an experiment only while wearing protective gloves, the loss of tactility is tolerable.

Three dimensional diagrams or models can be made to illustrate many different concepts including how the solar system is arranged, the components of a cell, or the structure of a plant. Craft supplies, such as Plaster of Paris, Popsicle sticks, and clay can all be used to make tactile diagrams.

There are also different types of paper which will become raised to make diagrams and graphs on paper more tactile. Piaf paper and thermoform paper are both used for this purpose. Thermoform paper can be placed over a raised surface and heated to conform to the surface. The thermoform paper can then be removed and used on its own. Piaf paper uses heat sensitivity to raise different areas based on greyscale shading, making the dark outlines of different diagrams three dimensional.

V2

Access through sound/smell:

- Incorporate activities which contain changes in sound
- Incorporate activities which contain changes in smell when it is safe to do so
- Incorporate sounds into the activities to give students feedback

It is important to incorporate activities which have changes in sound and smell to make the activities more multi-sensory. Changes in sound and smell can be used during reactions, allowing students with visual impairment to detect changes through their stronger senses. Sounds can also accompany visual changes to reinforce them when a complete substitute cannot be made. For example, if a noise like a click is used to signal that something has happened, the student will know when the visual change has occurred. Including non-verbal sounds and smells ensures that students with visual impairments can gain an understanding of what is happening during the reaction.

V3

Technology with verbal output:

- Talking tape measures, scales, rulers, and colour readers

For students that have severe vision impairments, there are devices such as talking tape measures and other tools which utilize a verbal output. These can allow students to participate in measuring activities that they otherwise would not be able to perform.

V4

Audio Recording:

- Record instructions on audio tape or in mp3 format
- Allow the students to submit audio tapes detailing their ideas and observations

For activities with complicated instructions, it can be hard to remember all of the instructions through memory. As an alternative to converting instructions to large text or Braille, they can be converted to audio format, utilizing a much stronger sensory input channel. In audio format, students can play instructions step by step, pausing in between and allowing time to complete the activity. The students can also review steps if they miss something the first time around. Mp3 formats are very accessible as they can be used on computers, which make it possible to read the labels on recordings using a screen reader or magnifier.

In addition to using audio recordings as an alternative format for delivering information to students, students can also record their own ideas and observations. This way, time is saved and students do not have write or type their answers, a task which may be difficult for some students.

V5

Aids for Targeting:

- Use containers with large openings
- Use a funnel
- A guide system can be helpful

If substances are being moved from one container to another, ensure that the openings are large enough for the student to move the material to the right place easily. If the opening is too small, the student may not be able to see it and will have difficulty targeting. Using a funnel is an easy way to widen the opening and make it easier for students with all different types of visual impairments to target small openings. For students with severe vision impairments, a device or person to guide the student to the area to pour is often very helpful.

V6

Braille:

- Convert text-based documents into Braille
- Allow students to use a Braille typewriter to record their answers

Although Braille is not the most widely used written communication method for students with visual impairments, for those who do use the medium it is important to supply them with access to Braille material. Many different places will transcribe information into Braille. In Australia, the Vision Australia Information Library Service (VAILS) will convert various materials into Braille form, but it usually takes about two weeks. Braille can also be applied to measuring devices like rulers so blind students can read the increments on the tool. Students can also use Braille typewriters to record their answers.

V7

Increase Colour Contrast:

- Utilize contrasting colours in measurement devices, PowerPoint, worksheets and visual aids
- Minimize use of colours which can not be seen by students

It is difficult for students with visual impairments to see objects or text that have very little colour contrast; these students need maximum colour contrast to see well. To account for this, it is best to use a light background with dark text or vice versa. Specifically, a light yellow or white background with black text works best. This applies to devices such as rulers, text on computer screens, and PowerPoint slides. In addition, adding colour to a clear liquid can make the liquid easier to see when measuring volumes.

Avoid non-contrasting colour combinations, such as red and green, because students who are colour-blind may not be able to distinguish the difference between such colours. If an experiment is being done where the colour change goes from red to green, it is suggested to use materials which will produce other colours or completely report the results in a drawing or illustration in which alternate colours can be used.

V8

Enlarged Text:

- Use a larger font size (18 is usually sufficient)
- Use a copier to enlarge a textual document

For students with visual impairments, text is not accessible if it is not transcribed into the right format. It is important to find a font size that ensures students with low vision are able to comfortably read the material. When material is in an electronic format the font size can be altered before being printed out and if material from a book is being used or worksheets are being copied, a copier can be used to enlarge the print of the text. Eighteen point font is usually sufficient for most users, but it depends greatly on the level of impairment. Some students may be able to read smaller text, but visual fatigue will set in much quicker. Text on measuring devices can also be enlarged as well as number keys on tools like calculators.

V9

Ensure Task or Demonstration is in Visual Field

- Place objects in student's visual field
- Encourage student to scan entire area

For students with a limited visual field, it is important that objects are located within the student's visual field. The visual field can be different for each student, so it is important to first identify where the student's visual range lies. An activity may need to be relocated in a vertical or horizontal direction. Additionally, activities may need to be positioned closer to students. Also, for students with a limited visual field, a task which is normally spread out may need to be consolidated so all the tools and materials can be seen at once. While students may have a limited visual field, it is still important to encourage them to scan the entire area so they are aware of their surroundings.

V10

First Person Experience:

- Show the student what is happening by having them experience it

First person experience allows a student to better understand certain phenomena such as force. For example, to show the effect of force on movement, push the student on a skateboard, rather than just showing a demonstration to the class. The student will be able to experience movement and gain a better understanding of force and the resultant motion.

V11

Good Keys and Legends

- Use good keys and legends when using diagrams or grasp
- Ensure that keys and legends are simple
- Incorporate textures into the keys and legends if tactile diagrams are being used

It is easier for a student to understand diagrams, whether they be tactile or enlarged two-dimensional, if there is a good key which is not overly complex. The simpler and more self-explanatory a diagram or graph is, the easier it is to understand. This is especially important for visually impaired students because if a student is accessing a diagram in a tactile manner there is only a very limited area that can be accessed at one time. Also, for students with low vision if the diagram is not labelled well it will be difficult to understand.

V12

Magnify/Enlarge:

- Enlarge images from microscopes or demonstrations using a camera
- Supply magnifying glasses to students with visual impairments
- Enlarge the size of pictures and diagrams
- Enlarge the size of objects and buttons

Using cameras connected to projectors or televisions to enlarge small demonstrations can allow students to see what is happening better. Similarly, connecting a microscope to a projector or television can give the student access to phenomena that occur on a scale that is normally too small for them to see. Magnifying glasses can be used to enlarge objects that are too small for students to see. In addition to using optics to enlarge objects in real time, enlarging the physical size of buttons or objects will make it easier for students to see or use them.

V13

Use Screen Magnifier:

- Put things in an electronic format and use computer software to magnify information displayed on computer screen

Screen magnifier software can be used to enlarge text or pictorial images to the desired level. It should be noted that for internet use, not all websites are compatible with screen magnifiers.

V14

Use Screen Reader

- Put things in an electronic format and use computer software to read written material to students

Screen readers are accessed through a computer. The software translates the electronic text into a verbal output. It should be noted not all websites and PDF files are compliant with screen readers.

V15

Simplify:

- Simplify instructions and explanations, be concise
- Use less text
- Simplify visual displays to ensure they are easy to comprehend

Too much text can become overwhelming and confusing for all students, particularly students with visual impairments. To account for this, it is important to make sure that written instructions and textual documents are as concise as possible. Also, pictures can be used in place of text in instances where students have low vision but are able to see the pictures.

For students with visual impairments, it can become very confusing if there are too many lines on a graph or if there are too many different figures on one diagram. By simplifying the graphs and diagrams, they are easier to understand for everyone and can be seen better on worksheets and posters. It should also be noted that different colour lines on graphs should be used with caution. Coloured lines are good when material is printed in colour but may be difficult to distinguish and if the graph is copied in black and white at any point, the colours will be changed to gray shades, which can be very hard to read.

V16

Team Approach:

- Put students in teams so that the students can help each other

Students with visual impairments may require peer helpers during classroom activities. Using a team approach to learning can optimize each student's strengths within activities. This way, every student can contribute in his or her own way and complete all the activities. For students with visual impairments, peer helpers may need to read off the numbers on a scale or stop watch, verbally explain visual changes, and aid the student in any other areas where vision is required. It is important to note that in some cases, a trained observer may be needed to describe visual changes because a student observer may not know what to look for. It is important to ensure that every member of the group contributes; therefore, while one member of the group may read the digital outputs from a scale, the student who is blind or visually impaired could record data or hold/position other objects.

V17

Use Computers as a Writing Alternative

- Allow students to type answers

Students with visual impairments, especially blind students, will have difficulty writing manually. As an alternative to manual writing, these students may use computers to input their answers. With the support of technologies like screen readers and screen magnifiers, it is easier for students to record their answers and observations.

7 SAM Evaluation

To evaluate SAM once it was completed, it was reviewed by professionals in each disability field and feedback from each professional was incorporated. As a final evaluation, three hypothetical case studies were performed using SAM to provide adaptations for Forensic Frenzy, a CSIROSEC program.

7.1 Reviewer Feedback

Reviewer feedback was integral in evaluating SAM. Professionals in each disability field reviewed the disability specific sections. The professionals provided the project team with feedback on how user friendly SAM was, the appropriateness of the adaptations, and the completeness of the adaptations. SAM was modified based on feedback from each reviewer and suggestions were incorporated into the final version of SAM. A summary of reviewer feedback can be found in Appendix S.

7.2 Case Studies

In addition to evaluating SAM usability and completeness based on reviewer feedback, the project team completed three case studies using SAM. A case study was completed for each type of disability accommodated for in SAM: auditory, mobility, and vision. While the case studies are based on an actual CSIRO program, Forensic Frenzy, it should be noted that they are hypothetical situations based only on program observations. The students are not real and the adaptations have not been tested. The case studies serve as an example of how SAM can be applied to adapt programs.

In each case study, a Year 10 student is participating in the CSIROSEC Forensic Frenzy program. A complete description of each activity in the Forensic Frenzy Program can be found in Appendix T.

For each student, the student's ability was matched with the spectrum provided in SAM. It was also determined which of the tasks listed in SAM are found in each activity within Forensic Frenzy. The tasks found in each activity and the student ability were then matched, making it possible to establish which solutions were appropriate to achieve program accessibility.

Along with covering three different types of disabilities, the three case studies also illustrate three different ways to use SAM. The three different approaches are outlined below. The three approaches exemplify the versatility of SAM and discuss a variety of individuals who may use SAM.

Approach 1:

This approach goes through each task listed in SAM to outline the barriers found in each activity. After that, tasks and student ability were paired to determine solutions. Using this approach one can take a type of task and determine from that which activities involve the task and what solutions would be required to make the program activities accessible.

Start with Task → Determine which Activities contain task
Task → Solutions
= Solutions for Activities based on type of task

Examples of individuals who would use this approach are PTs and specialist teachers. PTs and specialist teachers are used to making adaptations based on the types of tasks students must complete. By pairing activities and solutions based on the type of task, PTs and specialist teachers are able to look at what type of tasks students will need to complete and determine appropriate solutions.

Approach 2:

This approach goes through each solution proposed in SAM to determine how to make programs accessible for a student. The solutions proposed in SAM are first reviewed and it is determined which tasks correspond to the solutions listed in SAM. After this, the tasks from SAM that exist in each activity are determined. The activities and solutions are then paired thorough the tasks. This approach starts by identifying the solution and working backwards to determine activities to which the solution can be applied.

Solution → Tasks
Task → Activities
= Activities for which solutions are applicable

Examples of individuals who would use this approach are classroom teachers. Overall the benefit of this approach is that once a type of solution has been identified, it can be applied to other activities.

Approach 3:

This approach goes through the individual activities found in the Forensic Frenzy Program to determine appropriate accommodations. Tasks which are listed in SAM are then identified in each activity. Following this, solutions were outlined for making each activity accessible by finding the appropriate solution in the matrix to correspond to the student's ability and the task in SAM.

Activity → Task

Task → Solutions

= Solutions for each activity

Examples of individuals who may use this approach include educators for outreach programs like CSIROSEC. CSIROSEC's programs are organized into activities. By determining which solutions should be used for each activity, CSIROSEC can determine if these adaptations are feasible to make based on time, cost, and available materials. Additionally, if CSIRO evaluates a program and determines all activities in a program are accessible with the exception of one activity it is possible to either eliminate the activity or substitute in another activity.

7.2.1 Case Study - Approach 1, Auditory SAM

Student Description:

Chris is a Year 10 student attending a mainstream school with a deaf facility in a suburb close to Melbourne. Chris is profoundly deaf and communicates using Auslan. CSIRO is coming to his school to do the Forensic Frenzy program. CSIRO has incorporated the techniques outlined in the universal design section of SAM; most importantly, the CSIROSEC educator conducting the program is well versed in proper presentation style. CSIRO has been told that a teacher of the deaf will be present at the school, but CSIRO would like to know what adaptations they can make to allow Chris to fully access the program.

Spectrum:

For Chris, the "No Hearing, Uses Manual Communication" category on the spectrum will be used as a reference because it fits his ability level and communication style.

Program Activities:

<u>All Tasks:</u>

The first area of the matrix which was consulted was the "all tasks" category under the "No Hearing, Uses Manual Communication" column. Through this pairing of task and disability spectrum, the following solutions are applicable to this program:

- Provide appropriate classroom setup (A4)
- Convert verbal information to written format (A5)
- Be aware of sensory overload (A7)

In terms of classroom setup, there should be a clear visual pathway from Chris's seat to the presenter and other students. This can be successfully achieved through the use of a semi-circle setup. The lab benches should face the presenter, rather than the wall, to ensure that the student has access to an interpreter or teacher of the deaf. There should also be a visible place for the interpreter or teacher of the deaf to sign to the student, with proper lighting and location for the student to see both the interpreter and the demonstrations at the beginning and the end of the Forensics Frenzy program.

The next solution to be addressed is the conversion of verbal information into written format. In the Forensics Frenzy program, this applies to the instruction sheets. As Chris cannot hear the instructions, it is important that the written version of the instructions provide the same information so Chris is able to participate independently. Also, before the program begins, the presenter should walk the teacher of the deaf through the activities to allow them time to familiarize themselves with the activities so that they can properly give instructions to Chris through sign language.

<u>Others Accessing the Student's Language/Student Access to Incoming Language:</u>

Communication with the presenter and other students will be a barrier for Chris during this program. To account for this, the school should provide a third party signer for him (A8), in this case the teacher of deaf will act as the signer.

Language Comprehension:

Chris has a hard time with language comprehension because of the language barrier present among deaf students. The preparatory material should be provided to Chris's teacher beforehand so that the new vocabulary can be reviewed before the session (A6). Also, ensuring that the language on the instruction sheets is simple, concise, and easy to understand is very important (A9). Pictures of the procedure can be added to the instruction sheets to make them easier for him and other students to comprehend the steps required for each activity (A2).

Expression through English:

According to SAM, the last aspect to keep in mind is the extra time that Chris may require. Asking him to perform fewer activities will ensure that Chris has time to complete the important activities (M3).

Beyond the aforementioned activities, the Forensics Frenzy program is a very hands-on program which is accessible to students with hearing impairments. The activities are fairly self-explanatory, making the need to read the instruction sheets less of a barrier. The final discussion uses a board to review the crime scene through a textual and discussion based review. As long as the classroom is set up in a semi-circle and the presenter follows the universal design principles, Chris would be able to participate in the discussion through a third party signer.

7.2.2 Case Study - Approach 2, Mobility SAM

Student Description:

Michael is a student in Year 10 with Muscular Dystrophy (MD) and CSIRO is coming to his school next week to do the Forensic Frenzy program. CSIRO has already incorporated the techniques outlined in the universal design section of SAM and is wondering what additional modifications need to made to Forensic Frenzy so Michael can participate. He uses a wheelchair, which has a tray so things can be positioned close to him. Michael also has an aide that works with him and the aide has come to the class today in case he needs help with anything.

Spectrum:

Muscular dystrophy is a degenerative condition affecting muscle tone in the body. Children with muscular dystrophy typically lose control of their larger muscles, giving them limited strength and limited gross motor skills; however, they do not have a problem with spasticity and usually still have good fine motor control.

Program Activities:

Introduction and Wrap-up

The introduction and wrap-up to the Forensic Frenzy program do not require any adaptation for Michael because they only require students to listen. Any adaptations that Michael already uses in the everyday classroom to participate would be used.

All Activities

M6 (Extended Time): Extended time is listed as a solution in the "All Tasks" row of SAM for both limited fine motor skills and limited strength. It is important to realize that many of the activities may take longer for Michael to complete. To accommodate for this, some of the activities in Forensic Frenzy could be omitted. Michael's group should first complete the most important activities and then move on to the other activities. Some of the activities that are not essential to solving the crime in Forensic Frenzy are Facial Identification, Smooth Surfaces, and Facial Reconstruction.

M9 (Position Task in Student Operating Range): Position Task in Student Operating Range is listed as a solution in the "All Tasks" row of SAM for limited gross motor skills. Because Michael has limited gross motor skills, it is difficult for him to move his arms away from his body and complete activities on the lab bench. This can be remedied by moving the activities Michael has to complete to his tray. One extra adaptation that may be useful applies to the Dental X-Rays activity. In this activity, students are required to hold x-rays up to the light so they can see them. If a small light table was provided, Michael would be able to view the x-rays directly on his tray, which is in his operating range, instead of having someone hold them up to the light for him.

M15 (Teamwork and Co-activity): Teamwork and Co-activity is listed as a solution in the "All Tasks" row of SAM for both limited fine motor skills and limited strength. Teamwork in particular would work well for Michael because his group members would be able to move things to his tray or complete activities that Michael could not complete independently. Activities should only be completed by other members of the team if it is not feasible to properly adapt them, or the task is considered to be unimportant to the activity, such as turning the pages of the ballistic book.

<u>Envelope Ink, Fabric on the Fence/Fibre on the body, Is it Blood?, Oil Stains, Soil Testing, and Whose Blood?</u>

M8 (Low Resistance): Low resistance caps should be used where Michael would be required to remove a cap; this includes pen caps, as well as threaded caps used on containers. Easy to remove pop off caps are a good alternative to threaded caps. Low resistance also applies to any squeeze bottles that are used, such as the ones in the oil stains activity. A bottle that is easier to dispense liquid from could be used as an alternative. Additionally, another way of applying the oil on the paper towel should be implemented. An example of this would be having the oils in a small dish, with a popsicle stick for applying the oil, or applying the oil to the paper towels in advance.

M19 (Surface with Enhance Grip): A surface with enhanced grip should be used on all caps that Michael must remove. A cap with enhanced grip lessens the amount of pressure Michael is required to apply to prevent his hand from slipping.

<u>Smooth Surfaces</u>

M18 (Use Lightweight Object): It may be difficult for Michael to hold up the mug used in the smooth surfaces activity when making the fingerprint and applying the dust to see the fingerprint. This requires a certain level of strength in order to grasp the cup. The best accommodation for this would be using a lightweight object in place of the mug. The mug could be replaced with something as simple as a small piece of ceramic material, such as a tile, for Michael to use.

7.2.3 Case Study - Approach 3, Vision SAM

Student Description:

Kayla is a Year 10 student with no vision. She attends a mainstream school and her science class is taking a trip to the Melbourne CSIROSEC next week to do the Forensic Frenzy program. Kayla's visiting teacher has already spoken with someone at CSIROSEC and was able to obtain electronic copies of the instruction sheets and worksheets. By obtaining the electronic copies, the visiting teacher was able to have them converted into Braille so Kayla can use them at the program. CSIRO is wondering what they can do to adapt the activities in the program to make them more accessible to Kayla.

Spectrum:

The category of 'blind' from the Vision SAM spectrum will be used as a reference as it describes Kayla's visual abilities.

Program Activities:

<u>All Activities</u>

One solution which can be used for all activities is a team approach (V16). In instances where adaptations cannot be made due to limited resources, funding, or time, it is possible to have students work in teams and a Kayla's peers can assist her with completing the activities. One important note to make with this approach is Kayla should still be contributing to the group even though she may not be able to complete all parts of activities. A good example of implementing a team approach would be in the 'Is it Blood?' activity, a team member could tell Kayla whether or not there was a colour change and Kayla can record the findings.

<u>Ballistics - Type of Firearm</u>

In this activity Kayla will have difficulty viewing two dimensional images. In the activity Kayla must observe a shirt with a bullet hole and blood stains which is in a glass frame and compare it to pictures found in a book. Both the shirt and pictures are inaccessible to Kayla as they are two dimensional images. To make this activity accessible, it would be necessary to provide access through touch (V1). Rather than enclosing the shirt in a glass case the shirt could be mounted on a board so that Kayla can feel the size and shape of the bullet hole. Additionally, the two dimensional images in the book could be supplemented by adding texture to the areas showing blood splatter so the size and shape could be detected. A three dimensional model could also be created out of clay or another medium so Kayla could use touch to feel the hole left by the bullet, as well as the bullet holes and blood splatter displayed in the ballistics book.

Dental X-rays

In the Dental X-rays activity Kayla will again have difficulty viewing two dimensional images as the activity contains several X-rays which must be observed. To adapt this program, access through touch (V1) should be used. Bite plates or dentures could be used to compare three dimensional models of teeth. Students could observe chips in teeth, fillings, missing teeth, and number of teeth on three dimensional models instead of viewing them with x-rays. Other alternatives to bite plates and dentures would be using mouth guards and filling them with resin to get a positive impression. Plaster of Paris could also be used to compare differences between bite marks.

Envelope Ink

In this activity, Kayla will have difficulty viewing two dimensional images and also observing colour changes. In this activity chromatography is performed which is two dimensional. Also, there is a colour change and movement of colours in chromatography which Kayla will not be able to observe. The solution to accommodate these barriers is to incorporate access through touch (V1). While it will be difficult for Kayla to gain a thorough understanding of chromatography through a tactile means, it will be possible for her to compare samples. Samples can be prepared ahead of time which have different textures in different areas instead of different colours. Kayla can feel the differences between the samples to determine which type of ink was used to write on the envelope of the ransom note.

Fabric on the Fence/Fibre on the Body

The barrier present in this activity is observing colour changes. Kayla must compare colours of different pieces of fabric after a stain has been added to determine which fabric was found at the crime scene. Solutions to make this activity accessible include access through touch (V1) and access through smell (V2). Rather than having students add Shirlistain and visually compare fabric samples, it would be possible to use different types of fabric like cotton, wool, and nylon and compare them in a tactile manner to a sample which was found at the crime scene. To compare the fabrics using smell, several samples of the same fabric can be used which have a different deodorant, cologne, or perfume applied to them.

Facial Identification

With the facial identification program Kayla again encounters the barrier of viewing two dimensional images. In this instance the images are on a computer screen. The goal of the task is to use software to recreate the image of a suspect's face. To adapt this activity so Kayla may participate, access through sound should be provided (V2). Rather using visual identification of a suspect, the suspect can be identified through voice recognition. Several voice clips can be provided and the student can match the clips to the suspect's voice. To increase the difficulty level of the activity, the voice clips can be muffled or contain background noise. It is important to note that this activity does not relate to the crime investigation as it does not reveal any information relating to who committed the murder. This program does however allow CSIRO to use technology many schools may not otherwise have access to, so it would be desirable to adapt the program rather than omit it.

Fingerprints on the ransom note

As they are presented in the activity, the fingerprints are a two dimensional image which Kayla cannot access. To adapt this program the fingerprints should be made accessible through touch (V1). Imprints or three dimensional models of fingerprints can be made that students can feel. It is important that these fingerprints are enlarged in size as compared to normal fingerprints. Also, the models of fingerprints should be noticeably different and have distinct patterns.

Is it Blood?

In this activity Kayla must test fabrics with Hemastix to determine if blood is present on any of the fabrics. This is the barrier of observing colour changes. To overcome this barrier, the activity can be adapted so Kayla may access the information through smell (V2). Rather than have the material change colour when a chemical is added, a smell could be released which would be indicative of blood being detected.

Looking Complete

This task would not pose any barriers for Kayla as it is already accessible by touch.

Oil Stains

In the oil stains activity Kayla would have difficult reading text and observing colour changes. The container labels in the activity should be printed in Braille (V6) so that Kayla may read what they say. In the activity Kayla is required to determine the difference between types of oil by putting samples under ultraviolet light to detect fluorescence. Rather than usually a visual method to differentiate between oils, access through smell could be used (V2). The oils could have different smells and the smell could be compared to the sample found at the murder scene.

PAID Stamp

This activity is yet another activity which would pose a problem for Kayla as it involves viewing two dimensional images. In this instance it would be difficult for Kayla to see the results of the stamping in order to tell the difference between the stamps. To make this activity accessible to Kayla, access through touch (V1) should be made possible. Kayla is not able to see the print different stamps make on the paper; it would be beneficial to stamp into another medium, such as playdough, which the stamp could imprint so differences could be detected by touch.

Smooth Surfaces

For the smooth surfaces activity it would not be possible for Kayla to see the fingerprints which appear on the cup as a result of dusting. Unfortunately, simply feeling the fingerprints on the cup is not a viable solution to overcome this barrier as touching the fingerprints would smudge them. As this activity is not essential to the program and discovering who the murderer was, this activity could be omitted as content regarding fingerprints is presented in the other fingerprinting activity included in the program.

