A Vision of Whales:

Creating a Whale Research Program for Individuals who are Blind or Visually Impaired

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Abstract

The purpose of this research project was to explore how field experience can be used to increase understanding and researcher behaviours in young adults who are blind or visually impaired. This study probed effective teaching methods and solutions to accessibility issues through high-level participation in a field ecology research setting involving marine mammals. The weeklong program was executed in a pre-existing long-term gray whale ecology research site in Clayoquot Sound, British Columbia. Four research questions guided the overall planning of the program. The concentration of effort was applied to adapting the field site and equipment in order for students to use and access the resources during planned multisensory activities. Three post-secondary students spent a week in the field becoming active marine mammal researchers. Data for this study were gathered through a variety of qualitative methods including vocabulary checklists, journal writing, a group case study and questionnaires. The results of this program have implications for educational opportunities by highlighting how addressing and offering learning tools that appeal to a variety of learners can create new and vital opportunities for students who are visually impaired.

Preface

This graduate-level research thesis is an original study in the field of education for students who are blind or visually impaired. The study procedures were conducted, with supervision from the research committee, in particular by Dr. Cay Holbrook, in the faculty of Educational and Counselling Psychology and Special Education. Additional supervision was provided by Dr. Kim Zebehazy in the faculty of Educational and Counselling Psychology and Special Education, and from Dr. David Duffus of the Whale Research Lab, Department of Geography, University of Victoria. The graduate student conducted all elements of this study including data collection and evaluations. Therefore, the graduate student is considered the primary researcher for this study. The UBC Behavioral Research Ethics Board (BREB) approved the study proposal on March 11th, 2010, as a minimal-risk study. The BREB research approval number is H09-03426.

Table of Contents

List of Tables

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Introduction

Understanding and interest in science topics begins at an early age in part because science is all around us. Science is a fascinating subject that engages children from an early age. Science principles are used to explain why it rains, how our internal organs function and what we know about the solar system. Teachers and parents engage children formally and informally, exploring science by helping them explore the world around them in new and unique ways. In schools, students who are visually impaired are included in general education science classrooms and are expected to participate fully in science-related activities alongside their sighted peers. For those students, science should be an exciting subject that provides many opportunities for multi-sensory exploration.

As teaching philosophies grow and evolve, school districts have moved toward a model of inclusive education, so that classrooms are multicultural and multi-dimensional. Inclusive education can be defined as education that is non-discriminatory to gender, culture or disability (Ballard, 1997). The momentum of the last ten years has been toward full inclusion (Evans & Lunt, 2002). It is now common to have classroom groupings that include students who are gifted, students with average academic abilities, and students with learning, physical and/or sensory disabilities.

The model of universal design addresses all learners in the classroom through a variety of teaching methods. Universal Design for Learning (UDL) incorporates curricula, methods, materials and environments to support and challenge each learner (Pisha & Coyne, 2002). By using principles of UDL, teachers diversify their lesson plans to reach the broad needs and interests of students in their classrooms, while students become aware of how to identify their own learning strengths and capitalize upon them.

Teachers use UDL in classrooms to address the learning needs of students with visual impairments, and to make the curriculum and classroom materials accessible. One example of a curricular area that has been inaccessible to students who are blind or visually impaired is science. Current and evolving technology is making the laboratory safer by making it possible to conduct experiments that are multi-sensory, allowing students to participate actively in experiments. Technologies, such as auditory pipettes to measure liquid, Kevlar gloves for dissections and sensors that relay information to a text-to-speech screen reader give the student immediate and accurate information.

Kumar, Ramasamy and Stefanich (2001) recommended providing assistive technology wherever possible in a science classroom. The more ways that principles of Universal Design are used in the classroom, the more often students' individual needs can be addressed (Howard, 2004). A concept such as the inner workings of a plant cell and its internal apparatus can be examined through highly developed tactile models that differ in shape, texture and sizes. Another concept, such as biodiversity, may involve students who are blind or visually impaired by asking them to listen to a variety of bird calls, collecting information pertaining to each bird's size, shape, coloring and feeding preferences, then making an assessment of the number of species in a geographic area.

In a field-based setting, students with visual impairments can use multisensory approaches to gathering information, as well as orientation and mobility skills to navigate and learn about new environments. Although students' skills may differ depending on individual circumstances, many students have the ability to engage actively in learning opportunities, even on their initial encounter with novel science materials.

Barriers to Science Accessibility

Universal Design for Learning (UDL) is widely used in general education classrooms today. However, for students who are blind or visually impaired, if UDL principles are not used in the science classroom, students' understanding of science concepts may be limited by traditional teaching approaches since their learning needs may not be addressed. In such cases, these students may be challenged by a lack of access to high-quality multi-sensory equipment, a lack of teacher training for how to instruct students who are visually impaired, and the presumption that they are not capable of learning, understanding and conceptualizing many facets of science as it is considered a visually dominated group of disciplines.