Soil Testing

Tasks in this activity include reading text, targeting, and observing colour changes. The text in this activity is found on container labels and can be made accessible by converting it to Braille (V6). Targeting is an issue as Kayla is required to add the barium sulphate to the soil in areas which are in close proximity to each others. To accommodate this, aids for targeting (V5) would be used. In this instance, it would be helpful to use a larger tray with four section divisions to separate the soil. Also, a team approach (V16) could be used in which Kayla still carries out all of the steps in the experiment and has a team member inform her of colour changes. The main outcome of the activity is observing what colour change the soil makes. The purpose of this observation is to determine which soil sample found in the shoes of the suspects came from the crime scene. As an alternative to testing soil samples, the activity could compare footprints. A plastic cast could be made of a shoe print and shoes could be compared to the plastic cast to determine which suspect was at the scene of the crime. By physically comparing footprints, the information about who was at the crime scene is still obtained.

Tyre Tracks

The tyre track activity also presents the barrier of viewing two dimensional images. In this case access through touch (V1) should be used to make the program accessible. In the activity pictures of tyres and tyre tracks are used for comparisons. As a substitute for the pictures, actual tyres and tracks can be used. An imprint can be made of a tyre in Plaster of Paris and pieces of actual tyres can be used for comparison.

Whose Blood?

This activity is difficult for Kayla as it requires viewing two dimensional objects. There are printed sheets of paper which show bands on completed gel electrophoresis. This activity can be made accessible through the use of touch (V1). A three dimensional model can be made *with raised gel bands* that can be detected through touch. Another option would be to create a slab which had indents where each of the gel bands were located. In this manner a negative model with three dimensional bands of the murder's DNA could be fit with a positive model for each suspect and if the DNA for the two match, the two models would fit together like a puzzle.

Program Introduction

Much of the program introduction does not require any adaptation for Kayla as it is verbal discussion between the presenter and the student. The only area of the program introduction which would require adaptation is when the students are asked to refer to their worksheet packets. However, in Kayla's instance, the visiting teacher has already converted the worksheet packets to Braille so Kayla is able to access the information.

Program Wrap-Up

In the program wrap-up there is a classroom discussion regarding what students found in each activity. If students are able to record their answers electronically, as is suggested in the solution for an alternative to writing, students can review their findings with a screen reader (V15). Also, a display is used to visually organize clues students discovered during the program about the murderer. This display requires students be able to read text and a suitable alternative would be to put the results of the discussion in electronic format (V15).

8 Conclusion

The primary deliverable of this project was a framework to aid in the adaptation of hands-on science programs for students with auditory, mobility, and vision impairments. The framework came to be known as the Student Accessibility Matrix (SAM). SAM was developed from information obtained through a review of literature, interviews, and observations of Melbourne CSIROSEC programs. This information was culminated to gain a succinct understanding of the three disabilities SAM focuses on, as well as some general practices that are used in special education for students with auditory, mobility, and vision impairments.

The information acquired from literature was further expanded upon through interviews with experienced educators and disability specialists. Experienced educators and disability specialists from the United States and Australia were consulted regarding their previous experiences adapting programs for students with disabilities. The outcome of conducted interviews was a summary of best practices used in the education of students with auditory, mobility, and vision impairments, as well as a listing of resources are available to these students.

Through program observations at CSIROSEC, the project team was able to gain an understanding of the types of activities that SAM would be used to adapt. This information was supplemented by interviews with the Melbourne CSIRO staff, who had experience with the programs and suggestions on adaptations that could be made.

SAM contains both a universal design section and three disability specific sections. The universal design section details basic principles that should be incorporated into programs to make them accessible for all students. The disability specific sections contain a disability spectrum, activities that pose barriers for students with disabilities, and solutions to overcome barriers and provide accessibility.

To evaluate SAM, experts in each field reviewed SAM and their feedback was incorporated into the final version. Additionally, the project team completed three hypothetical case studies using SAM to adapt programming for students with a range of disabilities. The case studies were an opportunity to demonstrate how to use SAM and provide adaptations which can be implemented for one of the CSIROSEC programs.

Overall, SAM provides the CSIROSEC staff and science teachers around the world with the information that they need to successfully integrate all students into their programs.

SAM acts as a tool to make science activities accessible to everyone, regardless of their level of ability. Through the use of SAM, teachers will gain a better understanding of the capabilities of students with disabilities, as well as simple ways to accommodate for them. Students with disabilities have a strong drive to learn and will greatly benefit from teachers who design with them in mind. Proactively creating science activities and classrooms using universal design and the disability specific sections of SAM will greatly enhance people's awareness of the proper accommodations necessary for students with auditory, mobility, and vision impairments.

CSIRO research and development puts a large focus on innovation and with the addition of SAM, the organisation can expand this vision to disability inclusion. By integrating SAM and suggested adaptations into their programming, CSIROSEC will take the lead in creating inclusive learning environments. In this manner, CSRIOSEC will not only help others in overcoming the false impression that students with disabilities cannot participate in hands-on science programs, but also allow these students to investigate and pursue careers in science. By creating opportunities for students with disabilities in science, CSIROSEC will pave the path for others to follow their example.

9 Recommendations

After project completion, the project team identified several recommendations to present to the Melbourne CSIROSEC staff to make their programs more accessible. Additionally, the project team also identified areas in which SAM may be expanded. By applying SAM to make hands-on science programming more accessible, CSIRO Education will put itself at the forefront of disability accommodations in Australia.

The project team developed the following list of recommendations:

- Evaluate SAM by running pilot tests to accommodate programs;
- CSIRO should develop an insert detailing available disability accommodations;
- CSIRO should add a disability tick box onto their booking form;
- Put textual material into electronic format;
- Evaluate programs to determine which activities are essential;
- Incorporate multi-sensory activities into programs;
- Expand SAM to include ESL students and students with intellectual disabilities;
- Distribute SAM for others to use as a resource.

In order to fully evaluate SAM, it must first be tested through implementation. It is necessary to test SAM and its effectiveness adapting hands-on science programs in mainstream and specialist schools. This can be done through pilot studies which adapt CSIROSEC programs. Adapted programs can be implemented at specialist and mainstream schools. Following this, program accessibility can be evaluated by comparing accessibility before and after accommodations. In addition, success should be evaluated by determining whether or not learning goals are achieved. Overall, the purpose of conducting pilot studies is to bring validity to SAM by demonstrating its ability to effectively adapt programs.

Several options currently exist for CSIROSEC to apply SAM. By incorporating SAM into their programs, CSIROSEC could put together an insert to their advertising material detailing their ability to accommodate students with disabilities. This will make CSIROSEC more attractive to specialist schools and mainstream schools that are looking for hands-on science programs where all of their students can actively participate.

CSIROSEC should also ask for information regarding student abilities during booking so that staff can best adapt programs to accommodate students. Adding a disability 'tick box' to the program request form will enable CSIROSEC to initiate communication about the ability level of all students within the class. A conversation between the teacher at the school and the CSIROSEC staff member who books the program will need to take place before the program begins to ensure that the CSIROSEC staff member running the program understands the needs of the students in the class and can make the necessary adaptations to the program.

As a proactive to approach to the disability adaptations, the project team recommends CSIROSEC put all of their textual material in electronic format. Making this conversion certifies that CSIROSEC will be able to provide material ahead of time to teachers so that they can adapt it into the appropriate form for students with various impairments. Similarly, if the CSIROSEC staff member is aware that the student requires worksheets with enlarged font, they can print out the material in a larger font and bring it with them to the program. Also, keeping all of the instruction sheets and worksheets in electronic format will allow this material to be provided to teachers ahead of time. Providing the material ahead of time allows the teacher to go over the material with the students ahead of time if necessary.

To further adapt their programs, it is also important the CSIROSEC staff evaluate CSIRO programs and determine which activities are necessary to understand the underlying scientific concepts being taught. By doing this, CSIROSEC can be determine whether or not a student would gain the same knowledge and experience from the program if some activities were either omitted or substituted for with another activity. When evaluating their programs, CSIROSEC should incorporate the maximum number of multi-sensory activities which stimulate students through taste, smell, audio, visual, and touch to better include all students. The incorporation of multi-sensory activities will also provide students with a better overall understanding because they will be able to access the material in multiple ways.

In addition to the application of SAM to adapt CSIRO programming, SAM also serves as a global resource to make hands-on programs more accessible for students with disabilities. SAM serves as a simple and user friendly foundation for accommodating programs to make them more accessible for students with auditory, mobility, and visual impairments. SAM could be expanded upon to serve as a more encompassing resource to include ESL students as well as students with intellectual disabilities. Through interviews, providing for ESL students was identified as an area where accommodations are necessary. Also, the majority of the specialist schools in Victoria accommodate for students with intellectual disabilities. Due to this fact, it would be valuable to develop a matrix which details the proper accommodations and adaptations for these students. This tool would be particularly useful for the Melbourne CSIROSEC because they could better provide for specialist schools in the local area.

Lastly, it is important to distribute the material that has been developed so the necessary information reaches the maximum amount of people. A valuable project would be investigating the most successful distribution methods and developing packets or booklets that can be distributed about SAM and how to use it. Overall, SAM is the beginning of a transformation to universal design and a proactive approach to making accommodations for inclusive learning.

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Appendix A CSIRO Description

The Commonwealth Scientific and Industrial Research Organization (CSIRO) is Australia's National Science Agency. Founded in 1926 as the Council for Scientific and Industrial Research (CSIR), the main focus of the organization was conducting research to promote industries such as farming and mining. During WWII, CSIR also began working with the military on a variety of research topics. In 1949, CSIR stopped military work and became known as CSIRO (CSIROd, 2006).

Today, CSIRO employs more than 6,500 scientists in Australia. It is a governmentally funded agency, receiving a budget of almost $600 million (AUS) in 2006 through the Australian Government Federal Budget. CSIRO's services are used by businesses, industry, Australian and international communities, and both Commonwealth and State governments and agencies. CSIRO operates under the guidelines of the Science and Industry Research Act of 1949 and the Commonwealth Authorities and Companies Act of 1997 (CSIROd, 2006). The Science and Industry Research Act of 1949 details in great description the functioning of CSIRO. Such details include: power of the organization, co-operation with other organizations, the Chief Executive of the organization, the Board of the Organization, Advisory Committees, staff, strategic plans and annual operation plans, and finance (Australia, Science and Industry Research Act of 1949, 2004). The Commonwealth Authorities and Companies Act of 1997 regulates portions of CSIRO's finances as well as banking, investment, reporting, and accountability (Australia, Commonwealth Authorities and Companies Act of 1997, 2006).

CSIRO is a diverse organization, taking part in work ranging from scientific research to science education in schools. CSIRO has roots in a many different areas of science and has seven different research sectors including agribusiness, energy and transport, health, information, manufacturing, mineral resources, and environmental and natural resources. The agency divides its main functions into primary and secondary roles.

The primary roles of CSIRO are similar to the original council from which it was born, dealing mainly with scientific research and its application to benefit Australian industry and society. One of the secondary roles CSIRO is concerned with is education, including research training, publications, and hands-on science programs for schools. CSIRO's mission is "to deliver great science and innovative solutions for industry, society and the environment. We work on new ways to improve our quality of life, as well as the economic and social performance of a number of industry sectors through research and development." (CSIROb, 2006).

CSIRO's presence is apparent throughout Australia, as well as internationally. CSIRO has fifty locations all throughout Australia and a few other sites overseas located in France and Mexico. CSIRO works with over 80 different countries around the world, taking part in exciting research and aiding in global development. CSIRO works not only with foreign governments and large scale companies, but also with smaller businesses (CSIROc, 2006)

There are nine CSIRO Science Education Centres (CSIROSEC) throughout Australia. Overall these centres reach out to over 260,000 students annually who either visit the centres or have experienced programming through CSIROSEC school visits. The CSIRO Melbourne Education Centre functions as the CSIROSEC within Victoria. At this centre, CSIRO runs a range of programs, with a primary emphasis on the development and promotion of hands-on science education programs for students of all ages across Victoria.

One weakness with current educational programming is CSIRO does not focus on making its programs accessible to those with disabilities. This lack of accommodation is a barrier as it restricts CSIRO from outreach with specialist schools. Additionally, CSIRO has had interaction in the past with students with disabilities who either visit the centre or are in mainstreamed schools. CSIRO recognizes the fact that current programming does not accommodate students with disabilities and seeks to make adjustments to existing programs. This proactive role would maximize the number of students who are able to benefit from the unique programming the organization offers.

Appendix B Victorian Essential Learning Standards

The Victorian Education Learning Standards (VELS) were formed in order to ensure all students receive a quality education. The VELS include a section discussing disability standards for education which were outlined under the disability standards in the Disability Discrimination Act of 1992. The VELS have five guiding principles which include learning for all, the pursuit of excellence, engagement and effort, respect for evidence, and openness of mind. Other key areas of these standards include communication, design, creativity and technology, and thinking processes.

The VELS divides up standards by different domains which are as follows: health and physical education, interpersonal development, personal learning, civics and citizenship, the arts, English, the humanities, mathematics, science, communication, design, creativity and technology, and thinking processes.

In the science domain the standards include building understanding in the areas of environment, matter, energy, force, Earth, and the importance of understanding scale. Further standards are outline by grade level so each level has a different set of concepts students are expected to master. Another domain of interest to this project is the design, creativity, and technology domain. The main goals of this domain are to encourage design, creation and evaluation processes, and develop innovation. VELS define creativity as using lateral and critical thinking in combination with imagination. Additionally, this domain also calls for students to solve problems in both an individual and group environment. This interactivity and free learning is an underlying theme in informal education. Different examples of context for applying such principles include investigating how one grows, interacts with the world and eats, or how objects are constructed. These are principles that relate directly to hands-on science programming CSIRO has developed such as the sports science program which investigates the science behind playing sports.

Appendix C Example of Academic Accommodations

Excerpted from Working Together: K-12 Teachers and Students with Disabilities (University of Washington, 2003)

Disability	Accommodation
Low Vision	○ Seating near front of class ○ Large print handouts, lab signs, and labels ○ TV monitor connected to microscope to enlarge images ○ Class assignments made available in electronic format ○ Computer equipped to enlarge screen characters and images
Blindness	○ Audiotaped, Brailled, or electronic formatted lecture notes, hand outs, and texts ○ Verbal Descriptions of Visual Aids ○ Raised line drawings and tactile models of graphic materials. ○ Braille lab signs and equipment labels, auditory lab warning signals ○ Adaptive lab equipment (ie talking thermometres and calculators, light probes, and tactile timers). ○ Computer with optical character reader, video output, Braille screen display and printer output
Hearing Impairment	○ Interpreter, real-time captioning, FM system, note taker ○ Open or closed-captioning films, use of visual aids ○ Written assignments, lab instructions, demonstration summaries ○ Visual warning system for lab emergencies ○ Use of electronic mail for class and private discussions
Mobility Impairment	○ Note taker/lab assistant/ group lab assignments ○ Classrooms, labs, and field trips in accessible locations ○ Adjustable tables; lab equipment available within reach ○ Class assignments made available in electronic format ○ Computer Equipped with Special Input device (I.e. Voice Input, Morse Code, Alternate Keyboard).

Appendix D General Interview Agenda

- Introduce Project
- Find out what their role in the educational system is:
    - What are your responsibilities?
    - What age groups do you work with?
    - What is your past experience with education?
- Have you ever had students with disabilities in your classroom?
    - If so, what accommodations did you make for them in general?
    - Were they standard modifications or were they made on a case by case basis?
    - Did the modifications encompass a broad range of disability inclusion or each disability separately?
    - If not, have you ever thought about any modifications that you would make?
- Have you had any experience with laboratory or hands-on activities?
- What modifications, if any, were made to labs/hands-on science programs for students with disabilities?
- How do you determine what adaptations will work for certain students?
- Are the accommodations successful?
    - Are the students getting the most out of their education? (The same as everyone else?)
    - Do you have any examples of this?
    - Literature?
- How do you evaluate the success of the programs/effectiveness of the adaptations?
- Are there any 'general' modifications made for students with disabilities across the board? (universal design)
- Do you have any suggestions for us as we proceed with this project?

Appendix E Potential Mainstream School Interview Agenda (Phone)

- Introduce Project
  - My Name is ___ from CSIRO Education
  - Inquiring if there are students with disabilities at your school?
- If the school did not have students with disabilities enrolled in their school, the interviewer thanked the person for their term and the call was ended.
- If the school did have students with disabilities enrolled in their school, the following questions were asked:
  - What disabilities?
  - Speak with someone who makes accommodations?
    - Find out what their role in the educational system is:
      - What are your responsibilities?
      - What disabilities does your school accommodate for?
    - Are your modifications general or were they made on a case by case basis (student specific)?
    - Have you had any experience with laboratory or hands-on activities?
    - What modifications are made in your school?
    - How do you determine what adaptations will work for certain students?
    - How do you evaluate the success of the programs/effectiveness of the adaptations?
    - Are there any 'general' modifications made for students with disabilities across the board? (universal design)
    - Do you have any suggestions for us as we proceed with this project?

Appendix F Specialist School Interview Agenda (Phone)

- Introduce Project
    - My Name is ___ from CSIRO Education
    - What disabilities does your school accommodate for?

- If the school did not accommodate for mobility impaired, vision impaired, or deaf students, the interviewer thanked the person for their term and the call was ended.
- If the school did accommodate for mobility impaired, vision impaired, or deaf students, the following questions were asked:
    - Speak with someone in charge of adapting programs?
        - Find out what their role in the educational system is:
            - What are your responsibilities?
            - What disabilities does your school accommodate for?
        - Are your modifications general or were they made on a case by case basis (student specific)?
        - Have you had any experience with laboratory or hands-on activities?
        - What modifications are made in your school?
        - How do you determine what adaptations will work for certain students?
        - How do you evaluate the success of the programs/effectiveness of the adaptations?
        - Are there any ‘general’ modifications made for students with disabilities across the board? (universal design)
        - Do you have any suggestions for us as we proceed with this project?

Appendix G Administrator Interview Agenda

- Introduce Project
- Find out what their role in the educational system is:
    - What are your responsibilities?
    - What age groups does your school work with?
    - What is your past experience with education?
- How does your institution accommodate for students with disabilities?
    - Individual or general adaptations?
        - Anything comparable to IEP's?
    - Do they have individual aides, small classes, use technology?
- What does your institution do about science laboratories in particular?
    - Modifications made?
- How do you determine what adaptations will work for certain students?
- Are the accommodations successful?
    - Are the students getting the most out of their education? (The same as everyone else?)
    - Do you have any examples of this?
    - Literature?
- How do you evaluate the success of the programs/effectiveness of the adaptations?
- Do you have any suggestions for us as we proceed with this project?

Appendix H Victoria Department of Education Officer Interview Agenda

- Introduce Project
- What schools are required to accommodate for disabilities?
- How many mainstream specialist schools are there?
    - Is there a register of schools?
- What are schools required to do by DDA?
- How does funding work for programs?
    - What decides if students have an aide or not?
    - What determines if there is a special education coordinator at the school?
    - When are students taken out of the classrooms versus learning in the main classroom?
- When are individualized education plans applied?
- How is success measured?

Appendix I   Physiotherapist Interview Questions

1. We have our framework broken into four categories: fine motor skills, strength, range of motion, and gross motor skills. Are these appropriate categorizations?

2. Fine Motor Skills:
    a. What do these students have difficulty doing?
    b. What adaptations are made so that the students can participate independently?
    c. What types of activities would aides assist students in?

3. Strength:
    a. What do these students have difficulty doing?
    b. What adaptations are made so that the students can participate independently?
    c. What types of activities would aides assist students in?

4. Range of Motion:
    a. What do these students have difficulty doing?
    b. What adaptations are made so that the students can participate independently?
    c. What types of activities would aides assist students in?

5. Gross Motor Skills:
    a. What do these students have difficulty doing?
    b. What adaptations are made so that the students can participate independently?
    c. What types of activities would aides assist students in?

6. Are there any universal adaptations that can be made across the board for students with physical disabilities?

Appendix J Melbourne CSIROSEC Staff Interview Questions

- Interview staff 1 on 1 next week (30-45 minutes on average)
    - Interviewing people we have observed in regards to programs we have observed
        - Goals of activity
            - Quantitative goals of the activity
        - Primary aspects of the program versus secondary aspects
            - What is essential?
            - What is secondary?
        - How evaluate success? Is it just qualitative?
        - Discuss programs we observed
            - Barrier checklist sheet done for the program as broken down by the activity
            - Our solutions
            - Their thoughts
                - Alternative solutions
                - CSIROSEC conducive – too heavy, too much $$
    - Interview people who have had experience adapting programs in the past
        - Program that was adapted
        - Disabilities accommodated for
        - Adaptations made
        - Did the students get the same understanding of essential concepts?
        - Anything you would have done differently?
- Focus groups after all staff interviews are done to get feedback on the program we decide to adapt

Appendix K Melbourne CSIROSEC Staff Interviews

Interviewee: Karina
Interviewer: Nicholas Simone, Erin Vozzola, Lynn Worobey
Date: 04/04/07
Program: Gene Technology, Forensics, and other programs

Gene Technology Program

Vision

- Pipette
    - Practicing would probably be okay.
    - Getting the pipette into the gel would be the hardest part.
        - Gel could still be used.
        - It would be hard to feel what it is happening and put the pipette in the gel at the same time.
        - Use a bigger well?
            - You could masking tape around to make it fatter and longer and easier to put in.
                - What size?
        - Magnification for students with low vision.
        - Make gel out of something else with colour?
    - The students can't see the dial on the pipette of how much liquid is measured.
        - Preset Pipette?
        - Use a mechanical pipette (not a plastic pipette)?
        - Possibly borrow a different pipette that can be preset from another lab at CSIRO?
    - Construct a guide that could help students target where the pipette should go?
- DNA:
    - Colour will not mess up the DNA.
        - Add colour dye to soak up so that it is easier for students with visual impairments to see the difference.
        - First liquid could be collared.
        - Ethanol would need to stay colourless.
    - The test tubes are very small and would be hard to see the DNA in the middle because it is such a small amount.
        - It could be done on a bigger scale.
        - A bigger test tube could be used (8 ml)
        - The system is already set up for those if necessary.
- Power Point:
    - Hard to see.
    - A lighter background and darker font should be used.
- Visual Writing:
    - It is hard to read the writing on the whiteboards from far away.
    - Make sure the writing is big and legible for everyone to see.
    - "I'm getting bigger, guys, you'd be proud of me!" – Karina
    - Maybe use a balloon to demonstrate the cell?
    - Maybe use a container to demonstrate what the cell looks like?
        - Chromosomes are the most important part for Gene Tech.
        - Cost and size are important factors.
    - Maybe use something similar to the Earth that is used in Natural Disasters.

    - Maybe have a bag with all different "cell" parts that are different textures and the students could feel each one and try to figure out what it is.
    - Make it in electronic format?
- Instructions:
    - Maybe have a button at each station that is connected to a tape recorder that has the instructions on it, so the students could listen to it if they need further instructions.
- DNA Demonstration:
    - Seeing the gel is not as important as understanding how it has changed.
    - Tactile model?
    - Change the gel so the students can see it?
    - Maybe use string with marbles on it to help describe what a double helix looks like.
- Experience with the subject matter before hand is important for Gene Technology.

Mobility:

- Pipettes:
    - It would be hard for a student without fine motor skills to use the pipette.
        - Maybe use bigger pipettes that are easier to hold.
        - Maybe help the students use them.
        - Rig up something for the students to help them?
            - Some type of guide.
    - Staff could shake it for them.
    - Epindorph racks that you could use to put the test tubes in.

Forensics Program

- Wrap Up:
    - During the wrap up, it is hard to see the poster that all of the clues are put up on.
        - Make the poster bigger and easier to read.
- Worksheets:
    - During the presentation, the students have to continually reference clues that they have found → hard for visually impaired students to need to rely on that.
    - Easier worksheet could be used.
        - Tick boxes of who the evidence leans to.
- Computer Face Programs:
    - Almost impossible to use for students with blind students.
    - You could add a voice recognition station instead where there is a muffled voice clip of the criminal and then have different other voice clips and they have to try to match up who they think the voice clip is.
        - Cool for all students!
    - Car Screeching → Could match the noise of the car noises.
    - Not one of the vital programs to the crime investigation.
- Finger Printing:
    - Making your own finger prints doesn't really have an effect on a blind student or visually impaired student because they can not see their finger print on the cup very well or at all.
    - It is not an essential activity for the crime investigation.
    - More tactile way of looking at things?

        - Maybe use clay or play dough and try to feel the ridges in your finger prints?
    - Tactile for matching fingerprints.
        - Different moulds for finger prints and match them up that way?
        - Make sure that the finger prints are noticeably different.
    - Make sure that there are magnifying glasses for the visually impaired students.
- PAID Stamp:
    - Add foam to it or Velcro so that a student with fine motor skill disabilities could use it more easily.
    - Use darker ink so the result is easier to see.
    - Use play dough or something so that the stamp imprint could be felt as well as seen visually.
- Dental Records:
    - It is 2-Dimensional and you can not see it if you are blind.
        - Use bite plates or dentures.
        - More feeling instead of just a raised picture.
            - Add fillings into the bite plates or dentures so it is easier to tell the difference between them.
- Smell:
    - Incorporating Smell into the programs would be beneficial for everyone.
        - Different Perfume/Cologne
        - Smell the Oils
        - Smell soil (instead of colour change, scent change)
- Tyres:
    - Get real car tyres for students to look at it and feel and compare to a tactile tyre print.
        - Plaster of Paris tyre print for them to compare the tyre pieces to.
- DNA:
    - Make it more 3 D, like a puzzle
    - Make it in Braille?
    - Make something that links up to the right three and move it across all of them and see which one fits.
- Envelope Ink/Chromatography:
    - Different textures?
    - Make sure that the colours are distinct so that students who are colour blind can tell the difference.
        - Avoid red and greens together.
- Is there blood?
    - Could release a smell?
    - Scratch and Sniff objects?
- Facial Reconstruction:
    - Hard for students with mobility impairments to reach it.
    - The play dough gets hard and often falls off.
- Ballistics:
    - Hard to see the bullet hole because it is so small.
    - Can feel the hole?
- Soil:
    - Make there be a different scent released rather than a colour change.
    - Use a spoon to get different samples for those with fine motor disabilities.
- Preset amount of liquids and solids needed for all activities.

- Clothing:
  - All of the pieces of fabric are small.
  - It is hard to use if you have any type of visual or mobility impairment (hard to see and hard to reach/use).
  - Deodorant on different fabrics→ Different smells.
  - Different fabrics with different textures.

Natural Disasters:

- Physically shaking is required for a few activities.
- The students move around a lot.
  - Is that necessary?

Evaluation of Success:

- Something could be added into the teacher evaluation that is already handed out in the packet for teachers.
  - The survey could be refined and made better.

Extra Stuff:

- Air and Weather:
  - Sound to scare and wake up the kids
    - Required for the Activity?
- Continue to make things simpler.
- Power Point (in general):
  - Make sure to keep it simple.
  - Speak up when presenting a power point (always face forward)
  - Should we act things out more? (Karina's question)
- Laminate the framework or list of universal design ideals and put it in every case so that the presenters know what to do.
- Maybe ask the presenters to make sure that they go and talk to the teacher before hand to learn more about the school and what their class will be like. (Make the meeting with the teacher beforehand mandatory so that no one is caught off guard).
  - At that time, the presenter could walk interpreters through the activities.
  - They could be given a list from the teacher of what to be mindful of as well.
- Add a box on the registration sheet that has a box to check and next to it says: "Tick if you have students with disabilities."

Interviewee: Caitlin
Interviewer: Nicholas Simone, Erin Vozzola, Lynn Worobey
Date: 05/04/07
Program: Thinking Scientifically and Energy

Thinking Scientifically

- Moving powder
  - Could put preset amounts of powder in labelled film containers
  - Would be tedious and time consuming to refill all the containers, would add bulk to materials
- Gas release
  - Assembly is difficult even for students without disabilities
  - Students would not lose much concept
    - Could ask students why they are using a certain amount to ensure they know why it is important to use the same amount of substance each time
  - This activity could be left out of the program
- Pre-measuring
  - Pre-measuring would be difficult, taking 20 beakers to pre-measure would be difficult
- Sugar Activity
  - Have a small dot on the small grain sugar and a large dot on the large grain sugar
- Pendulum
  - This would be a good group activity
  - Student could still press start and stop just have another student say start, stop
  - It is the output that is important, not the act of operating the timer
- Rubber band cars
  - Wind the cars two times instead of five and it will not go as far so it can be done on a tabletop
- Water
  - Water can be coloured so it would be easier to see with partial sight

Energy

- For the hand crank lights where physical input is compared to solar energy the lights have a radio on them so the students could listen for how long the radio plays instead of see how long the light stays on

Interviewee: Simon
Interviewer: Nicholas Simone, Erin Vozzola, Lynn Worobey
Date: 05/04/07
Program: Air and Weather, Forensics, Previous Program Adaptations

Air and Weather

- Program is entirely demonstration based
    - Students cannot touch and this is not good for students who have visual impairments
    - Program would need to be shortened to allow for time to not talk while reactions or demonstrations are occurring
- It is possible to remove some portions of the verbal explanations without removing the science
- Most mainstream schools want the experience for kids and often presenters are teaching the teachers at the same time
    - Don't worry if the kids do not understand as long as the teachers do because they are the ones that follow up on the material

Forensics

- Soil
    - Used to use a plastic cast footprint and shoes for the activity instead of comparing soil
- Chromatography
    - Could use different papers with different tastes that make up one taste
    - The essence of the activity is that black ink is made up of other inks
- Oil stains
    - This activity would depend on how impaired the students was
        - Could potentially use something that glows brighter that could be seen with partial vision
    - Could also replace it with a different activity that uses another sense
- Clothing fibre
    - Different types of fabric that were the same colour and size but different textures
- Ballistics
    - Could be a tactile activity
    - Make the differences in hole size more obvious
- Dental x-rays
    - Use bite marks
    - Mouth guards and then positive impression by pouring in resin
    - Make obvious differences such as chipped teeth, pointed incisors, removed wisdom teeth
- Generally want students writing information down
- Potentially label containers by 1,2,3,4 instead of with suspect names
- Ballistics, face reconstruction, and the face program give CSIRO an edge over what teachers can do in the classroom

Adaptations

- Went to a school for students who were severely intellectually disabled
    - Did the force and movement program, the teachers wanted a very tactile program

- Simon went in planning to get up to be involved but students couldn't actually move anything other than their head, most were quadriplegic
- There was student who was the daughter of the teacher that Simon did a lot of the demonstrations with
- The program was poorly organized by the teacher
- The second class had only two students in wheelchairs

Interviewee: Merrin Fabre
Interviewer: Nicholas Simone, Erin Vozzola, Lynn Worobey
Date: 05/04/07
Program: General Ideas, Energy, Forensics, Natural Disasters, Disability

General Ideas:

- Instruction Sheets:
    - It would be easy for CSIRO to make another set of instruction sheets that have a larger font or simpler instructions.
    - They could make instructions more step by step for the students.
    - They could make some instruction sheets that have pictorial instructions.
- Prep Material:
    - CSIRO used to send the preparatory material to the teachers but they don't do that anymore.
    - Students come to the programs with different levels of understanding of the material.
        - Some students come at the very beginning of the unit and do not know anything about the material.
        - Some students come in the middle of the unit.
        - Some students come at the end and have an extensive background of the material.
    - It would be easy to send teachers electronic format of their material before hand if they needed it.
        - CSIRO could make things bigger before hand if they knew what font size worked best for the student.
- Presentations:
    - The presenters could try and make things more descriptive when they are explaining things.
- Safety:
    - It might be a safety issue sometimes for students to feel certain activities.
    - You would need more assistants for activities.
- Activities:
    - You could take the experiments out of the program that cannot be easily adapted.
    - You could "triplicate" experiments so that more students can do the same experiments.
        - Make extra copies of useful programs.
    - This would change the amount of students that could be in a group to do the programs.
    - As long as it does not affect the integrity of the program, you can take some of the programs out.
- Worksheets:
    - They could easily enlarge the worksheets for those students if that helps.
    - The worksheets could be changed to take away scientific skills (observational skills).
    - You could limit how much they need to write.
    - Make some worksheets simpler and use them when there is a student with a disability.
    - They could incorporate more discussion about what they have learned.

Energy:

- Will the ball smasher activity work for students?
    - They could feel and smell the affect of the balls smashing together.

Forensics:

- You could make the colour changes more obvious.
- Make the DNA raised.
- The fabric experiment is different for primary and secondary students.
    - Primary: look at fabric under a microscope.
    - Secondary: Could make it smell for them?
- Chromatograpy:
    - Merrin wants some time to think about this one.
    - Complex textures might not get it across.
    - The point of this activity is to DO chromatography.
- Ballistics:
    - Is it worth the time to adapt this one?
        - It could potentially be made.
- Dental Records:
    - Plaster of Paris could be used to look at the differences between different bite marks.
    - You would need to buy them.
    - Mouth guards could work really well.
- Labelling:
    - Labelling them with numbers would not be as effective because you loose the connection with identifying who it might be.
    - Using numbers actually makes it more confusing for the students. (Has been done before).
- Face Reconstructions:
    - Not relevant; just something extra.
    - It is an activity that the teachers cannot do which is important to keep a part of the programs.
    - You could take it out but it's fun for the students.
    - You could make it larger → Maybe get a projector for it or hook it up to a television. (Most schools have a TV that you can use).
- Chemical Reactions:
    - Making them smell could make people sick.
    - You could do different tests, though, which have different types of reactions.
- You could tell the students what is on there; blood or no blood.
- You can make sure that you have fresh play dough for the face sculpture so that the play dough does not fall off.
    - The new heads might be harder to use?

Natural Disasters:

- This is a fairly complex program.
    - There is a lot of timing and measurement.
- Different activities could be incorporated into it?
- You could make models of the waves that are usually seen through the slinky/rope activity.
- There is a program for the plate tectonics movement that is on a computer.

    - Enlarge/magnify it?
- Density:
    - The density experiment would be "a bit odd."
        - Can you feel the difference?
        - Does it get the concept of density across?
    - Volcanic rock is a necessity; it's what makes the activity so cool. (Only non-replicated part of the program; the rocks are actually from a volcano).

Disability Experience:
- She has had special needs kids in her classes but they had an aide that helped them.
- When speaking to ESL students, you speak to them differently.
    - She made sure that she showed them what to do.
    - She talked less and slower.
    - She said everything once.
    - She kept it to 1 or 2 concepts (simplified things).
    - Changed the presentation style in general.
    - All of the activities stayed the same.
- She makes sure that when she presents, the students don't HAVE to read the instruction sheets.

Appendix L Barrier Checklist

AUDITORY Barrier Checklist			
Task	***Barrier Present?***	***Barrier***	***Possible Solutions***
Reading (Labels, Instructions, Visual Displays)			
Reading a container label		Comprehending instructions	
Reading Instruction Sheet		Comprehending instructions	
Communication			
Listening to Verbal Instructions		Cannot hear instructions	
Students not facing each other		Cannot read lips/hear/sign during discussion	
Asking teacher/presenter/students questions		Cannot communicate verbally	
Presentation			
Presenter getting student attention		Cannot hear presenter	
Evaluation			
Evaluation in written form		Often cannot connect idea with written communication	
Other			
Sensory Overload		Multiple pieces of information delivered through one sense	

MOBILITY Barrier Checklist

Task	*Barrier Present?*	*Barrier*	*Possible Solutions*
Moving Substance			
Moving powder from one container to another		Holding containers, picking up powder, getting powder in potential narrow opening	
Moving a liquid from one container to another		Pouring Liquid, accuracy of pouring liquid	
Pipetting		Manipulating pipette, feeling the two different settings, discharging tip	
Moving/Manipulating Objects			
Pages to flip		Difficult to grasp and separate pages	
Applying force to move an object, pushing/pulling		Not strong enough to push/kick object, cannot apply focused force (only blunt force)	
Turning handle/crank		Strength required, range of motion required	
Shaking/Stirring		Holding container, shaking movement	
Twisting cap/Snapping cap on/off		Holding container, rotating cap, specific application of force to snap off cap	
Object difficult to hold onto		Object either too large or small for student to grasp and hold onto (i.e. rope, slinky)	
Measuring			
Measuring volume of a liquid		Adding/removing substance, accuracy of adding/removing substance	

		to get target mass	
Weighing mass of a solid		Fitting pieces together, holding pieces in one place, applying force to connect pieces	
Assembly			
Assembling device		Movement is not at level that can observed (table height to high, floor can't be seen)	
Tools			
Stopwatch		Manipulating stopwatch	
Calculator		Buttons too small, holding calculator	
Evaluation			
Evaluation in written form		Cannot write answer on sheet	
Activity Location			
Activity based on floor		Cannot reach from their wheelchair	
Activity based on desktop		Cannot reach from wheelchair	
Other			
Repetitive handling		Fatigue	
Work rate imposed by a process		Student must work faster than he or she is able	
Stooping		Reaching down to the floor to complete an activity	
Reaching upwards		Object is too high and out of student's reach	

Pushing or pulling		Student is not strong enough to push/pull object	
Holding loads of weight from the torso		Student is not strong enough to support load	

VISION Barrier Checklist			
Task	***Barrier Present?***	***Barrier***	***Possible Solutions***
Moving liquid or powder			
Moving powder from one container to another		Measuring proper amount of powder, getting powder in potential narrow opening	
Moving a liquid from one container to another		Pouring Liquid, accuracy of pouring liquid	
Pipetting		Seeing how/where the liquid is discharged, adjusting the pipette for different volumes	
Measuring			
Measuring Volume of a liquid		Pouring Liquid, accuracy of pouring liquid, reading measurement on epindorph	
Weighing mass of a solid		Reading output of scale, accuracy of adding/removing substance to get target mass	
Reading Angle		Cannot see protractor to read angle measurement	
Reading (Labels, Instructions, Visual Displays)			
Reading a Container Label		Cannot see print, contrast	
Reading Instruction Sheet		Cannot see print, contrast	
Reading a PowerPoint		Cannot see print, contrast	

Reading a poster/visual display		Cannot see print, contrast	
Map		Cannot see locations or attributes of different parts of the map	
Booklet/pamphlet/etc with pictures		Cannot see picture	
Movement			
Observing gas behaviour		Cannot see movement of gas	
Observing Liquid Movement		Waves, currents, cyclone movement, rising/sinking due to density, viscosity	
Observing displacement/movement		Observing acceleration, measuring distance between initial and final location	
Timing object movement		Observing when object has moved desired, seeing how much time has elapsed on the timer, knowing which buttons are start/stop/reset	
Presentation			
Descriptions do not coincide with hands-on availability		Student cannot feel object as is being described (i.e. describing foreign object student has never felt before)	
Observing Liquid Properties			
Dissolving solid in liquid		Observing rate of dissolution, measuring how dissolved the solid is	

Seeing separation in liquid		Cannot see precipitate, separation (i.e. water and oil due to density difference)	
Colour			
Colours used are of significance		Specific shade corresponds to a pH, commonly known object	
Colour changes		Cannot detect changes in colour	
Tools			
Stopwatch		Seeing which buttons are stop/start/lap reset, reading output	
Reading meter output		Setting meter, seeing output	
Calculator Use		Seeing buttons, seeing output from calculation	
Evaluation			
Evaluation in written form		Cannot see to write in worksheet	
Other			
Assembling device		Identifying how different parts fit together, fasteners and connectors	

Appendix M United States Interview Contact Information

Professor Martha Cyr
Position: WPI K-12 Outreach Director, Professor of Mechanical Engineering
Date: 06/02/07
Location: Higgins Laboratories, WPI
Interviewer: Nicholas Simone, Erin Vozzola, Lynn Worobey
Contact Information: mcyr@wpi.edu

Anna Gauthier
Position: Studying to be an Interpreter, Teacher of the Deaf
Date: 07/02/07
Phone Interview
Interviewer: Nicholas Simone, Erin Vozzola, Lynn Worobey

Joann Vandyke
Position: WPI Disability Coordinator
Date: 08/02/07
Location: Daniels Hall
Interviewer: Nicholas Simone, Erin Vozzola, Lynn Worobey
Contact Information: jvandyke@wpi.edu

Beth Geary
Position: Special Education Coordinator for Woodman Roberts Elementary School
Date: 19/02/07
Phone Interview
Interviewer: Nicholas Simone, Erin Vozzola, Lynn Worobey
Type of School: Mainstream
Contact Information: bgeary@asd20.org

Kristen Lavergne
Position: Vision Specialist for School District 20
Date: 26/02/07
Phone Interview
Interviewer: Nicholas Simone, Erin Vozzola
Type of School: Specialist
Contact Information: klavergne@asd20.org

Kate Fraser
Position: Science teacher at Secondary Program, Perkins School for the Blind
Date: 28/02/07
Phone Interview
Interviewer: Nicholas Simone, Erin Vozzola, Lynn Worobey
Type of School: Specialist
Contact Information: kate.fraser@perkins.org

Betsy Loring
Position: Exhibit Coordinator, Worcester Ecotarium
Date: 02/03/07

Location: Ecotarium
Interviewer: Nicholas Simone, Lynn Worobey
Contact Information: bloring@ecotarium.org

Rebekah Marchilena
Position: Science Teacher at The Learning Centre
Date: 02/03/07
Location: The Learning Centre
Interviewer: Nicholas Simone
Contact Information: Rebekah_marchilena@tlcdeaf.org

Appendix N Australian Interview Contact Information

Marie Fram, St. Alban's East Deaf Facility
Position: Program Coordinator for Deaf Facility
Date: 19/03/07
Location: St. Alban's East Deaf Facility
Interviewer: Nicholas Simone, Lynn Worobey
Type of School: Mainstream
Contact Information: 03 9364 5890

Elaine Rosewarne, Yarrabbah
Position: Science Coordinator
Date: 21/03/07
Phone Interview
Interviewer: Erin Vozzola
Type of School: Mainstream
Contact Information: 03 9580 0384

Lynn Deering, Diamond Valley Special School
Position: Assistant Principal
Date: 21/03/07
Phone Interview
Interviewer: Lynn Worobey
Type of School: Specialist
Contact Information: 03 9432 1022

Nicola LaClaude, Peninsula Special Developmental School
Position: Leading Teacher
Date: 21/03/07
Phone Interview
Interviewer: Lynn Worobey
Type: Specialist School
Contact Information: 03 5987 2649

Adam Broomfield, Cheltenham Secondary College
Position: Student Wellbeing Coordinator
Date: 21/03/07
Phone Interview
Interviewer: Lynn Worobey
Type: Mainstream School
Contact Information: 03 9555 5955

Mary Azer, Serpell Primary School
Position: Assistant Principal
Date: 21/03/07
Phone Interview
Interviewer: Lynn Worobey
Type of School: Mainstream
Contact Information: 03 9842 8182

Jane Dadge, South Gippsland Specialist School
Position: Principal
Date: 21/03/07
Phone Interview
Interviewer: Lynn Worobey
Type of School: Specialist
Contact Information: 03 5662 5896

Annie Edgerton, Swan Hill Special School
Position: Science Teacher
Date: 21/03/07
Phone Interview
Interviewer: Lynn Worobey
Type of School: Specialist
Contact Information: 03 5032 3683

Richard Hall, Wangaratta District Specialist School
Position: Science Teacher
Date: 21/03/07
Phone Interview
Interviewer: Erin Vozzola
Type of School: Specialist
Contact Information: 03 5721 7424

Bruce Schmidt, Victorian Department of Education
Position: Science Project Officer
Date: 21/03/07
Phone Interview
Interviewer: Erin Vozzloa
Contact Information: 03 5337 8444

Jim Bond, Victorian Department of Education
Position: Manager of Student Learning
Date: 21/03/07
Phone Interview
Interviewer: Lynn Worobey
Contact Information: bond.jim.r@edumail.vic.gov.au

Veronica Pinney, Warracknabeal Special School
Position: Principal
Date: 21/03/07
Phone Interview
Interviewer: Erin Vozzola
Type of School: Specialist
Contact Information: 03 5398 2564

Paul Baker, Victorian Department of Education
Position: Middle Years Coordinator Officer
Date: 21/03/07
Phone Interview

Interviewer: Erin Vozzola
Contact Information: 03 5337 8444

John Geddes and Jenn Cavanagh, Sunshine Deaf Facility
Position: Sunshine Deaf Facility Coordinator, Teacher of the Deaf
Date: 22/03/07
Location: Sunshine Deaf Facility
Interviewer: Nicholas Simone, Erin Vozzola
Type of School: Mainstream
Contact Information: 03 8311 5252

George Del Papa, Bellarine Secondary College
Position: Year 10 Science Teacher
Date: 26/03/07
Location: Bellarine Secondary College
Interviewer: Nicholas Simone, Lynn Worobey
Type of School: Mainstream
Contact Information: 03 5251 9000

Jenny Wishart, Bellarine Secondary College
Position: Specialist Teacher Coordinator
Date: 26/03/07
Location: Bellarine Secondary College
Interviewer: Nicholas Simone, Lynn Worobey
Type of School: Mainstream
Contact Information: 03 5251 9000

Joanne Anderson, Warrambool Senior Special School
Position: Classroom Teacher
Date: 27/03/07
Phone Interview
Interviewer: Erin Vozzola
Type of School: Specialist
Contact Information: 03 5561 1711

Sandra Greaves, Heather Saynor and Di Cantwell, East Ringwood Deaf Facility
Position: Teachers of the Deaf
Date: 27/03/07
Location: East Ringwood Deaf Facility
Interviewer: Nicholas Simone, Erin Vozzola
Type of School: Mainstream
Contact Information: 03 9870 6105

Elizabeth Grover, Aurora School
Position: Head of School Based Programs
Date: 28/03/07
Location: Aurora School
Interviewer: Nicholas Simone, Erin Vozzola
Type of School: Specialist
Contact Information: 03 8878 9878

Julie Gillespie, Yarra Valley Grammar School
Position: Head of Hearing Unit
Date: 28/03/07
Phone Interview
Interviewer: Nicholas Simone
Type of School: Mainstream
Contact Information: 03 9262 7700

Erica Povey, Ballarat Deaf Facility
Position: Deaf Facility Coordinator/Teacher of the Deaf, Ballarat Primary and Secondary Schools
Date: 29/03/07
Location: Ballarat Deaf Facility
Interviewer: Nicholas Simone, Lynn Worobey
Type of School: Mainstream
Contact Information: 03 5339 1202

Garry Stinchcombe, Burwood Education Centre
Position: Assistant Head of School and Support Skills Coordinator
Date: 02/04/07
Location: Burwood Education Centre
Interviewer: Nicholas Simone, Erin Vozzola, Lynn Worobey
Type of School: Specialist
Contact Information: 03 9808 6422

Colin Johanson
Designer and Director for COOL Mobility
Date: 15/04/07
Interviewer: Nicholas Simone, Erin Vozzola, Lynn Worobey
Contact Information: colin@coolmobility.com.au

Elaine Harrison, Glen Allen Specialist School
Position: Teacher, Mobility Specialist
Date: 16/04/07
Phone Interview
Interviewer: Erin Vozzola
Type of School: Specialist
Contact Information: 03 9561 1966

Jeremy Brett, Victorian College for the Deaf
Position: Science Teacher Year 8,9,10 and Math Teacher Year 10 and VCE
Date: 19/04/07
Location: Victorian College for the Deaf
Interviewer: Nicholas Simone, Erin Vozzola, Lynn Worobey
Type of School: Specialist
Contact Information: 03 9510 1706, brett.jeremy.t@edumail.vic.gov.au

Appendix O Interviews Conducted in the United States

Professor Martha Cyr
Position: WPI K-12 Outreach Coordinator, Professor of Mechanical Engineering
Date: 06/02/07
Location: Higgins Laboratories, WPI
Interviewer: Nicholas Simone, Erin Vozzola, Lynn Worobey
Contact Information: mcyr@wpi.edu

- Programming offered by WPI
    - WPI offers 3 types of programming
        - Direct student experiences
            - Students come to campus for the afternoon
            - Frontiers Program over the summer (High School age students)
            - Programs for girls entering 7^{th}-12^{th} grades
        - Professional development for K-12
            - Done for teachers from elementary school up
            - At the high school level help teachers think of engineering applications, show them how to use such applications, seek to engage kids not just make them memorize materials
            - Most teachers who are not high school teachers have a weak background in math and science, professional development seeks to stop perpetuating the cycle
            - Students are tested annually on state standards – for kids tested at elementary school level the teachers do not have the experience to properly educate the students
        - Providing resources
            - Teachers can borrow kits
            - Activities are developed that the teachers can use
- Previous experience working with students with disabilities
    - Professor Cyr has not had any previous direct experience with students with disabilities in her outreach work through WPI. Professor Cyr did not have any specific advice about how to integrate adaptability into existing programming however did comment she believed we would need to narrow our focus.
    - There are two levels of interaction incorporated to programming at WPI. The goal of programming is to make it so that these differences are accommodated for within the program. Programs have both 'advanced' and 'beginning' level worksheets. An example of a difference between the two is that for those with language disabilities there is less text and more picture content without making the sheets look different at first glance.
- Suggestions for the group
    - Professor Cyr believes that the biggest obstacle with this project is it currently calls for adapting such a wide variety of disabilities. In developing a framework we will need to focus on the underlying concept students should be walking away with.

Anna Gauthier
Position: Studying to be an Interpreter, Teacher of the Deaf
Date: 07/02/07
Phone Interview
Interviewer: Nicholas Simone, Erin Vozzola, Lynn Worobey

- Description of position
    - Studying to be an Interpreter for education, middle school to college
    - Has been teaching deaf students for many years
- Experience with science
    - Worked as an interpreter, dealing only with communication; does not do any education/modifications
    - Adaptations for education in general: must provide access to spoken language
    - Labs in print
    - Media captioned
    - Very broad spectrum: from totally deaf to only some hearing loss
- Labelling
    - USA
        - Deaf: Reserved for those that use sign language as main form of communication
        - Hard of Hearing: Still use English language to communicate
- Picture cards
    - Good for Little kids but lack of hearing has nothing to do with command of English language
- Language Development
    - Many children are not diagnosed until 3,4,or 5 years old, so they end up starting language development later
- Suggestions
    - Meet with school for the deaf
    - Meet with deaf people to figure out labels

Joann Vandyke
Position: WPI Disability Coordinator
Date: 08/02/07
Location: Daniels Hall
Interviewer: Nicholas Simone, Erin Vozzola, Lynn Worobey
Contact Information: jvandyke@wpi.edu

- Resources used to determine what accommodations to make for students
  - "Do-it" website
    - Outlines programs for K-12, focuses on making science labs available to students with disabilities
    - The site is strictly about disabilities, it provides sample PowerPoint's for presentations as well as suggestions for universal design.
    - The site is out of the University of Washington
- Accommodations
  - Accommodations are what schools must provide whereas universal design is focused on creating accessibility for everyone. Examples of this include printing handouts and sending emails it bigger font.
  - Universal design focuses on being proactive as opposed to reactive
  - An example of universal design is closed captioning on videos
- What WPI is required to do for students with disabilities
  - At the college levels there are specific laws that administration must comply with to provide accessibility in the educational setting.
    - For example, can alter class so student doesn't have to do public speaking or a class in Stratton Hall has to be moved to another building to be accessible.
    - In college it is not about success but accessibility: Joann's job is to level the playing field for those with disabilities. Other examples include for those with slower processing more test time is provided or scribing is provided for those who cannot write.
  - The disabilities office is required to provide for all students that are qualified to gain acceptance to WPI and take courses here
- Adapting programs for students with different disabilities
  - There was a blind student in years past at WPI however Joann is unsure that they took any science labs, was a CS major
  - Hearing impairment would not be difficult to accommodate in the lab
- How accommodations are put in place
  - Most of the accommodations WPI makes are reactive
  - The procedure Joann follows is the student must first prove they have a disability. This is done by going to a doctor or evaluator who provides guidelines as to how to accommodate the student. Following this Joann works with the student to develop a plan and checks in on the success of the plan.

Beth Geary
Position: Special Education Coordinator for Woodman Roberts Elementary School
Date: 19/02/07
Phone Interview
Interviewer: Nicholas Simone, Erin Vozzola, Lynn Worobey
Type of School: Mainstream
Contact Information: bgeary@asd20.org

- Description of Position
  - Beth works with core professionals that go into the classroom with the students
- How accommodations are made
  - A lot of the programming Beth does very much depends on the student
  - Beth has seven students in her room, each with very different needs
  - Often students are pre-taught information before learning it in the regular classroom.
- How programs are evaluated
  - Programs are evaluated on an individual basis.
  - The students have Individual Education Plans (IEP's) as well as individual goals set for them.
- Follow up information
  - Beth will fax us information about general information for students with disabilities
  - Beth will also send a hands-on science book to us with Erin's dad that outlines adaptations so we will have that once in Australia
  - Beth gave us contact information for the Vision Specialist in her district: Melissa Shular, mshular@asd20.org

Kristen Lavergne
Position: Vision Specialist for School District 20
Date: 26/02/07
Phone Interview
Interviewer: Nicholas Simone, Erin Vozzola
Type of School: Specialist
Contact Information: klavergne@asd20.org

- Job Description
    - Teacher of Visual Impairment, as well as orientation/mobility impairments
    - Pre-High School
- Biggest obstacle in adapting science programs
    - Being able to do labs and see all experiments and demos, especially upper level academics (biology, chemistry, etc.)
    - Many just have low vision – cannot see minute details
- How students are accommodated
    - Talk with teacher and make accommodations
        - Example: 10th grade Biology Lab
            - She went and verbally explained what was going on in the lab
    - Pair the student with student who can say what is happening
    - Television with tray underneath: anything placed on tray is magnified as much as you want
    - Use either colour or black and white, some children see better in one or the other
    - Modifications usually on case by case basis
    - General adaptation: Auditory/verbal description and using a hands-on approach
- Student aid
    - Assistance is provided on a case by case basis, but usually have a lab partner anyway
- When accommodations are made
    - Class setting – all accommodations made ahead of time
    - Teachers tell what they are going to teach and accommodations are given, which teacher implements
- How adaptations are evaluated
    - Ask – Did that work for you? Could you participate and get everything?
    - Can see with test performance if modifications worked
    - Teacher may know just from class ("I could tell she understood because the next day, she participated a lot", etc.)
    - If totally blind CC television would no work – use tactile diagrams instead
        - Example – bug (many already available)
        - If teacher looking at a specific part of the bug and insect is opened up, mimic with tactile diagram
        - Could just use Arts and Crafts stuff
        - Be Creative!!
    - Know student and what works for them
    - Many may not be good with tactile diagrams and auditory cues should be used unless use Braille
    - Tactile diagram = model of ANYTHING

    - Chemical molecules, maps, bugs, etc.
- Going over material beforehand with the students
    - More done with high school because of level of difficulty of information
    - Example: Model solar system w/ tactile diagram and go over with student before class. Then will have model, etc. in class already

Kate Fraser
Position: Science teacher at Secondary Program, Perkins School for the Blind
Date: 28/02/07
Phone Interview
Interviewer: Nicholas Simone, Erin Vozzola, Lynn Worobey
Type of School: Specialist
Contact Information: kate.fraser@perkins.org

- Job description
  - Kate is a full time Science teacher at Perkins
    - School is divided into programs
      - Secondary program is for upper middle school to high school students
    - 2 science teachers
    - Generalist teachers also incorporate science into class, no science background necessarily
    - Kate has been in this program for 10 years, at Perkins for 30 years
- How accommodations are made
  - Individual accommodations
  - Must adapt for particular group
  - Totally blind students – make activities as tactically as possible
    - Plastic beakers for measuring
    - Preset syringes rather than expect the students to get accurate measurements by pouting
    - Allows to safely draw up chemicals
  - Place in California – SAVI Science ("Science activities for visually impaired")
    - Developed Foss science modules
      - Marketed through science distributors, originated out of a grant
      - Very hands on for mainstreamed students, universal type of teaching
  - SAVI/SELPH Centre for multi-sensory learning
    - Produced modules aimed at kids with different physical and educational disabilities
    - Many have gone out of print
  - All programs must be adapted individually
  - Contrast is important for low vision students
  - A lot of organizational strategies and trays are used to organize materials
  - American Printing House for the Blind (APH)
    - Usable periodic tables in Braille, comes with book
- Classes at Perkins
  - Five blind kids in her chemistry class
    - Key = need small classes
    - More one on one time
    - Usually in mainstream schools have a one on one with a program aid
    - At Perkins have small classes and do more group work
- Tactile models
  - Tactile models from APH
    - Suggests buying the book "Basic Science Tactile Graphics" put out by APH
      - Contains teaching suggestions

            - Discusses how to use tactile graphics
        - Website for APH → get catalogue
        - Models of eye, seed, etc
            - Try to use the real thing though whenever possible
        - Weather fronts model
            - Lows are jagged lines and highs are smooth rounded lines
            - Snowflakes on maps
        - APH is where to go to get resources
        - For biology purchase more expensive cell models (like those used by doctors)
            - Full size skeletons
            - Organs of body and life size heart model
            - Hands on DNA model
- Adaptations made at Perkins
    - At Perkins they have one staff member to adapt materials
        - Must be meaningful adaptations
    - It is important to note if the student has visual memory or if they were blind since birth because if were blind since birth they cannot make analogous comparisons
        - Video of a cell from NOVA describes a cell as looking like a fried egg, this is not a good analogy
    - Measuring and Weighing are very difficult to do!!
        - Many students don't understand pounds, feet, etc
        - Measurement concepts are very hard to communicate
        - Braille rulers in inches/metres
        - Talking tape measure from England [Cobalt speech master talking tape measure]
        - Measure liquid with verbal outputs
        - Talking scale
        - APH has a colour metre
            - Noise to say when it turns on, place it against something (better for solid objects than for liquid) and will say colour
- Impact has technology had on your approach to adaptations
    - Because of technology students are able to participate more
        - Screen readers
        - Computer voice input/output
        - Trying to purchase scientific probe ware to be compatible with laptops
            - Would allow students to get verbal output about data being collected real time
- Other programs Perkins is involved with
    - Perkins has an International outreach program
        - Mostly in South America, Africa, Middle East, Armenia, China, Poland, Russia
        - Trying to develop service for kids who are blind/deaf blind
        - Targeted countries where it is the worst
        - 'Hilton Perkins Program'
            - $$ from Hilton Hotels
            - More information on website
                - Email people who do this??

- Other Literature
    - For literature on grants:
        - Check website
        - Resources
            - Guide: “activities in daily living for multi-impaired kids’
        - Website: Texas school for the blind
            - Much better publications than Perkins
- Measuring success
    - Spent summer for assessment measurement, not yet completed
    - Try something, adapt it, try it again
    - Criteria:
        - Efficiency – work simplification tasks
            - Is it the most efficient way to get the desired outcome?
    - Several iterations → design process
- Universal Design
    - Universal Design for Learning Website
        - Professor at Springfield Technical College
    - CAST website
        - Basically discusses Universal Design
        - Founded in 1984 – a lot of Universal Design/Accessibility was happening at this time
        - Multiple means of representation, expression, engagement
        - Learning disabilities as well as sensory and physical disabilities
- Email her updates!

Betsy Loring
Position: Exhibit Coordinator, Worcester Ecotarium
Date: 02/03/07
Location: Ecotarium
Interviewer: Nicholas Simone, Lynn Worobey
Contact Information: bloring@ecotarium.org

- Museums and Accessibility
  - Museum of Science and Natural History
    - They were successful not only in increasing accessibility but also increasing holding time
    - Mulitsensory displays are better for all
      - Auditory, visual, proprioreceptive
- Determining if patrons are learning/understanding the material:
  - Just presenting does not equal learning
  - Discovery is learning
  - Dinosaurs example
    - Measure foot prints and based on the distance between footprints it is possible to tell how fast the dinosaur was moving and based on that what type of dinosaur it was
    - Kids were able to measure distances
    - Kids were also able to use chalkboard paint on their feet and run around an area so they could make 'dinosaur tracks'
    - Other kids would have to draw out the paths their friends went on
    - Once the kids figured out how fast the dinosaur was moving they could set the treadmill to that speed and see how fast it was
- Testing modifications:
  - Build prototype
  - Print instructions
  - Listen to conversations among visitors to hear if they 'got it'
  - If people struggle with the exhibit prototype/can't figure it clues are given, see what works to get the visitor to understand it
  - Talk to people as they get stuck, ask them what they think the meaning of different parts are → it is all about what the visitors get out of the exhibit
- Look for unintended things people do at exhibit
  - Pollution example: marbles were runoff and would travel down
    - Were called pollution and everyone understood, called pollutants and people didn't know what those were
    - When the exhibit reset itself people thought that was part of the process, people must either not see that part or understand that it is resetting
    - If they don't understand it's resetting they add meaning to that action which is not desired
- Writing labels:
  - If you need to use a complicated word first think, if I crossed out the word would the sentence still make sense?
    - Free Persian kittens example
  - Chunk text
    - Varying sizes
    - If just read headlines should still be able to understand

        - Heading
        - General overview
        - ‘Geeks’
  - Constantly think, if I cross this out will it still make sense?
  - Distil down your information
  - Duck example
    - Bird dictionary, wanted to write a lot but limited self to2 sentences or 1 idea otherwise people won’t get the concepts you want them to
  - Don’t teach 2 things with one lesson, less real learning from this

Rebekah Marchilena
Position: Science Teacher at The Learning Centre
Date: 02/03/07
Location: The Learning Centre
Interviewer: Nicholas Simone
Contact Information: Rebekah_marchilena@tlcdeaf.org

- Job Description
  - Teaches Chemistry, Biology, Anatomy, and Technology
  - Makes all lectures and labs: **Given two separate lectures to look at**
  - Ages 13-22
  - Been teaching at the TLC for four years
  - Classes are sign only
- Visual Adaptations
  - Get majority of information through their eyes
  - Directions given pictorially, in English, and sign
  - Lectures on PowerPoint: every slide has pictures
  - Adapt for other disabilities too
  - Hands-on very important
  - Auditory part very important still: some still have hearing
  - Technology helps: lots of computer programs very good
  - Entirely deaf classroom different than mixed
  - Building a lab
  - NSTA Guide to School Science
  - Semi Circle good
  - Big Tables
  - Shelves on desks are bad, as is anything that blocks vision
  - Set up must ensure that instructor is visually accessible
  - Some facilities use FM intercom system: picks up voices and plays in earpieces
  - Lab benches along walls are bad: cannot see each other, coming up behind children does not work - centred bench works better.
  - Make sure communication is visible: positioning is very important
  - See through cabinet doors work well
  - Must always look at child: don't look at board, etc.
  - Open doors are bad: background noise
  - Ready made kits: sometimes can be a good starting point
  - Take a lot of pictures for labs: photograph labs to add to instructions
- Things to keep in mind and look at when making adaptations
  - Needs are many times different for each child
  - Who is in your class? How many are in the class? What are their needs?
    - Many different cases
  - Safety is important
    - Goggles must be scratch resistant, vented
    - Make students comfortable
  - Adaptations are a lot of trial and error
  - Hands on and visual are very important
    - Example: Popsicle sticks used as chromosomes to teach genetics
  - Deafness not considered a disability
- Room

    - Eye catching: posters work well
        - Change everything around
    - Make sure students have access to everything
    - To get attention: stomping or flashing lights works well
        - Concrete floor is bad – no vibrations
    - Laptop and LCD projector very helpful
- Different forms of assessment
    - Video tape signing
    - Skits
    - Poetry
- Suggestions for the project
    - Do all deaf kids grow up learning sign language in schools?
        - Might be on a school to school basis
    - When arrive in Australia, find out how language and everything works

Appendix P Interviews Conducted in Australia

Marie Fram
Position: Program Coordinator for Deaf Facility
Date: 19/03/07
Location: St. Alban's East Deaf Facility
Interviewer: Nicholas Simone, Lynn Worobey
Type of School: Mainstream
Contact Information: 03 9364 5890

- Information about Australia/St. Albans
  - 22 out of 365 kids with hearing loss
  - St. Alban's is a mainstreamed school
    - Most vision students are mainstreamed instead of having a specialist school, a lot of technical support for them in the mainstreamed environment
  - St Paul's
    - School for students with multiple disabilities
  - Fifteen deaf facilities throughout the state
  - Most of the time at St. Alban's students are in the mainstream class
    - Usually they are taken out to work on speech and listening
    - Teacher of deaf also work some in the classroom with students
    - Special education students really need to start off the learning with a good example and then follow up on that
- Evaluation and determining success
  - Trying to figure out when it is that deaf people learn certain language skills
    - Example: raising eyebrows indicates asking a question.
  - Evaluation
    - Generally will give them the option of choosing which answer is right rather than having them say and formulate the answer
  - How success is determined
    - Answer the question is the student meeting the basic goals of the activity
  - Schools have a formal listening/speech/language assessment
  - Looking for a sign language assessment
    - Behind in this because Auslan was only recognized as a language in 1987 while in the US sign language was recognized as one in 1967
- Barriers
  - There is a barrier in language
    - Example: only one sign for run yet it has many meanings in the English language
  - It is important to note that a student without hearing may also have another problem in their brain which leads to speech and language problems
  - Reading language is not the same as speaking and understanding talking
  - Just signing to a student does not mean they are understanding the material being presented
  - Problem with deaf students is they learn to be compliant
    - Often will not reply to question even if they know the answer
    - They are conscious of their speech and often worry others won't understand it so don't say anything

- Deaf students often know the answer but do not have the verbal connection to communicate it
  - Deaf students often get bogged down in the words
- Shades of meaning are difficult to communicate with deaf students
  - Example: they are often only told happy and sad in signs, there is no in between which allows them to communicate other emotions
- Energy example
  - Is a very abstract idea
  - Difficult to communicate to deaf students
  - Broke energy down into three types: battery, you plug it in, you generate it yourself (riding a bike)
  - Did lots of experiments with the students
  - Very hard because students got caught up in the words
  - Regular classroom wasn't taking the same approach deaf teacher was, this made it difficult
- Deaf kids are behind in language skills
  - Often not discovered they are deaf until they are two years old, this already puts them behind other students
  - Chronological age may be 11, while learning age might be 9
  - In 12 months the student might only progress 4 months in language skills
- Deaf have problems with this, the, s's at the end of words
  - Habitual tense is a problem – Mum comes to school on Mondays
    - S contains the hidden meaning of the word
- Cannot assume deaf students understand material even if they are saying the words
- With deafness and signing to say something you go straight from point A to point B however with someone who hears normally they are often rather verbose and not direct in their wording
- Intellectual disabilities are often obvious (you can see the child doesn't understand) however deaf children look very intelligent and it is harder to see if they are understanding
- Classes often place value on concrete material
  - Children get tired of this

- Adaptations
  - Deaf is defined as a cultural and linguistic difference
  - To adapt for deaf students you need to use simple language without being baby-ish
  - Teachers often use adaptations in their classroom that special education teachers have made for the deaf students
  - To teach deaf students break down material to the guts and be graphic in lessons
    - Get information into simplest form then add more language and bring it back up to a higher level of understanding
  - Deaf teachers see written goal that students are to accomplish
    - Goal is broken down into smaller goals
    - Information is made pictorial
    - Example: Rules and Neighbours
      - Presented to regular students as legislation and how countries and legislature, etc → Australia being friends with its neighbours
      - Deaf teachers determined that the main goal of the lesson was learning about rules and neighbours

        - Broke it up into three different levels: local, state, federal
        - For each level has sheet with picture of a government person as well as a picture of the level (for state picture of Victoria), the name of the leader, and a picture of the leader
        - Who is charge at home? Who are neighbours at home? Same questions for school and for Australia
    - Sheet given to other students was an overload of information, deaf teacher broke it down for students
- It is not a matter of teaching year 6 students grade 2 level material but rather cutting to the chase of the information for year 6 student material
    - Year six students still have world experience
    - Children are often aware if they are presented material below their learning level
- Teachers of deaf often step in during writing sessions
    - News for primary kids example
    - Deaf students often have lower language skills, they are in the classroom for the regular time and often taken out for another block ahead of time before class
- The best approach is simple experiments and the use of pictures
- Interpreters are often in the classroom
    - Whether there are interpreters though is a loaded political question in Australia
    - Teachers of the deaf will often sign but this is not the same as an interpreter
    - Interpreters are not paid well in the schools so teachers of the deaf often sign to students
    - Teachers of the deaf are full time in the classroom and will teach/sign as necessary
- Important to focus on how you can illustrate concepts
    - Words are for those who are deaf
    - Ask yourself – is what you are teaching at the level of the kids?
- Example of student wanting to buy something at the canteen
    - Child doesn't understand money
    - Children match coins with pictures of them on printed sheets
    - Use printed pictures to help illustrate the item to buy, example lemon mineral water ahs a picture of a lemon as well as a bottle of water
        - Must break things down for the students
    - Learn that two 50 cent pieces make $1 note
- Technology programs which generate pictures
    - Writing with symbols
        - Has different picture lists by country: Australia, United States, England
    - Clicker 5
- Some students learn sign language
- All students are equipped with hearing aids, some have cochlear implants (6 at this school)
- Teachers wear FM system
    - 1 metre is optimal listening distance
    - With FM system can have this level of hearing even with student sitting in the back of the room

- Some students have integrated aides, this is externally funded though
- Most deaf students have a hearing teacher
- Process of teaching is do it, talk about it, do it again
- Prep material = GREAT
  - The more information they receive ahead of time, the better
- Touch is a good way of learning, get the ideas out of the abstract
  - Example seeing astronaut food and how an astronaut goes to the bathroom in space

- IEP's
  - Aussie has IEP's
    - Not cut and dry like the states
    - Not like today is Thursday we will do ___, Wednesday we will do ___
    - Rather, teachers here would look at goals for children
      - IEP focuses on language, listening activities, 's', etc
      - Individual goals based on what done before and goals accordance with VELS
      - Difficult to put time period on goals
      - IEP = developmental
        - Start with I have no biscuits
        - Build up to I haven't got any biscuits
- Interaction with students who are not deaf
  - Communication between students
    - Is difficult
    - Does happen though (i.e. communicate in sandbox at recess)
    - Other students like Auslan
      - It's like a secret language they can know
  - Many kids who are not deaf watch interpreter
  - Hard for deaf students to understand what interpreter means
    - One language with FM of teacher
    - One language seeing with interpreter
  - Important for presenter/teacher to repeat questions children ask during class if they are the one that have the FM device on as the deaf student cannot hear other students
- Deaf in Australia
  - In Australia they do not use 'hearing impaired' but rather deaf
    - Hearing impaired sign in Auslan has 'bad' in it, deaf do not like this association
    - Refer to selves as deaf
    - At St. Alban's use deaf for all students
    - In other locations deaf means can learn through auditory cues while Deaf means sign language is their main form of communication
  - There is not a large deaf population in Australia
  - If a student signs depends on degree of hearing as well as family philosophy
- Follow-up
  - Can feel free to email her for anything in the future

Elaine Rosewarne
Position: Science Coordinator, Yarrabbah School
Date: 21/03/07
Phone Interview
Interviewer: Erin Vozzola
Type of School: Mainstream
Contact Information: 03 9580 0384

- Responsibilities within the school:
  - Provide equipment for science programs at the school.
  - Monitors the budget for science purchases.
  - Makes science boxes with activities in them.
  - Adapts the science activities for a wide range of abilities.
  - Works more with intellectual disabilities.
- Types of Adaptations:
  - Activities are made more concrete.
  - Everything is made more visual (making things visual is key)
  - The students need to see everything happening to get the most out of it.
  - The more hands-on the program is the better
  - Constructed planes and helicopters
    - Made it part way for the students and had them do the rest.
  - Pre-Cut or Pre-Prepare parts of the activity so that students without strong fine motor skills can still do the activity.
  - Made a wide range of activities in the science boxes so that students who are advanced can get a lot out of them and students with more prevalent disabilities can participate too.
  - Apply home type of science experiments to the schools; simple supplies that are easy to find. ("easy access")
  - Sometimes teachers aides are used or volunteers to help with the programs, because certain activities require one on one activity time for the students, so they sometimes add one extra person to staff the program.
- Measure Success:
  - She measures success through feedback from other teachers from her bigger events, such as Science Day. The teachers are all comfortable making adaptations, so they work together to make all of the programs better and more accessible to their students.
    - Working together is integral
- Advice:
  - Chemical Science is good because there is always something visually changing.
  - Make sure that you have a wide range
  - When designing experiments, make sure that they are getting the basic understanding (if you get too complicated, you might loose them).
  - Look for activities that:
    - Are simple in design
    - Don't have too many steps (short instructions)
    - Have a visual change.
    - Keep it interesting
  - Sight:
    - More sensory based learning is important

    - Incorporating touch, smell, and taste
- For students with intellectual abilities, lower level science experiments are best suited for them.

Lynn Deering, Diamond Valley Special School
Position: Assistant Principal
Date: 21/03/07
Phone Interview
Interviewer: Lynn Worobey
Type of School: Specialist
Contact Information: 03 9432 1022

- Contact information
    - Spoke with Assistant Principal
- Types of disabilities
    - Three students in wheelchairs
        - Cerebral palsy
        - Cannot verbally communicate
        - Two walk, one cannot
    - Many autistic students
    - Non verbal students is usually due to epilepsy or no language skills developed
    - All students also have an intellectual disability
- Adaptations
    - Accommodations are done on an individual basis
    - Children are grouped as much as possible by age/disability
        - Some older students are put in work placement
    - There are classroom assistants, not individualized assistants for each student
- Evaluation
    - School has the same outcomes as other high schools
    - Forms of assessment include photographs, videos, oral language, photo stories, PowerPoint's
        - Also commonly use matching
            - Instead of having the student formulate a verbal answer they provide different answers and the students must match the question to the answer
    - To evaluate success have 3 teacher checklists that teachers use, students must demonstrate knowledge and understanding
- Types of science done at the school
    - The school does what is known as moderated science
        - They have no science labs so activities are more along the lines of kitchen science

Nicola LaClaude, Peninsula Special Developmental School
Position: Leading Teacher
Date: 21/03/07
Phone Interview
Interviewer: Lynn Worobey
Type: Specialist School
Contact Information: 03 5987 2649

- Contact
  - Nicola, Leading Teacher
  - Her main project when she came to the school was implementing science in their school, prior to her there was no science program
- Disabilities
  - School accommodates students with mild intellectual disabilities, physical disabilities, students with multiple disabilities, and autistic children
- Adaptations
  - Group classes together as much as possible based on ability
  - First look at the maximum ability of the class and then focus on any outstanding student needs
  - Classes are of six to ten students
- Science program
  - The science program mostly focuses on environmental science
  - It is a very hands-on science program
  - They do not have a science lab as there is no room at the school for one
- Description of Environmental science program
  - Primary School
    - At this age students are mostly beginning readers and most cannot sit still for very long
    - To teach these students most activities are usually game based
    - Rubbish relay – sort garbage into different bins based on its type, if its recycled, etc
  - Middle School
    - More scientific based programs
    - No open flame is used
    - Is mostly kitchen based science
      - How does plastic break down over time? Bury plastic/shopping bags and see what happens
  - Secondary School
    - More inquiry based science
    - Students are immersed in a lot of activities
      - Biodiversity program
      - Took soil samples and looked at what bugs were in there, counted insects, counted birds, organized data in graphs
      - Following this got to decide what they wanted to do next, some decided they were interested in frogs – went and did pH and water tests collecting water in test tubes
    - At this level it is more self directed
  - Mobility impairments
    - All experiments are done collectively, the teacher or aid will act as an extension of the student's body

        - The teacher will be in the front of the class and someone will take the students hand and do the function "someone becomes their body"
    - They want students to have the same learning experience, they would rather alter the learning than the physical experience
- Evaluation
    - What do kids retain?
    - Can they recall data? Can they recall steps of the scientific process?
    - Teachers have a checklist
        - This helps them keep track of the students learning
        - There is no formally testing of the students, rather the teachers determine when the students have grasped the concepts
        - Some students may take a few years to grasp a concept
- CSIRO Education has come to their school and kids have loved the programs
    - The experience the students get in being involved in the action is important
    - Programs they have done are chemistry and natural disasters
        - They loved natural disasters
    - The programs are good because they convey basic concepts and give the students extra exposure she can provide them with in the classroom to different tools/technology/materials
    - Does not believe we need to adapt the programs very much

Adam Broomfield
Position: Student Wellbeing Coordinator, Cheltenham Secondary College
Date: 21/03/07
Phone Interview
Interviewer: Lynn Worobey
Type: Mainstream School
Contact Information: 03 9555 5955

- Students in program
    - 1 student has a chromosome disorder which affects his brain
        - Presents itself as a physical disability
        - Can't lift arms over a certain height
        - In the science lab he has a physically adapted program
    - Other students have intellectual disabilities
    - Intellectual disabilities are externally funded
    - Another student injured in a motor accident
        - Had an operation and will need another
        - Is in a leg brace which is transcutaneous and a wheelchair
- Types of aid
    - School has integration aides

Mary Azer, Serpell Primary School
Position: Assistant Principal
Date: 21/03/07
Phone Interview
Interviewer: Lynn Worobey
Type of School: Mainstream
Contact Information: 03 9842 8182

- Contact
  - Spoke with the Assistant Principal
- Disabilities
  - Disabilities accommodate for include blind, brittle bone syndrome, Aspersers, Autism and social/emotion disabilities
- Accommodations
  - Specific accommodations are made for each student (case by case basis)
  - For blind student:
    - Bright yellow poles
    - Inserts into concrete
    - Playground with rubberized surface
    - No sharp furniture
  - Students with sever disabilities have a teacher's that comes to assist them in the classroom
  - Students are not pulled out of the classroom for special/extra help

Jane Dadge
Position: Principal, South Gippsland Specialist School
Date: 21/03/07
Phone Interview
Interviewer: Lynn Worobey
Type of School: Specialist
Contact Information: 03 5662 5896

- Types of Disabilities:
    - Intellectual Disability is required but other disabilities are sometimes present in the students
- Hands-On Science Activities:
    - Environmental Science Education
    - Cooking (Used to teach science principals)
- Adaptations:
    - Sensory Programs for all of the students.
    - Individually based for each student.
- Determine Success:
    - Students' Engagement Level (if the students are very engaged, the more successful the program)
    - Level of interest of the students (if the students are interested, the more successful the program)
    - Level of Enjoyment (visible with students with disabilities – smiles, laugher, etc.)
    - Comprehension
        - Ask questions to test their understanding
- Suggestions:
    - Make sure everything is visually stimulating.
    - Tactile diagrams and demonstrations are useful and work well.
    - Use computer investigated learning.

Annie Edgerton
Position: Science Teacher, Swan Hill Special School
Date: 21/03/07
Phone Interview
Interviewer: Lynn Worobey
Type of School: Specialist
Contact Information: 03 5032 3683

- Science Programs:
  - Sensory Experiences
  - Hands-On Activities
  - Primary Students → Taste and Touch
  - Older Students: Modified Activities → Rocket Science
- Modifications:
  - Make things part way for some of the students.
    - Ex: Cut out things for the students.
  - Expectations:
    - Some students make the rockets and make them fly.
    - Some students just make the rockets and someone else helps to make them fly.
    - Some students just watch the whole time.
  - Individualized Goals and Program for each student.
- Success:
  - You can tell if the program is a success if the student is engaged and they complete the entire program.
- Every Day Learning Activities in the class (focus on things that are happening around them).

Richard Hall
Position: Science Teacher, Wangaratta District Specialist School
Date: 21/03/07
Phone Interview
Interviewer: Erin Vozzola
Type of School: Specialist
Contact Information: 03 5721 7424

- Disabilities:
  - Intellectual Disability (IQ scale of "immeasurable" to 70).
  - About 80 kids in the school (2 parts to the school):
    - Half have mild intellectual disability (delayed development)
    - Half have a higher disability (autism, Down Syndrome, etc. – don't respond).
- Science Programs:
  - Make rockets.
  - Balloon Launch (make predictions about where the balloons would land)
  - Applied Technology
    - 400 Piece Jeep (took 6 hours to build)
  - "Tom Baller"
    - Made incline and the students had to figure out how to slow the ball rolling time down.
  - The goal is to get kids to do as much as they can.
    - Depends on individual child.
    - Assistance might be necessary for them.
  - The students usually get a pretty good understanding from the activities.
- Modifications:
  - Make things easier.
  - Don't always use technology to make things easier.
  - A lot of extra people are always around to help (25 staff for 75 students).
- Success:
  - Democratic School: The students vote on everything.
    - If they want to do something, they all vote on it first.
  - Look at finished product.
    - Every student does something different.
- Suggestions:
  - Multi-sensory is always good!
  - Keep language simple.
    - "Best Guess" instead of Estimate/Hypothesize

Bruce Schmidt
Position: Science Project Officer, Victorian Department of Education
Date: 21/03/07
Phone Interview
Interviewer: Erin Vozzloa
Contact Information: 03 5337 8444

- Science Programs:
    - VELS
        - Framework for Science in Schools
        - Progression Points for teachers to follow
        - It also points out that you integrate across other areas beyond science.
            - All disciplines include other things → Personal Growth, Communication, etc.
- Primary School
    - There is a challenge of teachers who don't feel confident to teach science
    - DOE Provides resources to support schools to become more confident.
        - "Sample Science"
            - Describes a computer science curriculum for teachers to follow.
            - Prep – Year 10
            - Series of science and technology media resources
        - STEPS, Science Trek
            - Booklets with DVDs and Activities
            - Focus on Hands-On Activities
        - Teachers Online Primary Science
            - Images and Clips
            - CD covering different science areas
            - Frequently asked questions and misconceptions (to prepare teachers to answer students' questions)
        - Primary Connections
            - Government Provided
            - Australian Academy of Science (developed)
            - Collaborative
            - 22 Programs
            - Linking literacy with Science
            - Inquiry Approach
            - Units have Phases: Engage, Explore, Explain, Elaborate, Evaluate
        - Developing a Secondary Version of Primary Connections → Science by Doing
- Two Dimensions of VELS:
    - Learning and Knowledge
    - Science at Work (Investigative Approach
        - Skills Needed
        - Communication about careers
        - Science literary necessary to be involved in world (example - Energy)
- Science Continuum:
    - Goes through standards and progression points
    - Example of projects that you can do with your students

    - Examples of where students should be (example of student work)
- Disability Teaching:
    - No resource for teachers currently available
    - CREST Project (run through CSIRO)
        - Investigate science and present them with awards.
        - Already accessible for disabled students?
- Personal Experience:
    - Was a teacher
    - “In 16 years of teaching, I never had a student with an auditory impairment and had one student with a visual impairment.” (Schmidt)
    - Had a visually impaired student
        - The student had an aide who assisted and adapted everything
    - Adaptations were “done on the run” (no resource and teachers were expected to do them on their own time).
        - He blew up the work sheets and things so the student could see them.
- Advice:
    - Observe disabled students in science classes
        - See how they work in science groups
        - See what adaptations are being made already within the classroom.

Jim Bond
Position: Manager of Student Learning, Victorian Department of Education
Date: 21/03/07
Phone Interview
Interviewer: Lynn Worobey
Contact Information: bond.jim.r@edumail.vic.gov.au

- Disabilities program
  - Disabilities program is state-wide
- Student funding
  - There is an application process for students with disabilities
    - 6 levels of funding
    - Funding ranges from $3000-30,000
    - Amount of funding depends on the needs of child, assessment is criteria based so there are criteria for each level of funding
- Schools required to make programs accessible
  - All schools are required to make their programs accessible for students with special needs
- Department of Education Regions
  - There are 9 regions throughout Australia
    - Positions are pretty much parallel from region to region
    - There is also a Central Office as well as a Well Being Office
  - Grampian Region
    - There are 130 government schools, this is composed of primary and secondary schools
    - 4 specialist schools in the region
      - All based on having an intellectual disability
    - Many schools have a hearing unit attached to them however the unit is not a separate entity it is part of the school
- Visiting teacher service
  - Is a regional service
  - Offer programming advice, look at appropriate materials
  - One for visual, hearing, and physical
    - Visual – Joanna Simms - 5331 8334
    - Hearing – Helen Greenbank - 5331 8362
    - Physical – Eleanor Ryan – 5332 8457
- Special Education Coordinator
  - There is not necessarily a special education coordinator at each school
    - Schools are self-managing schools, this means the school gets a global budget and they then decide what staff they want to employ. The staff will vary from school to school
- Australia has the equivalent of IEP's
  - These are common for students with disabilities
  - One of the most important factors in education for disabled students is the Program Support Group (PSG)
    - This is the connection between the home, school, and other services
    - The group meets and determines goals for child
  - Success is determined individually
    - Teachers are required to report back to parents

        - Students with disabilities can be exempted from state-wide testing that occurs
- Department of Education Website should be helpful
    - Go to student→student program→disabilities→booklets
- In regards to accordance with VELS:
    - Students with disabilities do not have meet the same standards, the focus is more on relating the VELS to learning goals of the child

Veronica Pinney, Warracknabeal Special School
Position: Principal
Date: 21/03/07
Phone Interview
Interviewer: Erin Vozzola
Type of School: Specialist
Contact Information: 03 5398 2564

Disabilities:
- Intellectual Disabilities (70 or below IQ)

Science Program:
- Required to work towards the VELS.
- Hands-On Science
    - Very Visual Program
    - Primary Students
        - Use a theme of science to help them learn.
        - Kitchen
        - Weather → Weather Watch!
    - "In Your Face" Experiments and Concepts
    - Factual
    - Day to Day Things
    - Nature walk
- Teachers run experiments so that the students can SEE them.
    - Very visual
- The programs are modified further by each individual teacher depending on the range of ability in the classroom.
- Very individualized program in general.

Success:
- Evaluation is built into the program.
- Success depends on each student and their disability level.
- They demonstrate something that they have learned.

Suggestions:
- Make sure that the ideas are concrete
- Deliver messages in many different ways → verbally and visually.
- White Board, Pictures, Computer-generated picture board maker, etc.
- Present everything in several different ways.
- MULTI EVERYTHING!
    - Multi Sensory
    - Multi Delivery Types

Paul Baker
Position: Middle Years Coordinator for the Victorian Department of Education
Date: 21/03/07
Phone Interview
Interviewer: Erin Vozzola
Contact Information: 03 5337 8444

- All schools are required to provide adaptations to their programs so that students with disabilities can participate
  - They need to find ways for the students to participate in everything
  - It is a basic expectation
    - Especially in primary schools
- Schools get money to provide for students with disabilities
  - For example: building ramps and making the buildings accessible for the student
  - Signing Assistants may be necessary for some students.
- Teachers Aides
  - Sometimes schools get teachers aides when they have a student with disabilities
  - Not all schools get teachers aides
    - It depends on special funding (the funding could also potentially go towards equipment)
    - Not all students qualify
    - Some get certain amounts of time with the teacher aide (all dependent on the student's disabilities)
    - The schools also have to decide where the best place is to allocate the aide time
- Primary Schools
  - There are no special education coordinators in primary schools, but sometimes they have well being coordinator.
- Secondary Schools
  - Special Education Coordinators are often in schools.
  - The student is assessed and if it is deemed appropriate that they are in need of special accommodations, a PSG meets to make decisions.
    - There is a cut off score that determines the amount of funding that that student gets.
  - PSG (Parent Support Group):
    - Comprised of parents, sometimes the child, teacher, principal, integration officer
    - This group sets the goals for the child
    - Decisions are best made about how to achieve those goals
    - There are different categories of needing assistance (dependent on the disability)
    - The student gets whatever support that they need
    - Individualized Learning Plan (ILP) is an option as well
- Success Assessment
  - The student is sometimes tested against the common standards that all students are tested against
    - There are certain scores which denote achievement and comprehension
    - It is a running scale over twelve months

            - Progress is tracked
            - More conducive to students with disabilities because their individual productivity can be tracked
    - Assessed against specific goals for the child
- Personal Experience/Thoughts
    - History Teacher and had students with special needs (deaf students, students with cerebral palsy)
        - Would assign activities with less writing or oral assessments or bulleted summaries instead of full papers
        - More individualized assignments that fit the students' needs
        - Hands on science requires more care and assessment
        - The students might be good at recording observations and could play that role within a group
            - Within a group setting, students with disabilities could have designated tasks that coincide with what they know and can do
- Personal Theory
    - ILP (Individualized Lesson Plans) focus on weaknesses instead of strengths and that should be turned around and we should highlight a student's strengths.

John Geddes and Jenn Cavanagh
Position: Sunshine Deaf Facility Coordinator, Teacher of the Deaf
Date: 22/03/07
Location: Sunshine Deaf Facility
Interviewer: Nicholas Simone, Erin Vozzola
Type of School: Mainstream
Contact Information: 03 8311 5252

- Sunshine Deaf Facility is a poor, low socio-economic government school
    - There are approximately fifteen deaf students total
    - They can go to a local school and have a teacher of the deaf come about once a week for support with school work
    - At Sunshine, the students attend mainstream classes and have support of the facility in all classes
    - Only deaf facility in west Melbourne
    - Special school for the deaf on St. Kilda Road
        - At Sunshine, students are in a hearing world
        - At specialist school, they are in the deaf world
- Many students have multiple disabilities
    - ESL is big too
        - English is not first language for 95% of students
        - Many of the families are not English speaking
- Literacy levels are low in the entire school
    - There is a broad range of students there: some are doing well and some are struggling
- Deaf kids always behind in language
    - Analogous to ESL students
- Profoundly deaf use Auslan
        - If they are assessed in Auslan, they would do much better but that is not the case
        - If they sign, need an interpreter all the time
- Deaf education is very expensive and there is never enough money
- Many times the parents make the choice about signing, schools, etc.
- Most kids have hearing aids but what they get out of them varies
    - Support from health system very good
    - Many reject the hearing aid at an older age (about high school)
- Very rarely do the deaf students have to make decisions about what to do next when taking part in things
    - Good to have "check points" to check level of understanding before moving on
    - Step by step processes work well
- When doing experiments
    - Deaf students don't have the same language skills
    - Many times will go over experiment first, then do it the next day
    - Teacher of the deaf usually there to help them but takes longer for them to do it
    - Deaf students get into the habit of copying those around them instead of doing it for themselves
- Students are in mainstream classes and two periods in the deaf facility

    - The facility's role is to work closely with the mainstream classes to adapt what is being taught
    - They would like to get programs ahead of time so vocabulary could be looked at and other adaptations made but that is not usually the case
        - Best teachers do this and prepare two levels of lessons
    - As secondary teachers, the teachers of the deaf specialise and do not know everything: do their best to teach all that they can
- Types of adaptations that are made
    - Modifying language
    - Summaries
    - Develop a way of assessment and exercises that are meaningful to the students
        - Toughest task is to figure out how to test while not depending on the English language
        - Look at ideas put forth, not language
    - VISUAL is very good
    - Captioning
    - Many times, the work that is required is cut down, ensuring that the students still get to do the important parts
- To evaluate the adaptations, they see if the students know the information at the end (and may compare to peers). Usually there is no time to go back and change what was done, but if that was possible it would be done
- Senior campus is Year 11 and 12 – VCE
    - Have six periods of classes and usually one is deaf work
    - What students must learn is fixed
    - Need a lot of tutorial work: have a teacher with them all the time that knows when they do not understand concepts
        - Takes a lot of time
- Junior campus gets 2-3 periods each week
    - "Totally integrated" and in mainstream classes all the time
        - Nonetheless, it is sometimes appropriate to take them out
- The Sunshine school in general has tried to increase literacy
    - Time tabled literacy classes three to four times a week
    - Oral kids have stayed in the mainstream literacy class, but the deaf facility has been able to take the signers and do a separate class
- The students are usually unsupported at home
    - Being further away from school also isolates them socially
- Yarra Valley Grammar School
    - Methodist's College Ladies
    - Have a lot more money – would be interesting as a comparison: possible that they have more resources there
- Specific Teaching strategies for Science
    - Solid introduction beforehand, with a good review after
        - Cannot assume they have the background, even in language
    - Science is one area where they usually have partners
        - Partners are not necessarily deaf
            - Communication through gestures
    - Abstract concepts that cannot be seen are very difficult for the deaf
    - Demonstrations work very well
    - Must be presented in a simpler language
    - Videos that do not have a ton of language are good

        - i.e. Mr. Bean
- For deaf students, must pull out major point (what you're aiming at), do proper introduction and experiment, then test
- Size of chunks that each student can process is on an individual basis
    - Step programs are excellent – do one part and once you understand everything, you can then move on
    - Instructions should be very visual, making sure not to trip up the students with key vocab words
    - Have them do the experiment and then ask them what they saw
- Important to keep coming back and reinforcing material
- Good teachers are aware of the learning process, not the teaching process
- TAFE – Technical Education
    - 2/3 of the students go to TAFE
    - Much more supportive to education
        - One year – get certificate
        - Build up to get a diploma, and eventually can take courses at Uni

George Del Papa
Position: Year 10 Science Teacher
Date: 26/03/07
Location: Bellarine Secondary College
Interviewer: Nicholas Simone, Lynn Worobey
Type of School: Mainstream
Contact Information: 03 5251 9000

- Preparatory Material
    - The class has been doing a forensics science unit
        - Tyre tracks by photographs
        - Footprint casts
        - Hair/paint chip analysis under a microscope
        - Fingerprinting – using super glue/iodine and tape
        - Casting teeth – cheese, play dough
        - Bones – structures, measurements, by length of one bone tell how tall person was
        - Liver – left out, observed, could tell how old it was by the number of insects
        - Documentary videos on forensic science
- Opinions on CSIRO Education program
    - Ballistics is good for CSIRO Education to do as he has a lot of trouble doing it
    - Tried the UV light CSIRO Education did and failed
    - Some CSIRO Education activities they have seen, some they have not

Jenny Wishart
Position: Specialist Teacher Coordinator
Date: 26/03/07
Location: Bellarine Secondary College
Interviewer: Nicholas Simone, Lynn Worobey
Type of School: Mainstream
Contact Information: 03 5251 9000

- How their program is set up
    - There are twenty-eight students, three with hearing impairments
- Adaptations
    - Adaptations are made specific to the students
    - Students have teacher's aides and visiting teacher that come in to work with them
        - One time per week the visiting teacher for the region comes to visit with them one on one
        - The visiting teacher checks to make sure the student is on track
            - Well do things outside of school too such as have lunch with them, take them to conferences, and involve them in the deaf world
    - Assistance depends on the severity of the disability
        - One student has a microphone to help her hear
        - One student must sit at the front of the room
        - All students can lip read
            - Students that can lip read are able to pick up more than other students
        - Two students are not severe
        - All students have hearing aids
    - The aide breaks down all of the information into smaller more accessible pieces of information
    - First the teacher goes through the material and then the aide comes
        - Most assistance is given right in the classroom, students usually aren't pulled out of class
    - There is a student with muscular dystrophy, this student has one on one assistance in the lab
    - If a student cannot do the subject they will be withdrawn

Joanne Anderson
Position: Classroom Teacher, Warrambool Senior Special School
Date: 27/03/07
Phone Interview
Interviewer: Erin Vozzola
Type of School: Specialist
Contact Information: 03 5561 1711

- Disabilities
    - All disabilities: Intellectual, autism, CP, Physical.
- Modifications
    - All of the programs are individually modified.
- Science Programs
    - Relevant topics are chosen.
    - Hands-On Emphasis
    - Experiments are done → Hypotheses are encouraged.
    - High Interest Activities
- Types of Hands-On Activities
    - Experiments
    - Science of Food (Water Boils; why?)
    - Things that can see the process happening in front of them
    - Weather
- Determine Necessary Adaptations
    - They know the students well enough to know their strengths and weaknesses
    - Most appropriate
- Physical Disabilities
    - Blind
        - Tactile Diagrams (Touch)
        - Very Simple
        - Use the other senses:
            - Taste
            - Touch Sound
            - Smell
        - Make sure everything is safe and he could put it in his mouth or his hand and he would be okay.
    - Cerebral Palsy
        - Have trouble holding on to things sometimes and may need an aide to help them.
        - Involve all the senses for them.
- Successful
    - You know it was successful if the kids can tell you the results.
    - And if they all participate and are engaged.
- Advice
    - Incorporate all the senses!
    - Make things interesting!
    - Keep everything simple!
    - Make sure the experiments will work easily and our guaranteed to be successful (won't fail or not react or something)
    - Make sure that everything is safe (no hazardous chemicals)

Sandra Greaves, Heather Saynor, and Di Cantwell
Position: Teachers of the Deaf
Date: 27/03/07
Location: East Ringwood Deaf Facility
Interviewer: Nicholas Simone, Erin Vozzola
Type of School: Mainstream
Contact Information: 03 9870 6105

- Disabilities
  - Hearing Loss (Moderate to Profound)
- Technology
  - ALL the students at the school have hearing aids
  - Frequency Units
  - Cochlear Implants
  - Doesn't take away disability
- Program
  - Deaf Facility: The students are integrated into the classroom but the teachers of the deaf come into the classroom with the students or take them out of the classroom at times. ("With Primary Teachers + Support from teachers of the deaf")
    - The goal is to make classroom work clearer and address language needs
  - Three types of deaf programs
    - Facilities (where the students have teachers of the deaf at the school all the time)
    - Travelling Teachers (teacher of the deaf comes to the school a few times a week)
    - Teachers' Aide
  - Teacher of the Deaf's Role
    - There to interpret
      - All students at this school sign
      - Take students out of the classroom and break down some of the concepts
  - Adaptations
    - Modify language
      - Present language for them
      - Initial Language is done within a small group
    - Get plans for the term:
      - Take vocab and plan to suit the needs of the deaf children
      - Depends on level of disability (modify to get to the level of other classmates)
    - Modifications depend on the group
    - Sudanese kids work well with the hearing impaired students (because they are both essentially ESL students)
  - Science
    - The students might miss some things because they are trying to watch the interpreter, too
    - The teachers need to know before hand what is going to happen so they can tell the student when to look at the demonstration and stop signing for a moment

        - When CSIRO Education came, they walked her through the instructions for each of the experiments so they knew how to explain it to their students
        - Helpful for people to have background to help people helping them
        - They have science themes that change every two years
        - Every Wednesday, they have a science session
            - No changes to the actual experiments for the deaf students
                - Reinforcement of the information
                    - They usually take twice as long to write the report
        - Visually give them structure
            - Pictures are great!
            - The more visual, the better!
            - More than one way to teach everything and the teacher can decide which to use
            - Basic concepts are used
        - They cannot respond to just talking
            - Depends on how the individual teacher wants to change things
    - Group Work
        - The students work well in groups!
            - It is best of the partner can sign
        - Doing different activities in a group where they can see what is happening is great (and what CSIRO Education already does!)
    - Students
        - Vocabulary is behind because the children aren't exposed to words on television or in conversation through association
        - (You hear your mom and dad use words a lot before you learn what they mean)
            - Need vocabulary directly given to them
            - Language gap widens as they get older because they don't hear things around them
        - Signing
            - Half Use speech/Listening
            - Half Use Signing
        - They want the students to be the same as hearing students
            - Including having access to the same curriculum
                - Immersed in the classroom
        - Goal: Same assessment as the class
    - Signing
        - Interpreter: interprets EXACTLY what is said (somewhat like a translator)
        - Teacher of the deaf: will change what is said to help the student understand ("thinking on their feet")
        - Convey emotions while signing is important
        - More profound hearing impairments are more likely to sign.
            - Visual Stimulus
        - Hard to find signs for some scientific concepts, which makes it harder to communicate about them

        - Occasionally, use look up the sign using the ASL (American Sign Language) dictionary
  - Australian Disability Services
    - Hearing difficulties are often hard to pick out
    - Language disability is the key
    - Australia → Australian Hearing Service
  - Victorian College of the Deaf
    - Prep to Year 12 (Under 60 students)
  - Visual
    - Visiting Teachers is used more
    - A lot of support in mainstreamed schools
    - Aurora → Has a deaf blind area
    - Use computers to visually stimulate things
      - Can demonstrate more abstract concepts
  - The First Secondary Deaf Facility was opened in 1984
  - It is harder for students to get into uni with a disability and even harder to get a job afterwards
- Suggestions
  - Modify the language
  - Make things visual
  - Make sure there is enough time built in to observe and absorb the material

Elizabeth Grover
Position: Head of School Based Programs
Date: 28/03/07
Location: Aurora School
Interviewer: Nicholas Simone, Erin Vozzola
Type of School: Specialist
Contact Information: 03 8878 9878

- Job Description
    - Elizabeth is the head of School Based Programs
- Aurora is a government school that has both school based and home based programs
    - School Based
        - Deaf Blind Education
            - Age 5-17
            - Most students can see but what they see doesn't reach the brain
                - Known as Cortical Blindness
        - Early Education Programs (3-7 years old)
            - 3 year old Kindergarten, 4 year old Kindergarten, Preparatory (5-7 years old)
            - All teachers are trained teachers of the Deaf in small classes
            - Many classes are mixed with different disabilities
    - Home Based: Early Intervention Program
        - Work with families of Deaf children at their home when the child is first diagnosed (could be at one month old or maybe not until two years)
        - Utilises teachers of the Deaf, Psychologists and Social Workers
- Students must have a hearing loss of 40 dB (slight to moderate) on three frequencies to be allowed into the school
    - Most students tend to be much more deaf
    - Mainly referred to Aurora by Early Intervention Programs, word of mouth or hospital
    - Vision report required for Deaf Blind program
- Students have a choice of where to go for school once they are done at Aurora
    - Regular school without support
    - Regular school with a Visiting Teacher every week or so
    - Regular school with a Deaf facility
    - School for the Deaf
    - Special school if the main disability to be treated is intellectual
- Teachers plan the curriculum for their classes
    - All are trained teachers of the Deaf
    - Different strategies are used depending on the child
        - Lots of stuff is visual using objects, even drawing a picture
            - Digital Cameras are used all the time to take pictures of children doing things, other objects, etc.
                - May ask the child what they are doing in a certain picture to reinforce ideas
        - Some use sign language
        - Some are in groups and use spoken language
        - Some are mixed oral and sign
        - Lots of mime and gesture

- Don’t have anything specifically called “science” at the school, but have it integrated in the studies
    - Learn more of a sense of the concepts through experience
        - Hot and Cold
        - Rain
    - Take students out on excursions
        - Beach to look at waves, sand, etc.
        - Park to look at clouds and trees
- Deaf Blind Education – How is it done if a lot of the teaching is visual
    - Difficult to know how much the students actually pick up
    - Use object reference
        - Give student a book before they are taken to the library and once they get there, take the book back. This way the students know where they are going
    - Much of it is child specific and differs between children
        - Individualized programs with different goals are used for each child
- Tour of school was given
    - Many classrooms used picture boards, one on one interaction and stimuli for many different senses

Julie Gillespie
Position: Head of Hearing Unit at Yarra Valley Grammar School
Date: 28/03/07
Phone Interview
Interviewer: Nicholas Simone
Type of School: Mainstream
Contact Information: 03 9262 7700

- Yarra Valley is an oral facility and the students are mainstreamed. They take all the same classes as other students
- The Hearing Unit has twelve teachers of the Deaf (full and part time) that support the students at the school
    - The teachers of the Deaf work with each student. They may go to the classes, take notes for the students and also revise the material (sometimes making it more visual) and go over it again with the students. There is also some one on one time
        - In the Junior School (up to Year 9), each student has their own teacher with them
        - In years 10, 11 and 12 teachers are matched more with the subject because the material is at a higher lever
    - Make adaptations needed for the students
        - Goal is for the students to access information at the same level as their peers, but that is sometimes challenging
        - Main adaptation is simplifying the language used to teach the material while still reinforcing the vocabulary terms used
            - There is usually a gap in the language
            - Usually helps to simplify the language, then take it up to a higher level and ensure that the students are where they should be in their class
        - May need more time than other students
        - Activities with repetition and a meaningful context are very good
- Have students that partake in science classes at the school
    - Year 11 Biology, also Chemistry, etc.
- Evaluation of adaptations
    - Mainly see if the Deaf students can complete the tasks for each class
    - Sometimes the class is modified
        - ESL is usually taken instead of English because it is less demanding
        - Things may be written in a different form and sometimes a different assessment
    - Some students are up at the level of their hearing peers, while some are not; however, given the disability and gap in language, the level should still be appropriate

Erica Povey
Position: Deaf Facility Coordinator/Teacher of the Deaf, Ballarat Primary and Secondary Schools
Location: Ballarat Deaf Facility
Date: 29/03/07
Interviewer: Nicholas Simone, Lynn Worobey
Type of School: Mainstream
Contact Information: 03 5339 1202

- Position
    - Teacher of the Deaf
    - Erica is the coordinator of all three schools in Ballarat
- Ballarat Deaf Facility
    - This is the fifth year the deaf facility has been at the Primary school
    - Previously there was a separate school for the deaf which was there for fifty years
        - The school was a small school and there were not as many options for the students
        - There was less subject matter, small classes, and teachers were very conscious of the limits of kids
        - Children could be only at the school from age three to age seventeen
        - Subject matter presented to the students was much less complex
    - The facility is part of the Ballarat Primary School
    - There are six students in the regular classrooms
        - The children are assigned to classes based on their age
    - Teachers of the deaf work in the classroom or take the students out individually or in groups
    - At the secondary school there are five deaf students
- Problem areas
    - Language is the biggest problem are
    - Abstract ideas
        - One morning a week Erica works with a year seven in cooking class, there is language the student doesn't know
        - Teacher gives the student the recipe and lets the student go
        - Erica helps the student with a reading problem
        - Other possible option for the teacher presentation would be for the teacher to first demonstrate what they are doing
        - A benefit of doing it the way the teacher does though is the students experience doing the activity and then understand it through follow up
    - New words
        - With normal hearing one has heard the word before and given a meaningful explanation it is possible to create a link however deaf students haven't heard the word before so they cannot make this link
    - Days of the week are difficult
        - Each day has to present today is Thursday, yesterday was Wednesday, and tomorrow is Friday
    - Time and tenses are difficult
    - A list of vocabulary for children to review ahead of time could help

            - Good for kids who like learning new words, some students work well in an analytical way and looking up definitions of bones and organs and this was a good way to help them retain the information
            - Part of Erica's job is pre-teaching vocabulary however usually they don't get around to this as there is a lot of other material teachers of the deaf must cover
        - Long presentations
            - These are hard for deaf students
            - The best way to adapt them is to have the maximum number of visual aids, pictures, and diagrams
        - If the student misses two or three words then they are lost
        - Deaf students are very good at nodding and making it seem as though they understand
            - To ensure they understand one should stop often, ask questions, and have the students repeat back to you
                - This will reveal gaps in communication and understanding
- Deaf facility students
    - To be in the deaf facility there are eligibility requirements the students must meet
    - Deaf students have the same goals as VELS however it is tailored for some students
    - Some students meet VELS requirements, some do not, and some can still be in the normal classroom setting but just need extra support
    - All students have individualized education plans
- Accommodations
    - The main barrier is language
    - Adapt programs so they are more visual
    - Teachers of the deaf show classroom teachers the way to present in visual way
    - One teacher uses a whiteboard and writes down everything as she talks
        - This is good if student reading skills are good, however this is often not the case
    - At the primary school there are no full time communication aides
        - One student at the primary school relies on sign language
            - Most of the time in class there is a teacher of the deaf working with the student
            - Sometimes the student is pulled out of the classroom
            - Sometimes there is no one with the student
    - At the secondary school in labs there is no adaptation other than language
        - At this levels the students have communications aides
    - At the secondary school they employ communication aides
    - In Ballarat they do not have interpreters but rather communication aides who work like integration aides, these aides also help with explanation and note taking
    - Adaptations are made on a student by student basis
    - All students have hearing aids provided by the state
    - Teachers also use FM units
    - Three students have cochlear implants out of the six students at the primary school
        - Cochlear implants are free for children up to twenty-one and are continually updated

        - Once or two times a week a visiting teacher will come visit the most severely disabled students
            - Visiting teachers are very limited in what they are able to do
            - They are there for a very short time and responsible for providing service for teachers about the best teaching methods for the child as well as maintain hearing aids
            - Generally the visiting teacher is there at most two hours per week
        - Teacher positioning
            - Having the teacher stand in one place in the room and not wander makes it easier
            - When a teacher stands in front of a bright light this is bad as their face looks like a shadow and students cannot lip read
        - Front Row Pro
            - New technology
            - Made by phonic ear, this a speaker in each corner of the classroom and the teacher wears a microphone
            - This system isn't just for the deaf but all students
            - The system amplifies the teachers voice slightly, wherever the student is they are closer to the sound
            - Lions Club has sponsored, each school can get the system installed in one classroom for no cost
- Communication
    - Some students use sign
    - Some students are oral, they lip read and use speech
- Evaluation of Success
    - Boils down to knowing the student and following up to what has been done in class
- Science Classes
    - One girl last year was withdrawn from science class, she was bright however it was difficult and not a good teacher
    - A lot of concepts are difficult and language is abstract
    - Last year there was a year 10 deaf student who studied forensics science

Garry Stinchcombe
Position: Assistant Head of School and Support Skills Coordinator at Vision Australia Burwood School
Date: 02/04/07
Location: Burwood
Interviewer: Nicholas Simone, Erin Vozzola, Lynn Worobey
Type of School: Specialist
Contact Information: 03 9808 6422

- Burwood
  - Burwood is a specialist primary school
    - It is specialist in that the students who attend school have an additionally disability in addition to the visual impairment and the curriculum is modified for them
    - All students at the school are legally blind (6/60 vision)
    - They also have students come and visit each week or for a camp over holidays to do activities
  - At the school they have no science classes
    - The mainstream schools do them and science is accessed through the mainstream curriculum
  - The curriculum is based on one from the United States known as the expanded core curriculum which was generated at the Texas School for the Blind
    - Expanded core curriculum – details what students who are vision impaired need to access
- Science
  - A lot of science is observation based
  - Often the student will work with a third party
    - This requires teaching someone to be skilful in being their observers
  - Colour changes described to students (many also have a colour deficit)
    - The student still needs to understand the material and know what it means if the solution turns blue, they just need help with the observation
- Braille
  - Braille has special codes
  - Codes are added for literature and math
  - There are also chemistry codes, circuits, and electrical information
  - Students need expanded knowledge to access these codes
  - Very few people use Braille
    - Of people who are legally blind only 5-10% use Braille
    - In Victoria, which has a population of four million, there are less than one hundred students who use Braille
  - There are not a lot of training courses to support Braille
    - In Australia there have been no new trainees in over ten years
  - It is a lot easier to get a computer to speak the words than read them
  - There is a Braille font available on the internet
  - Braille is universal however science and math codes in Australia are different than those in the United States
  - In Australia they have tried to simplify Braille
    - Use the unified English Braille Code
    - Each symbol only means two things

- Jot a Dot, pocket Brailler
    - Has a refresher display
    - Blue tooth technology
    - Can type in or record in Braille
    - Can detach and plug it into the computer
    - Produced by Freedom Scientific (they produce JAWS as well)
    - Is able to interface with any Microsoft product
    - The kids love it
    - Costs about $12,000
- Technical Support
    - Screen Reader
        - It is hard to make equations linear for screen readers
            - This is a problem for higher education
        - Speed hearing
    - Screen magnifiers
        - Some students get sea sick with these
        - Some websites are not compatible
    - Talking calculators
    - Students taught to operate a computer with keyboard
    - Technology is important because it reinforces future proofing concepts, the students sight may continue to deteriorate as they older
- Teacher Training
    - Teachers are given an overview of low vision, Braille, tactile, and early intervention
    - The teacher may then choose to do further research in areas like reading/writing Braille
- Worksheets
    - To make them accessible use large print
    - To make them accessible it best to put them electronically in a word document and then send that to someone else and they make the decision, based on their interaction with the student, as to what font size is appropriate or if Braille is needed
        - The electronic file can be turned into Braille or large print
    - PDF is not a good format, often there is no way to make them accessible unless it after version 7.0.2 which has an internal reader that can be manipulated with third party assistive technology
- Instructions
    - Use more descriptive verbal instructions
    - Students will make due with what they are given
    - Repeat/just say things which are important
    - Give the students the important information – don't compromise this for the theatre portion in science demonstrations
    - The student may just need to sit in the front of the room to see
    - Allow the student to look at the objects before or after (show them: this is what we will do, this is the setup of the room), before is preferred however it is not always feasible to do so
- Who adapts the material to make it accessible?
    - Depends on the setup of the school
    - Each child's needs are different

    - Some schools externally send out their material to the Vision Australia Library which puts it into Braille and sends it back
        - Often takes between ten and twenty days
    - Others give the material to the teacher's aide who puts the information into Braille
    - For CSIRO Education the suggestion would be on the registration form to just have a checkbox asking if the students have any disabilities and give material in electronic format a week before the program
- Visiting Teacher
    - What the teacher does depends on the level of support the student qualifies for
        - The amount of time the visiting teacher spends at the school is proportional to the student's need
        - The teacher could visit for three, half-days for a primary school student however once the student is in VCE only one time per week
            - This is trying to encourage independence and withdrawal of intensity
        - Generally the visiting teacher will visit once a week or once a fortnight
        - Visits also depend on the school's ability to cope
            - If the school has a good and experienced network to support the student then the visiting teacher will not visit as much
    - Responsibilities
        - See that the child is succeeding
            - If not, questions why
        - Negotiate resource preparation
            - Sit down with the teacher and highlight what is required
                - For example, of five similar diagrams, they may choose which one conveys the point best or break it up into smaller chunks
        - Funding
        - Negotiate for teacher support
        - Some teaching however they make it a point not to take over the primary teaching role as if this is the case the school will not do the teaching
- Diagrams
    - Bigger
    - Large print
    - New colour scheme
    - Tactile
    - PIAF
        - Swell paper
        - Photocopy the image onto paper, the black print bubbles up
        - Cost is $2.50 per sheet
        - Lasts for a long time
        - Might not feel five layers of greyscale, simple outlines are the best
    - Thermaform
        - Prepare diagram using tape, pipe cleaners, etc and melt the thermoform on top of it and suck the air out
        - Can take up to an hour to make a diagram
        - Cost is $0.25 per sheet
        - Feels like styrene, not pleasant to touch

    - Straw example
        - Feeling a tactile diagram is similar to looking through a straw at a picture, you can only feel what is under your fingertips at the time, it is very difficult to get the whole picture
    - Diagram should have good keys/legends, good descriptions, and good information
    - Simple diagrams are much better
- Tactile Standards
    - Texas School for the Blind
    - American Foundation for the Blind (AFB)
    - Round table Australia Blind – search for on Google
- Vision Library
    - Known as VAILS
    - Have a source of tactile documents, change documents to large print, convert text to Braille
    - Andrew Nichols – 1300 654 656, is in charge of converting books for students, can put us in contact with someone in transcription who does tactile diagrams. Ask the person for additional information about Round Table
- Describing Science Material
    - Teachers and students need training
        - Need to know what to anticipate
    - It is important to know what you can expect the students to know
        - A lot of blind students don't really watch TV anymore as it is very visual
- Reading
    - Most students can manage size 18 font, some can read smaller but not for long – vision fatigue will set in
    - Audio support is important in visual reading
- Language problem
    - "Up here, down there, across to there" all mean nothing to someone that is blind
- Tiredness
    - Blind people must think about everything very carefully
        - Crossing a road there is a big effort to make the decision while for people with normal vision it is not a task
- Measurements
    - Usually done in partners
    - Make sure the partner does not do all the work
    - Partner does X, blind student does the recording
- Hands-On Activities
    - Blind people learn from experience so the hands-on aspect is wonderful
- Sound
    - Sound is good to incorporate
    - Does not have to be complicated bells and whistles
    - Can just be a 'click' when a process is done

Colin Johanson
Designer and Director for COOL Mobility
Date: 15/04/07
Interviewer: Nicholas Simone, Erin Vozzola, Lynn Worobey
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Writing
- Using a computer in place of manually writing
- Most standard mice are accessible and if they are not the student will bring his her own
- If a student takes computer classes they will use the same adaptive equipment for all computer classes
- A basic trackball mouse can be used
- Some are able to use a touchpad

Twisting
- Colin has no pincher grip but can still turn a dial
- Grip surface on dial and can adjust
- Someone else can also adjust the dial for the student

Buttons
- Enlarged buttons is good
- Positive click – get feedback that have succeeded in clicking button
  - Proprioception is important for buttons
  - If there is no positive statement of success the student will try and do it too many times

Crank
- Ball on the end of the crank
  - Put hand as socket over the ball, used with crutches

Tweezers/Forceps
- If cannot grasp a handle, cannot grasp tweezers/forceps
- Instead use artery clamps because it is possible to use scissors (known as haemostats or artery forceps)
  - To use as forceps remove the resistance
  - To use to move pieces or hold for an extended period of time do not remove resistance
  - Sold in electrical shops, are made of brass so they are not expensive

Flipping Pages
- Page turners do not work
  - Papers have different sizes, densities, etc
- The best page turner is putting it in PDF form
  - PDF should be from a text and not a scan, the PDF should be unlocked
- Tabbed pages are good

Grasping
- Velcro is very good
  - Gloves with Velcro lining and Velcro on a tool
  - Velcro straps
    - Very adaptable but not very comfortable
  - There is self adhesive Velcro in addition to regular Velcro
    - With self adhesive Velcro can peel it off after and also stick it on to the student's hand
- Always carry duct tape

Pushing/Pulling

- Can often push or pull heavy lever but not do both
  - Colin can pull but not push
  - Depends on what muscles are present
    - Colin can pull Nick's chair but not do a push up, his tricep was replaced by a tendon which gives him the function of a tricep but not its strength

Occupation Therapist Scale of Strength

- 5 is normal strength
- 4 is almost full power
- 3 is function against gravity
- 2 is below normal function
- 1 is some function without gravity
- Add +/- to the numbers to further classify

Lack of gross motor skills

- Students can point at a display board with their eyes, on the board can list a matrix of different commands such as higher/lower, harder/softer, hotter/colder
  - For math it can contain symbols for multiply, divide, add, subtract, higher, lower, etc
- Many people have their own methods of adaptation they have developed
- May be able to operate a mouse with cursor buttons
- Use head pointers
- May not have function of their arm but can move shoulder and use their elbow
- Supplies used to make adaptations include blue tack, rubber bands and Velcro
  - To make good rubber bands cut of slices of yellow rubber gloves as they will be wide and soft
- Colin's friend is able to drive however when it comes to carrying a tea kettle he cannot do this as it requires he stabilize not only his arms but also his whole body
- Colin holding a glass – his left hand has no proprioception and no muscle to turn his wrist back up if it falls
- People have different fields of vision based on how their head may have to be oriented

Range of motion

- Some can reach far out but not close to their body, others the opposite is true

Spectrum

- Generalizations are hard because there is a lot of permutation/variation/combo
- Fine motor skills are difficult because in some senses a student may have them while in other they may not
  - Example reaching out to push a button is different than

Technology

- Joystick on electric wheelchairs can be interfaced to switch on houselights, turn on the television, change channels, play games, etc
  - Perhaps the joystick can be interfaced with science projects as well
- Students often bring their own adaptive technology
- Use an mp3 recording of instructions and headphones and students will be able to listen at their own pace
  - Mp3's are a very readily available technology as opposed to audio tapes

Funding

- Varies from state to state in the United states
- School receives funding for adaptive technology

- In Australia funding does not vary between states but rather between assessors
- Regions get money allocated to them
- Medicare and Medicaid pay for personal adaptive technologies but it must be demonstrated the technologies are needed in the home environment
- There is an aids of appliances scheme through which federal funding is provided which is distributed through hospitals
    - Each hospital gets money allocated annually
    - This funding can cover wheelchairs, cushions, ramps, car modifications, home modifications to a limited extent
    - You can apply to a hospital in the area you are a resident in, where you work, or where you go school

Other Notes

- Adaptations will always be a team effort
- Cerebral Palsy (CP) is the most prevalent disability in mainstreamed schools
    - With CP students their speech is often difficult to understand, speech varies from person to person, to understand what CP students are saying a lot is about looking at in context (it is the same way for students learning foreign languages)
- The only common denominator between disabilities is they are all different
- Listen to what people do, what adaptations they have made, how they have accomplished tasks
- Generally the student will have an aide
- Create a checklist for teachers to fill out – the teachers will know what the limits are and how they have overcome problems in the past
    - Can include points regarding if the student can stand, if they can sit under a bench, etc
    - With each point teacher can indicate if the student needs assistance, has assistance, or does not require assistance
    - Checklist is impersonal, teachers are more likely to fill it out, it is quick and focused
        - Checklist can focus on the task at hand: student must be able to reach above X and move things from X to Y.
- Teachers will know their students the best
- Maximize ability and minimize disability
- You can never make the disability disappear but it is possible to take simple measures such as putting buttons where students can reach them
- Technology has radically changed and will continue to
- Universal design is more common, it is changing the way people live and work and disabled people are a good place to start universal design
    - Example: trackballs which are good for those who are disabled are also very good for graphic design as positioning clicking the mouse are two separate tasks
- Must look at the problems from a student's frame of reference
    - It is not a half failure if the student can only do half of the activity on their own – this is 50% more compared to not being able to do anything which is worth thousands of percentages of improvement
- Those who have a disability will often compensate by concentrating really hard
    - Cannot complete a task and listen at the same time

- If you can engage kids to the point where they are absorbed and tune out other stimuli then you have succeeded
- Videos will be a very important mechanism through which to get teachers and administrators interested and involved
    - Show examples of severely disabled who can participate in the program
    - By showing severely disabled can do it that implies those with lesser disabilities can as well
    - These kids can be given a chance!!
    - Very important to peak interest and stop people from just breezing through

Elaine Harrison
Position: Teacher, Mobility Specialist at Glen Allen Specialist School
Date: 16/04/07
Phone Interview
Interviewer: Erin Vozzola
Type of School: Specialist
Contact Information: 03 9561 1966

- Responsibilities:
    - Elaine works with students who have mobility impairments, visual impairments, and auditory impairments.
    - Her students are severely disabled.
- Students with disabilities
    - Children with CP cannot grasp
    - Children with MD can have fine motor skills but they can't do things for very long or they get tired fairly quickly or they do not have enough concentration to keep their body focused for that long.
    - The students she works with usually need 1 on 1 attention.
    - Coactive assistance is usually used for these students because they do not have enough motivation to do it on their own.
- Adaptations:
    - She tries to do activities that do not involve holding onto things.
    - She does very visual experiments.
    - She makes things tactile.
        - Example: Push child's fingers into putty.
    - She makes sure that there are sounds and smells incorporated into everything.
    - Tiny little steps are necessary.
    - Use blue tack to stick things together.
    - Use a power-board switch so that students can use switches to turn things on and off.
    - *Use non-slip mats on trays for students when they are working with things so that they do not slip around.
        - They work well on trays.
        - They are fairly inexpensive.
    - Graphics are used and students are asked to look at what they want to see/do/say.
- Advice:
    - For severely disabled students, the act of participation is the important part.
    - Using Velcro gloves to help students hold on to things would help students with enough cognitive ability to focus on picking those things up.
    - Interactive Computer Programs are useful.
    - A lot of the issues in the spectrum run together for most students with disabilities.
- Gross Motor Skills:
    - Arm wraps are used to keep a child's arms in control better.
    - Preparing them and walking them through activities is a good idea.
    - Verbal prompting is necessary.
    - Sometimes a child's arms will work independently or together.
    - Head rests are used on their chairs to keep their heads up.

    - These students usually need 1 on 1 help.
    - Smell is VERY important.
        - Examples:
            - She makes basic salt dough and adds smells into it to see which one they respond to.
            - Different herbs are sometime used, as well as vanilla scents, lemon scents, etc.
            - She adds scents to coloured paints as well so that they associate the colours with another sense.
- Range of Motion:
    - The range of motion is an issue, depending on cognition.
    - Helpers are needed for students with these impairments often.
    - OT does a lot of work with them.
- Universal:
    - Keep things:
        - Basic
        - Multi-sensory
        - Small steps
        - Short (maybe only do parts of a larger experiment)
        - More of an experience than focused on the learning.
        - First person (if the child can hold a piece of what's happening or actively participate in what is happening, they get more out of it).
    - Use scissor boards (all students can access them).
    - Holders for different tools to help them hold them (glue stick holders, beaker holders, etc.)

Jeremy Brett
Position: Science Teacher Year 8,9,10 and Math Teacher Year 10 and VCE
Date: 19/04/07
Location: Victorian College for the Deaf
Interviewer: Nicholas Simone, Erin Vozzola, Lynn Worobey
Type of School: Specialist
Contact Information: 03 9510 1706, brett.jeremy.t@edumail.vic.gov.au

Spectrum
- For students that cannot verbalize it is important to note that these students can communicate through interpreter in sign, the curriculum is still accessible to them, and there is still a way for them to ask teachers questions

Language gap
- It was good that SAM mentions deaf literacy

SAM
- The matrix is user friendly and easy to access

Alternative forms of assessment
- Video is often used
- Deaf students who struggle with literacy may have a cognitive understanding of the material and sign it in video
- They will build up a digital portfolio of video of students signing as evidence of student understanding

Tactile
- It is important to make activities as tactile as possible
- Create activities student can feel and move and touch, concepts will sink in better with students

Graphic and visual thinking organizers
- Charts
- Venn Diagrams
- Language development is a limiting factor on deaf students' ability to think so organizers which help them sort out their thoughts are important
- Order and structure are important
- Example of guide: 1. Identify problem/situation/concept 2. Ask why? 3. Once the question is answered ask why again
- For experiments will often use flowcharts

Reverse key
- What are the things you cannot measure with a scale?
- Thinking the opposite of what things are used for can help cement what they are used for

Science videos
- Are often on DVD format
- A teacher at the school found a grant which funds getting subtitles for DVD's
- DNA video example – the graphics and everything are great but there is talking in the background so students miss information because they have to go back and forth between the screen and the interpreter
- There are some problems with subtitling as a result of the language gap
- It is important that the subtitles are directed at the level of the students
    - Wouldn't sign to a Year 7 the same way one would sign to a Year 12

Talking/Lecturing

- With the preparatory talks before experiments students will get lost if they are delayed in language or the sequence of instructions are too long
- It is important to structure instructions such that 3 or so instructions are given, that part of the activity is done and then more instructions are give
- Instructions should be short, simple and brief.
- In a theoretical class if a teacher talks for too longs student attention will be lost
- A good approach is to talk for five to ten minutes, do some work, check on the students, give students some one on one time, do a summary of what students did, and then move on to the next topic
- Chunking is important – the more you can break down the better

Equipment and experiments

- Let students have time with the equipment beforehand to explore it as long as doing so is safe
- Hands-on and applied learning are very good for deaf students

Victorian College for the Deaf

- All students at VCD sign
- VCD has a bilingual-bicultural philosophy
- The two categories of students are profoundly deaf and oral
- Teachers are told to turn their voice off when they speak to the class as whole
- If you speak while you sign the signing is grammatically poor because you are signing in English word order
- Auslan has classifiers which are when the hands move in a specific direction or space in relation to the body, these are lost when one signs and talks at the same time
- Some kids needs signing in the English word order
- For students who are oral not speaking to them and only signing will often improve their Auslan

Worksheets and reading material

- The packet we brought with us for SAM would be too much for a deaf student to read, they would be overwhelmed
- If a student is in the frame of mind that they are overwhelmed and there is too much text they will not get into the material
- It is important that hand-outs are aesthetically pleasing, they should have a balance between pictures, diagrams, and text

Extra time

- It may take longer to get through a lesson plan than anticipated so it is important that CSIRO presenters discuss the program with teachers to get feedback on anything they need to cut out to shorten the program

Appendix Q Notes from CSIRO Education Program Observations

Air and Weather: Year 4-6
Simon at CSIROSEC, Main Lab

- Brought all of students in and had them sit down on the floor
- General Introduction of CSIRO
- What does a scientist look like?
  - All different, depends on what they are doing?
- Introduced Air and Weather
  - What air is doing = weather
    - Hot, Cold, whether it is moving or not
- Asked students if there was air in the glass he was holding
  - Turned upside down – air still? Cupped with hand – still?
  - Repeated with bottle and bag
  - You cannot see the air, but can see its effect on the bag
- Demonstration with ping pong ball – put glass over ping pong ball floating in water and pushed to the bottom
  - Ping pong ball stay at bottom because the air was trapped
  - If glass was tilted, air was let out and glass filled up with water
  - Repeated with a tissue and confirmed that it did not get wet
- Explained that air has weight (mass)
  - 1 kg/cm^2
  - Showed concept by snapping a ruler in half (one side was "held down" by a piece of newspaper)
    - Explained that gases push up, down and in all directions, hence he got the gas out from under the newspaper and the gas on top held it down
- Explained that cold air contracts (like when you are cold and bundle up) and hot air expands
- Took a bottle and put boiling water in it, emptied the water and placed a balloon on the top. Once the bottle cooled down enough, it sucked in the balloon
- Simon took a balloon and blew it up and asked what air was made up of
  - 21% O_2, 78% N_2, and 1 % other gases (water vapour, CO_2, etc.)
- Explained that Nitrogen can be a liquid at very low temperatures (-196^o C)
  - Placed a fully inflated balloon into some liquid nitrogen and the balloon flattened out
  - Had two students blow on the balloon and it re-inflated
- Poured some liquid nitrogen into a bottle so the students could see it boil
  - Then placed a balloon on top of the bottle and it inflated
- He then asked the children about the ice that had formed on the outside of the bottle and containers, explaining that the water came from the air
- Explained that Nitrogen as a gas takes up 70 times more space than as a liquid
- Explained how dew and frost on grass, as well as fog, are from water in the air
  - Air warms up and rises, cools and wants to form water vapour
  - Water vapour grabs onto dust, pollution, pollen particles and forms a cloud
  - Rain occurs when too much water vapour tries to form
    - Snow if freezes quick, hail if freezes slow
- Some matches were thrown in a jar with a small amount of water. Pulling a glove covering the jar formed a cloud in the jar
- Explained Air Pressure

    - High Pressure Vs. Low Pressure System (High pressure system has more air)
- Listed some weather events
    - Tropical cyclone
    - Tornado
- Showed the students a tornado bottle (two soda bottles connected)
    - Operates slowly with air transferring only through bubbles
    - Once a vortex forms, there is a column of air, which is much faster
- Hero Engine – with liquid Nitrogen (first one used steam)
    - Rotating bottle in a glass of water powered by released of Nitrogen from tubes

Driving Innovations: Year 8
Sean at John Paul College

- Sean started out with a general introduction of CSIRO
- Explained that most cars can run on diesel, petrol or gas but wanted to know what some problems were with those fuels
    - They pollute and we are running out of them
    - Alterative sources of energy
        - Batteries, hydrogen
- Did a demonstration and asked for a volunteer
    - A balloon was filled up with hydrogen through a reaction between Magnesium and Hydrochloric acid
    - All students were asked to cover their ears and the volunteer held a rod with the balloon. The balloon was ignited and light on fire (normally there is a loud bang)
- Explained how a hydrogen fuel cell could be used for cars by using hydrogen and oxygen to create water and electricity
- Sean then went thorough all of the different activities around the room, telling the students to read each instruction sheet and do the activities in groups of three

- **Under the Bonnet**
    - This activity is meant to simulate a combustion reaction in a cars engine
        - Students had a small container with a cork. The cork was removed and some fuel was squirted in, ignited with a spark and the cork blew off
            - The explosion did make some noise
        - There was also a small model car engine but it was not operating properly
- **Buckle Up**
    - Students had to pull a handle back and launch a small car into a wall. The doll inside was unbuckled one time and buckled the other to see the difference a seat belt makes
        - Car didn't hit very hard because the table was longer than normal
    - The handle was a little difficult to operate
- **PowerPoint on Crash Testing**
    - Students had to flip through a PowerPoint slide show with some text and movies about crash testing (dummies with and without seatbelts)
        - Text had good contrast but a smaller size font
    - PowerPoint was 100% visual
- **Crumple Cans**
    - Students had to place a car release a car down and ramp with and with out an aluminium can on the front and compare the different accelerometre graphs
        - Car was very heavy: tough to lift and hold
        - Difficult to get into slots of ramp
        - Removing car also difficult
        - The accelerometre graph was not easy conceptually: many students didn't know what to do with it

- Sean called everyone back when time was up and went over a few activities
    - Under the Bonnet: oxygen needed in the chamber for explosion to happen and will not work if fuel is all liquid

- Driving Distraction: even if the car was off the road only 1% of the time that is still a lot
- Crumple Cans: the can in the front of the truck absorbs some energy just like a crumple zone on newer cars does
  - Air bag is like a personal crumple zone

Energy: Year 3-4
Caitlin at CSIROSEC, Main Lab

- General introduction of CSIRO
- Asked the students what they thought a scientist looked like
- Talked about Energy – what are some different types?
    - Mechanical, Hydro, Wind
    - "Movement energy" – Kinetic!
- Ask if you could create energy from nothing – No!
    - Energy an be converted from one form to another
        - i.e. between heat, light, sound, electrical
- Story about Will and Nick: Will had to knock an apple of off his sons head with a bow and arrow
    - Knocked an apple off of a volunteers head using an air cannon
        - Air cannon used potential energy in elastics
        - Filled air cannon with smoke so students could see it
- She then said they had a bunch of experiments to get them thinking about energy. An instruction sheet was at each experiment – Groups of 2-3

- **Dropping Balls**
    - Had to drop two different size balls and observe what happened
    - Balls tended to bounce all over the place
- **Slinky**
    - Had to make a slinky go down a set of steps
    - Tough to start sometimes, could be tough for mobility
- **Marbles on a spiral track**
    - Get different points for where it lands afterwards
    - Easy to start and can hear marble very well
- **Hopper Poppers**
    - Semi-circle that is turned inside out and pops
    - Could be a little tough to turn inside out
- **Ball Smasher**
    - A little difficult to get balls out
    - Children told to smell the paper – good for low vision!
- **Rubber Band Racer**
    - Hard for mobility impaired to operate wheels of car
- **Balloon Hovercraft**
    - Used bike pump to inflate balloon
        - Tough for even Caitlin to do alone, but was ok with a helper
    - Floated a little bit on the lab bench
- **Rattlebacks**
    - Small stone like objects that will only spin one way, will reverse direction if spun the other way and will spin if rocked
    - Easy to operate – just tap it
    - Must tap somewhat gently – most kids hit it too hard and just walked away
- **Solar Fan**
    - Quick and easy
        - Turn on outlet and light turns on, powering the fan via a solar panel
- **Balls suspended by string**

  - Started one ball in motion and it transferred its energy to the other one that was attached
  - Easy to start – just needs a light tap
- **Solar and Crank Powered Torch**
  - Operating switches was difficult and most children didn't understand it (setting it to charge and switching to on, etc.)
  - Turning handle not optimal for mobility impairment
  - Supposed to time charging but few did
- **Plasma Ball**
  - Simple: turn it on and touch it, coloured "spark" goes toward finger
- **Pendulum**
  - Small size works well
  - Nothing to set up
  - Winnie was safe sitting on the stool
- **Gyro Ring**
  - Must start spin – difficult for many
  - Keep turning large ring
- The students were called back to discuss some experiments
  - Ball Smasher
    - Heat energy, sound energy (showed them by hitting balls together)
  - Solar Powered Fan
    - Light energy
    - Electricity to Light and Heat energy to Electricity to Kinetic energy
  - Gyro ring
    - Energy transferred from big to small rings

- Ethanol bottle demonstration – blew cork off bottle and demonstrated a couple different types of energy
  - Electrical with heat
  - Sound
- Other notes
  - Lots of activities were going on all at once
  - Caitlin said that in school the students learn about alternative power sources that can create electricity
    - i.e. wind, solar

Energy: Year 3-4
Merrin at CSIROSEC

- General introduction of CSIRO
- Merrin explained that today's program was about energy and asked what the students had learned in school about energy
    - Description of energy
    - Types of energy
    - Light energy
        - Light switch on light
        - Can carry energy
        - Changes from electricity energy to light energy
- Story about William Tell
    - Son was kidnapped and to get him back, William had to shoot an apple off of his son's head using a bow and arrow
    - Merrin re-enacted the scene using an air cannon and a volunteer
    - She then described how the air cannon works
        - Energy is put into the air to make it move
        - Energy is stored in the elastic band
    - Smoke was used to show the air leaving the air cannon
- Highlighted parts of each activity by going around the room and explaining the worksheets. The students then did the activities in groups of two or three

- **Dropping Balls**
    - Two balls were dropped – think about energy acting, does it stay the same or change?
    - Difficult to coordinate sometimes
    - Must hold balls up and grasp them
    - Must be able to see where balls go after they bounce
- **Slinky**
    - Slinky walked down the stairs
    - Must see as it goes down, but might be able to hear it hit each step
    - Required only a gentle touch to start
- **Marbles Twister**
    - Had to reach top of track
    - Had to see marble move and see how velocity changed
- **Popper Balls**
    - Flip inside out let pop or drop it – see how high it bounces
    - Inverting disc difficult
    - Seeing movement of disc
    - Must keep disc away from face after inverting
- **Ball Smasher**
    - Two large ball bearings smash into each other on a ramp, observe what happens to paper in middle
    - Balls difficult to get out of track sometimes
- **Elastic Car**
    - May be difficult for blind student to attach rubber band
    - Could be difficult for students without fine motor skills to operate
- **Balloon Hovercraft**

- Balloons had to be filled up from a pump, end twisted, set on table and allowed to untwist and float
- Difficult to hold pump up
    - Generally required two people – one to pump, one to hold balloon
    - Had to lean down to reach

- **Rattlebacks**
  - Must spin slender stones and observe their movement
    - Will only spin one way
    - Cannot feel movement without stopping motion
- **Solar Fan**
  - Must reach over to switch on outlet and line solar panel up with lights, causing a small fan to spin
- **Two Pendulums**
  - One partner had to hold down the stand while one ball is started
    - Other ball then starts to move
- **Solar Light and Crank**
  - Runs off energy you put into it
  - Must set different dials to charge light (timer was there also to tell how long to charge)
    - Dials and crank difficult for mobility impaired to use
- **Plasma Ball**
  - Lights up on touch and red light goes to finger
- **Pendulum and Winnie the Pooh**
  - Must be able to reach pendulum and balance Pooh
- **Gyro Ring**
  - Must get all six small rings spinning and then rotate large ring
    - Difficult for mobility

- Merrin called the students back for one last demonstration
- Bottle with Cork
  - Electricity "added" to bottle by touching a screw in the bottle with a Tesla coil
  - Explosion of ethanol caused cork was blown off bottle and made a loud noise
  - Types of energy
    - Sound
    - Movement (kinetic)
    - Light (saw blue inside of bottle)
    - Heat (bottle gets warm)
  - Did demonstration one more time
- Merrin then discussed a few of the activities and how energy was related to them

Force and Movement: Year 3-4
Simon at CSIROSEC

- General CSIRO Introduction
- First, a couple demonstrations were done
    - Visually impaired wouldn't be able to see demonstrations
- Skateboard
    - There is a student on the skateboard and Simon uses that to demonstrate applied force = movement
        - Pushes student
        - Pulls student
        - Uses a rope to pull her
        - She pulls herself along the rope
        - Simon gets the girl to try and pull him while she is on the skateboard without touching the ground
            - The intended concept: Effect of weight on necessary force sizes.
- Pressure Playdough
    - Simon had one student come up to the class and stand (mobility impaired student could use hand) on a box with one shoe off next to a big container of playdough
        - He wears a flip flop and then a high heel.
        - He has the student step in different playdough containers so that you can compare it.
- The students then began the activities

- **Unusual Birds Activity/ Hanging out Activity**
    - The students balance the birds on their fingers
    - The students are encouraged to figure out what makes the birds balance all the time
        - The birds have weights in the nose and in the wings to make them balance that way
- **Building Bridges**
    - There are blocks and the students match up the blocks onto the lines on a board
        - Visually Impaired may not be able to see lines
    - When the blocks are matched up, the bridge can stand up on its own.
- **To Wheel or not to Wheel**
    - Different sized blocks are rolled along a track.
    - The students are encouraged to decide which one FEELS better.
- **Obedient Can Activity**
    - Plastic cylinder with rubber bands on each end and a cushion in between.
    - When you roll the can, it comes back to you.
        - The rubber bands wind as you roll it and then wind back.
- **Elastic Collisions Activity**
    - Balls are along a track with runners on top and bottom.
    - You knock the balls against each other and watch them hit each other to see what happens.
    - Notice that one always comes back until you hit 4 balls against one ball.
- **The Big Lever Activity**

    - Lever and Fulcrum experiment → try different places to put the fulcrum.
    - The students lift each other up using the lever.
        - Tough for Mobility Impaired

- Other notes
    - Chairs not used with primary school students → sat on the floor with pillow
    - The Green Lab has the experiments on the tables around the room and the middle is empty and is where the students put down their pillows and sit in the middle.
    - Not much room in the Green Lab for an interpreter or wheelchairs
    - Fine motor skills are required to do a lot of the activities in this lab
    - Several Positive aspects to the program
        - Instructions are fairly simple and self-explanatory in most cases.
        - VERY hands-on lesson
        - Kids made noticeable connections with the experiments and the concepts being taught in the classroom.
        - Step by step lesson.
        - Inherently adaptable program – they change the experiments and demonstrations for different age levels and it is still effective.
        - The layout of the program works well for students with hearing impairments (demonstration/introduction, hands-on activity, demonstration/debrief).

Forensic Frenzy: Year 10
Karina at Bellamarine Secondary School

- Karina began with a general introduction of CSIRO
- She then asked what the students thought they would be working with today and what people work with at crime scenes
  - Fingerprints
  - Blood
  - Weapons
- Asked what else forensic scientists investigate
  - Missing persons, bombs
- Asked what skills were needed
  - Communication because, unlike the TV shows, there is not only one person that does everything
  - Good observation skill
  - Perseverance
- The student booklets were then passed out and a volunteer read the story of the crime
  - The victim died from a gunshot; hence, there are three possibilities
    - Murder, suicide or an accident
  - Explained how the victim could be identified from dental records because our teeth don't change much over time
  - Read evidence that was found at the crime scene: shirt, oil, ransom note, fabric
  - Nathan Bloom was abducted from a local bar = over 18
  - Suspects were introduced and why they were suspect was discussed
    - Rodney Georgiou: unemployed, seen at scene, lives alone, known for criminal activity and physically fit
    - Maria Crossman: associated with Bloom family, works at laboratory and could just ask Nathan to come in the car
    - Eric Smythe: works where Bloom family gambles and owns guns
    - Tracy Zammitt: Owns a gun, hard time financially and works at laboratory
  - Explained the observations and conclusions sheet, as well as the separate stations to be done in groups of two or three

- **Facial Identification**
  - Look at a picture for 30 seconds and then try to reconstruct it using a computer program
  - Not a lot of contrast and differences between some features
  - Not essential to solving the crime
- **Paid Stamp**
  - Found on back of ransom note, must try a few different ones to determines who owned the stamp used
  - Using the stamp could be a problem for mobility impaired
  - Matching could be difficult for vision impaired
    - Ink not dark
    - Shapes similar and small
- **Dusting for Fingerprints**
  - Student applied one of their fingerprints on a coffee cup and used dust to make it visible
  - Difficult to see

- Not essential to solving the crime

- **Comparing Fingerprints**
  - Must use magnifying glass to match fingerprints from suspects to fingerprints on the ransom note and a lab bench
  - Finger prints are small
    - Possibly enlarge?
  - Might be hard to see subtleties of each fingerprint
- **Dental X-Rays**
  - X-Ray from victim compared to Nathan Bloom's and other missing persons
  - X-Rays do not have a large amount of contrast, could be difficult to see
- **Tyre Tracks**
  - Must match tyre tracks from scene to one of the suspects
    - All tyres different because they wear differently
  - Seeing track in dirt may be difficult, seeing individuals treads of other tyres in pictures
  - Actual 3-D tire would work well
- **Pen Ink Chromatography**
  - Must draw a line from each suspects pen and use chromatography to separate colours
  - Actually seeing the chromatograph is necessary
    - Could do using tactile strategy with textures
  - Some of the colours did not have much contrast
- **Stained Cloth**
  - A sample of cloth was tested to see if it had blood on it. If hemastix strip turned green, the fabric was positive for blood
    - Could maybe produce smell instead of colour?
  - Using the tweezers could be difficult
- **DNA Profiling**
  - DNA profiles of blood from the scene and from each suspect were already done. The students had to match the blood from the scene to one of the other profiles
  - Could be adapted for blind by using protrusions
- **Ballistics**
  - The front and back of a shirt was shown
    - Knew victim was shot from front because the hole in the back was bigger
  - Size of the hole was matched to a gun via pictures
    - Could make it so a blind student could feel the hole
    - Pages in book with pictures were large and easy to flip
  - Amount of gun residue determined shooting distance, which would be different for a murder and a suicide
    - Difficult to see gun powder and sometimes distinguish from blood (use texture?)
- **Fingerprints on Gun**
  - Must match the fingerprints on two guns to suspects
  - Results of Greiss tests (testing for gun residue on hands) were given
  - Seeing subtleties of fingerprints could be difficult
- **Soil**
  - Must match the soil from the crime scene to soil from one of the suspect's shoe via pH test

    - Must mix dirt with solution and see colour to determine pH by comparison with given card
        - Mixing could be difficult for mobility impairment
        - Matching could be difficult for visually impaired
        - Reading labels on different soils and solutions
    - Bottle could be difficult to use, as well as using the spoon to get dirt
- **Oil**
    - Place different samples of oil under UV light
    - Reading labels on containers
    - Must match level of "fluorescence" (brightness) of oil on victim to oil from the suspects' vehicles
    - Seeing the level of fluorescence could be difficult
- **Facial Reconstruction**
    - Apply Play-Doh to a skull with pegs as a guide to create a face
    - Moulding the Play-Doh could be difficult
        - Could maybe most of the face done and have students finish it – less fatigue and easier to put on face
- **Fibres**
    - Must use a dye on different pieces of fabric from suspects and match to samples found on victim and fence
    - Tweezers difficult to manipulate cloth with
    - Bottles to add droplets
        - Difficult to squeeze and must squeeze into small space
        - Fatigue because of repetition
    - Might be hard to see colour differences

- Karina called everyone back after about an hour to discuss the results from each station
    - A board was used to put up evidence under each suspects name
        - Print may have been a little small
    - All of the evidence was given, but the actual outcome of the case was not told
- Other notes
    - Many of the visual aspects of the program could be adapted by using tactile diagrams

Gene Technology: Year 10
Kane at CSIROSEC, Main Lab

- Started with a general introduction to CSIRO

- **Gel Electrophoresis**
- Kane started up a PowerPoint on the wall showing pictures of muscle fibres, chromosomes and DNA
- He then asked what came to mind when the students thought of genes. Technology?
    - Gel Electrophoresis: Word means gel electricity/separate
    - Two metres of DNA per cell; DNA in all of body could stretch from Earth to moon about 17 times
    - DNA is coiled in the nucleus to package it
        - Zoomed in picture showed CATG bases
- Handed out a sheet with the murder of Sally Smith on it
    - Had a volunteer read
- Showed chromosomes on screen and explained how one came from dad, one from mum
    - Polymorphic: many forms
    - NOTE: Colour contrast on PowerPoint was very poor (black on dark blue)
- Placed gel under a camera (very difficult to see)
    - Brought around the gel for everyone to feel it
    - Why use the gel?
        - Mesh so smaller fragments could move easier (analogy of racing a dog through a doggie door)
- Explained how a buffer was needed to conduct electricity (water doesn't conduct it on it's on own) and to control pH. This was set up under the camera
- Showed the students a micropipette
    - Explained a microlitre was a millionth of a litre
- Groups of three were formed to go to the benches on the side of the lab
- They had to practice measuring liquid with the micropipette after Kane demonstrated
    - Would be difficult without fine motor skills
    - Had to take liquid from small vile and then replace it
- Ten volunteers were taken to put the DNA samples in the small cells in the gel using the micropipettes
    - The volunteers were gathered around the red lab bench
- Explained how DNA is clear and must be dyed to see
    - Glycerol also used to make it heavier
- Next Kane had to place the charges and asked the students which to put where. He then explained the proper setup
    - The gel electrophoresis takes about a half-hour to run, so the students had a break, which allowed for individual questions and discussion
- **DNA Extraction**
- Kane made a drawing of a plant cell on the white board and explained how soaps destroys the cell walls
- The students moved back to the workstations and brought the tube at the workstation to the centrifuge
    - They loaded the tubes into the centrifuge, then Kane ran it
        - Could be difficult for low vision/fine motor skills

- The tubes were taken out of the centrifuge and the liquid on top was poured out
- Students had to fill up the tubes to the 4 mL mark with the red bottle
  - Mark was difficult to see; also had to use pipette
- The solution was mashed up with a stick, then brought to the centrifuge again
- Ethanol was added and the DNA precipitated out as a thin layer
  - Could be difficult to see as it was just kind of an opaque layer

- **Gel Electrophoresis (2)**
  - The gel was taken out and blue dye was added to see the DNA
  - A PowerPoint was used to show the different loci for the different suspects
    - Kane explained how both needed to match
  - The gel didn't develop, so he had to grab a different one to show the students – it was pretty apparent where the lines had moved to
  - Kane then went through the questions in the packet
- Other notes
  - This teacher was going to make the students do a report on what they had done at the CSIROSEC today. They had already learned about DNA and cells.

Gene Technology: Year 10
Karina/Sean at Broadmeadows Secondary

- General Introduction to CSIRO

Gel Electrophoresis

- What is Gel?
    - Examples you have heard of?
    - Goes around and lets students feel an gel
    - Breaks down the word electrophoresis to electro is electric and phoresis is separation
    - Explains today will be loading gels and separating them with electricity
- PowerPoint (Lights turned off)
    - Blue background with black text very difficult to see
    - Hard to see body builder
    - Muscle made of muscle fibres which are cells
        - Cells contain nucleus
        - Nucleus contains chromosomes (What is in them? How are they arranged? How many are there?)
        - Chromosomes are made up of DNA
            - What is the charge of DNA?
            - Have 2 metres of DNA in each chromosome
            - Histones are what DNA wraps around
            - Structure of DNA
            - Protein subunits (nucleotides)
            - Nucleotides are complementary
- Handed out worksheet
- One student reads sheet out loud
- Karina begins to explain the scenario that the student just read
- PowerPoint brought back up
    - Explains parts of chromosome: centromere, locus A, locus B
    - Position A on chromosome 5, chose this area because it is polymorphic
- Explains running a gel in terms of suspects
- Compares DNA movement to small/cat through cat door
- Sample mixed with glycerol to make more dense
- Buffer conducts electricity, has salt in it, also much pH the buffer to match pH of cells
- Video of gel on screen
    - Points out wells on screen
- Shows pipette, asks have you seen this before? Where?
    - Explains range of accuracy of pipette, pipette tips, where hold pipette ("hook part"), how to work a pipette, the two points of resistance
- Students usually practice pipetting however this session was 70 minutes instead of 90
- Karina explains how to load sample and does an example
- Points out negative and positive electrodes on the lid, negative electrode is at the end closest to DNA while positive is at the opposite end so it can attract DNA
    - Note, difficult to see video

DNA Extraction

- On board draws picture of plant cell, how do you know it is a plant cell?
- Labels cell wall, cell membrane, nuclear membrane, chromosomes
    - Writing on the board was small and hard to read (pre-printed labels can tape up on board?)
    - Other things drawn in cell referred to as 'stuff'
- Explains different detergent activity, erases structure as detergent would break it down
    - Has class respond is cell membrane a carbohydrate, protein or fat? Ask about washing dishes, what do you use to get grease off? Also use detergent to break up cell membrane
- Splits class up into groups of 2
    - Each group has a box as well as wheat solution in tube
- Loads tubes in centrifuge
    - Put opposite each other in centrifuge so not unbalanced
    - Karina operates centrifuge
    - Poor out excess solution
- Students use plastic pipette to add solution to epindorph
    - Karina shows students how much solution to have
    - Mix in epindorph by shaking
- Centrifuge again
    - Add alcohol
    - Alcohol causes DNA to precipitate so can see it (looks cloudy at the interface of the two liquids)

Gel Electrophoresis (2)

- Karina shows students how dye formed in different colour bands
    - Dye gives an idea of how far DNA travelled
- Stain gel
    - Bands become blue
    - Walk around with sample that was previously completed and points out DNA bands
- PowerPoint
    - Shows picture of where bands were, goes through if each person is guilty or innocent based on matching bands
- Recap experiment, go through questions on sheet

Gene Technology: Year 10
Karina at CSIROSEC

- Introduction of CSIRO and herself.
- Whiteboard:
    - Gel Electrophoresis
    - DNA Extraction
- Karina explains what these both mean (talking and showed gel and let some students touch it).
- PowerPoint Slides
    - Somewhat hard to see everything
    - Some explanations are very lengthy and it would be difficult for a deaf student to watch an interpreter and the PowerPoint
    - Pictures:
        - Strong Man
        - Cells
        - Chromosomes
    - Lots of hand motions were used to help her describe what she is talking about.
    - Double helix diagrams are on the screen.
- Worksheets
    - The worksheets had questions on them that the students were supposed to answer.
- There is a lot of background noise because there is another program going on in the Green Lab behind us.
- Pipette Practice:
    - Karina shows the students how to use a micro-pipette (putting a tip on and bring up liquid in it).
    - Asks the students to work in groups of 2 or 3 and then go to their station and practice using the pipette.
- Stations:
    - Yellow box with tips in it
    - Pipette
    - Tupperware container filled with necessary equipment.
    - Two small pipettes (one marked with a red piece of tape)
    - Two containers with screw on/off lids (one marked with a red piece of tape)
    - Wooden stick.
    - Test tube with blue liquid in it.
- When the students were done practicing, they sat down.
- Karina shows the students the gel by lifting it up.
- There is a camera on the gel which is projected onto the wall (through power point projector)
    - Image from camera is difficult to see
- She shows all of the samples (5 total) and uses a pipette to pick one up and put it in the well on the gel.
- She invites a student to volunteer and come and do the same thing that she did for the next one.
- This happens 3 more times and Karina helps guide the pipette to the right place.
- The camera stays on the gel so that the students can watch it.
    - Karina encourages the students to come up and look at it during breaks.
- She brings the white board back up:

    - Draws a picture of a plant cell and labels the parts of the cell with help from the students.
- Karina explains the next activity:
    - She shows them a yellow tube
    - She points out the centrifuges in the front of the room.
        - All groups need to use the centrifuge.
    - She describes the necessary materials:
        - Liquid (detergent) with red tape on it and pipette with red tape on it.
            - Add to yellow tube.
- The students do the experiment:
    - One student from each group comes up to take a yellow tube from Karina and then they all go to the centrifuge, which gets crowded at the front of the classroom.
        - All the students gather around to watch the centrifuge.
        - While this is happening, students go up to the front of the room to see the DNA.
    - The students find the container with red tape on it and use the pipette to add 4 ml of detergent.
    - They use the stick to mix it all together.
- Students all sit back down.
    - Karina uses the picture of a cell on the whiteboard to explain what has happened.
- Students do the next part of the experiment:
    - They use the centrifuge
        - Area where the centrifuge is would not be suitable for students with mobility impairments because it gets very crowded
    - They add alcohol to the test tube
    - A cloudy substance appears in the middle of the DNA (Visual recognition is necessary)
        - Not much contrast and tough to see
- Karina asks everyone to clean up and sit back down.
- Karina walks around and shows the students the DNA (with the dye on the gel)
    - Everyone looks at the gel as she passes it around.
- The power point shows the bands for each suspect and the students figure out who it was
- The students copy everything onto their worksheets
- Karina goes through all of the questions on the worksheet and the students answer them
- Other notes
    - The lab desks would be hard to use for students with wheelchairs at all stations; the areas where there are indents in the counter would need to be reserved for the students

Natural Disasters: Year 4-6
Simon at CSIROSEC

- Simon began by asking several questions and getting student responses
    - What is a disaster?
        - Bad, affects lots of people/language/animals
    - What is a natural disaster?
        - Caused by nature
    - Opposite of natural disaster?
        - Caused by human being
    - Examples of natural disasters:
        - Volcano, tornado, earthquake, cyclone, tsunami, bushfire, drought, sandstorm, monsoon, avalanche, blizzard, rockslide, meteoroids/asteroids
    - Human made disasters:
        - Light fire, oil leak, war, global warming
- Categorized natural disaster based on where it occurs
- Used very small squishy globe and showed atmosphere, space, inside of earth
    - Outside layer = crust
        - Is it made of one piece? No, made of plates
    - Magma
        - Is molten rock, liquid phase
    - Inner/outer core
        - Outer core is made of iron and nickel and is in the liquid state
        - Inner core is made of solid metal
- Showed students the instruction sheet, explained students should first read the instructions then do the experiment
- Students work in groups of 3

- **All Together Now**
    - Jigsaw puzzle, fit together, compare to sheet of paper to see where volcanoes would be on the puzzle, unassembled for next group
    - Could feel pieces fit together for puzzle
    - Cannot see observe where volcanoes are on map, cannot see how that coincides with puzzle
    - 3D puzzle?
    - Purpose of puzzle is shows edges of plates, need to identify if volcanoes are on edges
- **Animated Earth**
    - Flip book, see how earth changes
    - Not at all visually accessible
    - Hard to flip through for mobility
    - Possible Computer Animation?
- **I Feel the Earth Move**
    - Rope – send pulse and wave propagates
    - Slinky – compress and let go
    - Cannot see movement and would be hard to feel
    - Difficult for mobility
        - Holding rope/slinky (hand grip device? Handle?)
- **How Dense Are You?**

    - Pour water in the cylinder, drop rock in, water rises the volume of the rock weigh rock, use calculator to determine density
    - Density explained by Simon
    - Blue liquid good for contrast
    - Rocks big enough to pick up
    - Pouring liquid could be difficult, as well as reaching the top of the graduated cylinder
    - Getting rock out of beaker was difficult
    - Different rocks felt different (smooth, light and porous, rough)
    - Using the scale (buttons, etc.) could be difficult
    - Reading Graduated cylinder difficult
    - SIMON: "Conceptually this is the toughest"
- **It's Runny Hunny**
    - Time how long it takes the marble to fall through liquid (testing viscosity)
    - Contrast – hard to see marble in brown tube
    - Operate stopwatch
    - Must see movement to time it
    - "glass display case problem"
    - Labels on tubes A,B,C,D (bigger/Braille)
    - May be possible to have students feel difference in viscosity using a glove
- **Shaking All Over**
    - Have a seismometre, hit box to make an 'earthquake', observe metre and find longest earthquake, fastest vibration
    - Usually takes a kick or other application of force to get an 'earthquake' to read
    - Had to hold seismometre to stop it from moving in between tests
    - Reading metre tough
    - Seeing movement of seismometre could be difficult
    - Sheet with four different pictures labelled A,B,C,D each had different type of wave could result from an 'earthquake', figure out what type of application of force would make those waves
- **Round the Twist**
    - Fill jug, pour water back into open top container and see what happens
    - Filling large container with water and holding it up difficult
    - Reaching top of other container to pour water in from first container difficult
    - Seeing water movement
    - Good contrast because water was dyed blue
- **Slip Sliding Away**
    - Determine angle at which sand starts to slide (mimics landslide)
    - Reading angle could be tough
    - Turning handle to change angle difficult for mobility
    - Observing sand move but can hear it slide

- Students regrouped for discussion
    - Discussed viscous experiment and compared to lava
        - Changes in viscosity due to heat
    - Air inside the rocks in the density experiment make then very light and different types of rocks form from different types of lava
        - Causes some rocks to float because they are less dense
    - Tectonic plates
        - Volcanoes are on the edges

Natural Disasters: Year 5-6
Merrin at Strathmore Primary School

- Introduction
- Discussion:
  - The students all sit in front of Merrin on the floor.
  - Merrin sits on a seat, which makes it easier for all of the students to see.
  - Merrin asks the students what they think a natural disaster is.
  - The students take turns answering questions out loud.
- Visual Aid:
  - Merrin takes out a small globe and breaks it in half.
  - The inside has the layers of the earth labelled and she explains things about all of them.
    - It is not a very tactile visual aid because everything is flat, but it visually gets the message across.
- Merrin walks around the room and explains all of the activities by lifting them up and showing the students how to use them and through verbal explanation.
- The students get into groups of 3 and stay seated.
- The students get worksheets and go to whichever station they choose.

- **Puzzle**
  - The students make a puzzle and compare it to a map that has active volcanoes marked on it.
  - Barriers:
    - Visual:
      - The students could not see the area where the puzzle pieces go.
      - The student could not compare it to the 2-D map of the world.
        - Make a map that has raised bumps where the volcanoes are.
        - Maybe put the volcano dots on the puzzle so that the student can feel where they are?
    - Auditory:
      - Good for students with auditory impairments because it is simple and a visual recognition of the concepts.
- **Animated Earth**
  - There are two books at this station; one is a picture book about natural disasters and another is a flip book that students flip through and it shows the continents moving.
  - This activity may be changing to a computer program instead.
  - Barriers:
    - Visual:
      - The children cannot see the flip book or the picture book. (Not very adaptable for visual impairments).
    - Mobility:
      - It might be hard to flip through the flip book if a student had mobility impairments.
        - Have another student help them.
- **Earthquake**
  - The students hit the table or jump on the ground around the table to try and make the pin on the voltmetre attached to the seismograph move the most.

- Barriers:
  - Visual:
    - The student cannot see the voltmetre reaction and it is not something that you can feel or hear to get a reading.

- **Water Vortex**
  - The students pour water into a container and watch the water vortex that forms as the water escapes into a tub below.
  - Barriers:
    - Visual:
      - The student would not be able to see any part of this experiment because it is a small water vortex and there is no contrast in the water.
    - Mobility:
      - It would be hard for a student with strength disabilities to lift the 2 L of water because it is quite heavy.

- **Viscosity**
  - The students turn tubes upside down and time how long it takes for a ball bearing in it to reach the bottom. (The longer the time the ball bearing takes, the more viscous the liquid is).
  - Barriers:
    - Visual:
      - The tube is just a tube for a student with visual impairments; they cannot feel the difference because it is inside a plastic tube.
      - The ball bearings would be hard to see; it was hard for the students without visual impairments to see the ball bearings as it is.
        - Maybe have some open containers of honey, water, etc. that the student could feel to understand the concept of viscosity.
    - Mobility:
      - Would need enough motor skills to hold and flip the tubes.
      - Would need strength to lift the tubes and hold them or be able to reach a table to put them on.
        - Might need someone to help them.

- **Rope and Slinky**
  - The students go on the floor and stretch the slinky out and pull one end and stay holding on to both ends to see what happens to the slinky.
  - The students do the same thing with a rope to see the patterns of waves in the rope.
  - Barriers:
    - Visual:
      - It would be hard for the students to see the patterns that occur in the slinky and the rope.
    - Mobility:
      - There would need to be a table for the students to do it on because it would not work for them on the floor.
      - They will need at least enough strength to hold on to a rope or slinky for a little while.

- **Density**
  - The students weigh 3 different kids of rocks on a scale.
  - The students put the rocks in a graduated cylinder and record the water displacement.
  - The students divide the two with a calculator to find the density.
  - The students do not find the weight and density in the younger version of the program.
  - Barriers:
    - Visual:
      - The student would not be able to see the measurements on the scale or the graduated cylinder.
      - The student would not be able to use the calculator.
    - Mobility:
      - The student would need to reach the top of the graduated cylinder which can be quite high because it is on top of a table/lab counter.

Thinking Scientifically: Year 7
Caitlin at Niddrie Secondary School

- Room was set up with long tables in the middle and lab benches along the walls
- Began with a general introduction of CSIRO
    - Talked about Australian money: CSIRO made polymer used
- Asked students to describe science
    - Is it the best way of answering questions?
        - Ask kids to think of ways to find out what she had for breakfast
            - Easiest way is to ask
- Showed Paper Airplanes and asked which is best: only visual (blind/visually impaired student could not participate)
    - What does "best" mean though? – not a good science question, because there are different suggestions
    - Asked for a student volunteer to construct a paper airplane
    - Two more volunteers were selected – The 3 threw airplanes at the Americans
        - Not a fair trial because different people throwing
    - How to make fair?
        - Have one person throw (not builder of any of planes due to bias)
- No instructions are given for the stations – only a sheet with some information
- Must devise steps to answer the question. The purpose is to get the students to design their own experiments
    - Question
    - Hypothesis
    - Variables – 3
        - What you find/measure
        - What you change
        - Everything else that is kept the same
- 5 experiments, must show all of above info in workbook
    - They are given the question that must be answered
- Briefly went over each experiment, giving pointers and restrictions for each

- **Gas Production**
    - most difficult
    - Kids had to read sheet and figure out what to do
    - First forgot plug – where did the gas go?
    - Lots of interaction with each other
    - Stopwatch weird to figure out
    - Measuring, dumping, tipping and putting stopper on all areas that may be difficult for mobility
- **Dissolving Sugar**
    - Asked me for clarification on a question
    - "It already dissolved?!" – tough to see when it was actually dissolved
    - Measuring one flat teaspoon and getting water – tough to do for mobility
- **Pendulum**
    - Asked Lynn about stopwatch
    - Looking at the pendulum to know the period was difficult
    - Setting up pendulum might be difficult for mobility
- **Electro Chemistry**
    - Placement of metal not definitive

    - Measuring voltage and setting up voltmetre could be difficult for some with a vision impairment
- **Rubber band racer**
    - Setting up (winding with rubber band, placing weights) difficult for mobility and vision
    - Measuring with regular tape difficult for someone with a vision impairment

- After everything was done, the kids were asked to tidy up a bit and head back to their seats
    - An experiment was discussed (multiple if time) based on number that completed it
    - Talked about the different variables that could cause error
        - Different people starting the pendulum and the watch
    - Must find errors and re-do experiment
        - Many saw they messed up the gas experiment and re-did
    - Discussions were not the same each session
- Other notes
    - Nothing sent ahead of time
    - School had random noises that were typical to a school (students' voices, etc.)
    - Caitlin is easy to see and hear.
        - She turns around sometimes to write on the board and you cannot see her face
    - Caitlin went around and helped the kids where she was needed
        - Looked over sheets to make sure they were on the right track
        - Had to tell them not to eat anything
    - There was a lot of talking and interaction between the students in each group
    - First teachers did not walk around and interact with the students at all
    - Second teacher liked this program better than a previous one they had done
        - Making Goo: "just ran around and mixed stuff"
- Talking with Caitlin
    - Once had visually impaired child in holiday science (parents didn't inform CSIRO)
        - Ok if someone was helping him, but very difficult to cut out everything and even get pizza
    - Aspersers, autism are relatively easy to accommodate for
        - CSIROSEC usually has someone aid them
    - Usually if kids are in a mainstream school and an aide is needed, they have one
        - Once had a mobility impaired child with crutches and poor motor skills – child had an aide w/ them
    - One area that is not accommodated for is other languages
        - In general, Australia does nothing
            - i.e. Great Ocean Road: all signs are only in English
    - When she worked at a museum in London, she had to adapt some trail exhibits to be multi-sensory (feel polar bear fur, etc.)

Appendix R Summary Checklist

AUDITORY Summary Checklist		
Task	***Barrier***	***Programs with Barrier Present***
Reading (Labels, Instructions, Visual Displays)		
Reading a container label	Comprehending instructions	
Reading Instruction Sheet	Comprehending instructions	ALL PROGRAMS
Communication		
Listening to Verbal Instructions	Cannot hear instructions	ALL PROGRAMS
Students not facing each other	Cannot read lips/hear/sign during discussion	ALL PROGRAMS
Asking teacher/presenter/students questions	Cannot communicate verbally	ALL PROGRAMS
Presentation		
Presenter getting student attention	Cannot hear presenter	ALL PROGRAMS
Evaluation		
Evaluation in written form	Often cannot connect idea with written communication	ALL PROGRAMS
Other		
Sensory Overload	Multiple pieces of information delivered through one sense	ALL PROGRAMS

MOBILITY Summary Checklist		
Task	***Barrier***	***Programs with Barrier Present***
Moving Substance		
Moving powder from one container to another	Holding containers, picking up powder, getting powder in potential narrow opening	Forensic Frenzy
Moving a liquid from one container to another	Pouring Liquid, accuracy of pouring liquid	Natural Disasters
Pipetting	Manipulating pipette, feeling the two different settings, discharging tip	Gene Technology
Moving/Manipulating Objects		
Pages to flip	Difficult to grasp and separate pages	Forensic Frenzy Natural Disasters
Applying force to move an object, pushing/pulling	Not strong enough to push/kick object, cannot apply focused force (only blunt force)	Energy Force and Movement Natural Disasters
Turning handle/crank	Strength required, range of motion required	Driving Innovations Energy
Shaking/Stirring	Holding container, shaking movement	Gene Technology
Twisting cap/Snapping cap on/off	Holding container, rotating cap, specific application of force to snap off cap	Forensic Frenzy Gene Technology
Object difficult to hold onto	Object either too large or small for student to grasp and hold onto (i.e. rope, slinky)	Driving Innovations Energy Force and Movement Forensic Frenzy Natural Disasters

Measuring		
Measuring volume of a liquid	Adding/removing substance, accuracy of adding/removing substance to get target mass	Gene Technology Natural Disasters
Weighing mass of a solid	Fitting pieces together, holding pieces in one place, applying force to connect pieces	Natural Disasters
Assembly		
Assembling device	Movement is not at level that can observed (table height to high, floor can't be seen)	Driving Innovations Energy Force and Movement Natural Disasters
Tools		
Stopwatch	Manipulating stopwatch	Driving Innovations Natural Disasters
Calculator	Buttons too small, holding calculator	
Evaluation		
Evaluation in written form	Cannot write answer on sheet	ALL PROGRAMS
Activity Location		
Activity based on floor	Cannot reach from their wheelchair	Force and Movement
Activity based on desktop	Cannot reach from wheelchair	Driving Innovations Force and Movement Forensic Frenzy Gene Technology Natural Disasters
Other		
Repetitive handling	Fatigue	Energy Force and Movement

Stooping	Reaching down to the floor to complete an activity	Force and Movement
Reaching upwards	Object is too high and out of student's reach	Energy Force and Movement Natural Disasters
Pushing or pulling	Student is not strong enough to push/pull object	Force and Movement
Holding loads of weight from the torso	Student is not strong enough to support load	Force and Movement Natural Disasters

VISION Summary Checklist		
Task	***Barrier***	***Programs with Barrier Present***
Moving liquid or powder		
Moving powder from one container to another	Measuring proper amount of powder, getting powder in potential narrow opening	Forensic Frenzy Thinking Scientifically
Moving a liquid from one container to another	Pouring Liquid, accuracy of pouring liquid	Forensic Frenzy Natural Disasters Thinking Scientifically
Pipetting	Seeing how/where the liquid is discharged, adjusting the pipette for different volumes	Gene Technology
Measuring		
Measuring Volume of a liquid	Pouring Liquid, accuracy of pouring liquid, reading measurement on epindorph	Gene Technology Thinking Scientifically
Weighing mass of a solid	Reading output of scale, accuracy of adding/removing substance to get target mass	Natural Disasters
Reading Angle	Cannot see protractor to read angle measurement	Natural Disasters
Reading (Labels, Instructions, Visual Displays)		
Reading a container label	Cannot see print, contrast	Forensic Frenzy Gene Technology Natural Disasters Thinking Scientifically

Reading Instruction Sheet	Cannot see print, contrast	ALL PROGRAMS
Reading a PowerPoint	Cannot see print, contrast	Driving Innovations Gene Technology
Reading a poster/visual display	Cannot see print, contrast	Driving Innovations Forensic Frenzy Gene Technology
Map	Cannot see locations or attributes of different parts of the map	Natural Disasters
Booklet/pamphlet/etc with pictures	Cannot see picture	Forensic Frenzy Natural Disasters
Movement		
Observing gas behaviour	Cannot see movement of gas	Air and Weather Driving Innovations Thinking Scientifically
Observing Liquid Movement	Waves, currents, cyclone movement, rising/sinking due to density, viscosity	Air and Weather Natural Disasters
Observing displacement/movement	Observing acceleration, measuring distance between initial and final location	Air and Weather Driving Innovations Energy Force and Movement Gene Technology Natural Disasters
Timing object movement	Observing when object has moved desired, seeing how much time has elapsed on the timer, knowing which buttons are start/stop/reset	Driving Innovations Natural Disasters Thinking Scientifically

Presentation		
Descriptions do not coincide with hands-on availability	Student cannot feel object as is being described (i.e. describing foreign object student has never felt before)	ALL PROGRAMS
Observing Liquid Properties		
Dissolving solid in liquid	Observing rate of dissolution, measuring how dissolved the solid is	Thinking Scientifically
Seeing separation in liquid	Cannot see precipitate, separation (i.e. water and oil due to density difference)	Gene Technology
Colour		
Colours used are of significance	Specific shade corresponds to a pH, commonly known object	Forensic Frenzy
Colour changes	Cannot detect changes in colour	Forensic Frenzy Gene Technology
Tools		
Stopwatch	Seeing which buttons are stop/start/lap reset, reading output	Driving Innovations Natural Disasters
Reading metre output	Setting metre, seeing output	Natural Disasters
Calculator Use	Seeing buttons, seeing output from calculation	Natural Disasters
Evaluation		
Evaluation in written form	Cannot see to write in worksheet	ALL PROGRAMS

Other		
Assembling device	Identifying how different parts fit together, fasteners and connectors	Driving Innovations Energy

Appendix S Compilation of SAM Reviewer Feedback

Reviewer Name	Matrix Reviewed	Suggestions	General Comments
Jeremy Brett	Auditory	- Signing on video can be an alternate form of assessment - Create activities student can feel and move and touch, concepts will sink in better with students - Graphics and visual thinking organizers should be used (ex: Venn diagrams, flow charts) - Make sure subtitles are appropriate for different age levels - Students are overwhelmed by too much text - Programs may need to be shortened to allow extra time for students	- User friendly and easy to access - Good that the matrix mentions deaf literacy
Anna Gauthier	Auditory	- “Can Verbalize” should be “Can Verbalize Orally” - “Cannot Verbalize” should be “Use manual communication” - Hearing impaired should be changed to hearing loss - Verbalization is the use of words and pertaining to all languages, not just spoken words. - Non-traditional signs are based on cognates - Ask higher order thinking skill questions (HOTS) - Partial hearing should be changed to usable residual hearing - Various other grammatical and vocabulary changes	- Many paragraphs nicely worded
Erica Povey	Auditory		- The matrix presents the situation and solutions in a logical manner and is easy to follow, provided time is taken to absorb the introductory material

			- Impressive - Very comprehensive - Addressed a range of issues and included some good examples with enhance the descriptions. - Good inclusion highlighting the difficulties deaf students may have beyond just hearing the information but processing the language.
Colin Johanson	Mobility		- Looks good. - Glad to see his comments were put to good use. - Did not see any errors. - Premises seem logical.
Kate Fraser	Vision	- Another task: assessing when something is full - Students do not always have a heightened sense of touch but have just learned to use their sense of touch more effectively - White letters on a black background can work well for presentations and text - Encourage students to scan area to locate all objects	- "Absolutely wonderful!" - User friendly - Would recommend this as a resource for other people - Would like a copy when it gets published
Garry Stinchcombe	Vision	- Labelling tactile diagrams is great but can sometimes be too complicated - There are more complexities associated with this disability; the matrix serves more as an overview - Thinking laterally and innovatively are key considerations	- Great resource - Well collated

Appendix T Forensic Frenzy Program Description

Ballistics - Type of Firearm:

- Look at the entry and exit holes in the t-shirt on display.
- Compare those with entry and exit holes in the t-shirts in a book with different bullet holes and firing distances.

Envelope Ink:

- Draw a short, horizontal line with a black pen a white strip of paper.
- Write the name of the suspect on the top of the paper.
- Repeat the first 2 steps with the other black pens.
- Carefully place the bottom of the paper into the water. Make sure that the ink marks are above the water level.
- Watch the water rise up the paper. Take the paper out after a few minutes.
- The ink from the envelope has been tested in the same way. This ink pattern is covered in plastic. Compare this ink pattern with the patterns from the suspects' pens.

Dental X-Rays:

- Hold the victim's X-ray up to the light. This lets you see it more clearly.
- Look for similarities between the X-ray from the victim and those from the missing persons.

Fabric on the fence, fibres on the body:

- Use tweezers to take a small piece of each of the 4 fabrics from our suspects and place it into a square of the yellow box.
- Wet the fabrics.
- Put 1-2 drops of Shirlastain onto the wet fabric.
- Rinse the fabrics with water, remove with tweezers and put them onto the blotting paper.
- Compare the colours of the fabrics with that of the fabric found on the fence, and the fibres found on the victim's clothes. These have already been trated with Shirlastain, and have been laminated.

Facial Identification:

- Look at the picture of Rodney Georgiou for 30 seconds and then turn it face down.
- Use the computer program to reconstruct his face.
- You can increase the size and position of different features on the face.
- Compare the picture that you recreate and the actual picture of Rodney Georgiou when you are finished.

Fingerprints:

- Compare the prints with the fingerprints of the four suspects.

Is it blood? Whose blood?

- Take a "Hemastix" from the container.
- Using tweezers, take a piece of the fabric and put it in the centre of the bowl.
- Stir the fabric in the water for 15 seconds.

- Place the yellow end of the "Hemastix" on the damp cloth for 5 – 10 seconds, and check the colour. If any of it turns green, the fabric was stained with blood.

Looking Complete:
- Mould the plasticine onto the front of the skull.
- Use the blue pegs as a guide for the depth of the skin layer.

Oil Stains:
- Locate the bottles of oil.
- Place a smaller smear of oil from the victim's clothing (evidence) onto a piece of filter paper. Write "victim" near the smear.
- Place a drop of each of the other oil samples on the same piece of filter paper.
- Place the filter paper in the light box, under the UV light.
- Compare the "evidence" with oils obtained from the suspects.

PAID Stamp:
- Stamp each of the PAID stamps on a blank page in your workbook.
- Compare these with the PAID stamp found by detectives on the back of the ransom note. Look for scratches, dents or other flaws.

Smooth Surfaces:
- Wipe the mug with a tissue to remove any fingerprints.
- Make a thumbprint on the mug.
- Dip the brush into the fingerprint powder.
- Tap off the excess powder.
- Lightly brush the area where your fingers touched the mug.
- Examine the fingerprints with a magnifying glass.
- When finished, clean the mug with a tissue.

Soil Testing:
- Place a quarter of a spoon of the crime scene soil sample onto the clean white tile.
- Add one drop of the liquid and mix it with the soil with an icy-pole stick.
- Puff the white powder onto the soil so that the soil is just covered with powder. Do not stir powder in. Two puffs should be plenty.
- Match the soil colour with one on the chart. Each colour has a number near it. This number tells you the amount of acid in the soil. It is called the pH of the soil.
- Repeat steps 1 – 4 for each of the other samples taken from the suspects' shoes.
- Wipe the soil into the bin and wash the white tile.

Tyre Tracks:
- Look at the photo of the tyre tracks taken from the crime scene. Notice any distinctive patterns.
- Look at the photos of the 4 suspects' tyres. Make sure that you look for strange marks or bald patches.
- Compare the crime scene photo to the suspects' tyre photos.