Sahin and Yorek (2009) stated that because many science concepts are and depend on visual representation, they can often be difficult to teach. To understand the world around us from large to microscopic changes that occur, our sensory systems record and digest the myriad of changes. We can smell the change in the air in springtime and hear the chemical reaction in a container in a laboratory, but we rely strongly on sight to complete much of our data assimilation. As Willoughby and Duffy (1989) suggest, "[U]nfortunately science is still a subject where blind students sometimes are left out partially or completely" (p. 327). For the student who is visually impaired and interested in science, lack of active participation in the science classroom, laboratory and field experiences can be frustrating and challenging because of inaccessible instruction.

Accommodations to support learning for a student who is blind are often considered too challenging and costly for schools (Winchatz & Riccobono, 2007). In addition, there is an absence of preparation in non-visual teaching methods for general education classroom teachers. Usually, the training of general classroom teachers does not prepare them for teaching students who are visually impaired. This leads to the general case described by Fraser and Maguvhe, (2008): “[E]ducators are not aware of what should be done to accommodate blind and visually-impaired learners during the acquisition of Science Process Skills and/or assessment” (p.85). It follows that a lack of teacher awareness will result in limited student opportunities. Erwin, Perkins, Ayala, Fine & Rubin (2001) noted that one of the most important questions teachers can ask is, “How can I support my students' inquiry about the world? This question is particularly important for teachers who work with children who are visually impaired" (p. 338).

In addition to making instruction accessible, general education classroom teachers, school administrators and parents often express concern for the safety of students who are blind or visually impaired in the classroom, laboratory and the field. According to Winchatz and Riccobono (2007),

> “As a consequence of their isolation at school, lack of appropriate classroom materials, and unfamiliarity of teachers and parents with their needs as nonvisual learners, students rarely develop an interest in Science, Technology, Engineering and Math disciplines, and even if they do show interest and talent, they are often discouraged from pursuing these fields” (p. 1855).

Even during general education science classes, the laboratory can easily be the scene of accidents given the exposure to chemicals, glass objects, burners, scalpels and other items that may cause harm to a student. For many teachers, the presence of a student with a disability adds another dimension of concern. Based on a national survey in the United States of grade 7–12 science teachers, 59% of teachers expressed the belief that the presence of students with disabilities in the laboratory was an increased safety risk (Stefanich, 2007). Those perceptions may be strong, but Stefanich continued by stating there is no research evidence that students with disabilities present a greater risk than any other students.

Concern that the student with a visual impairment is in danger may originate from a fear that since students cannot see what they are doing in the lab, they will injure themselves or others around them. Teachers may believe that without vision, a student cannot safely conduct science work. This belief can have serious consequences for the student who is blind or visually impaired. In the past, it was not uncommon to find a student with a visual impairment sitting next to another student and recording data while the sighted student mixed the chemicals or conducted a dissection. As technology improved, there has been considerable movement toward creating technologies to allow students who are visually impaired to participate more fully, but there still is much ground to be covered. Finally, many teachers who have less experience with students with visual impairment do not know how capable these individuals actually are, and are unsure how to gauge their skill level.

Science Opportunities Outside of School

As previously discussed, there are challenges to science classroom instruction for students who are visually impaired; therefore, alternative instructional options have arisen. One option that confronts logistical issues head on is the idea of a “science camp.” Currently, there are a number of science camps in North America that are designed for youth who are blind or visually impaired. The camps offer opportunities for learning with multi-sensory activities to maximize the students’ experience. These camps include Space Camp in Huntsville, Alabama (Lewis, 2005), and the Oceanography Camp in Woods Hole, Massachusetts (Fraser, 2008). Both camps are available to youth who are blind and/or visually impaired and interested in science, particularly in oceanography or space. These camps offer science in a manner that allow students to be fully involved and engaged in learning and socializing in a setting that is tailored to their learning needs.

These educational settings may be the route to advancing students' knowledge and interest in a manner in which their impairments are dealt with by a combination of educational and scientific adaptations. The disadvantages of these camps are that students are taken out of the day-to-day routine of school, are limited in the number of students they can accommodate and are expensive. Nonetheless, learning experiences outside of the classroom are an investment that will pay off many times over if it allows educators to bring students with visual impairments into scientific enterprises. It would be tragic to leave students out of educational field experiences merely because of a disability, since many of these students are an untapped well of ideas, enthusiasm and intellectual potential for scientific contribution.

Science and Marine Field Work: Untested Waters

The purpose of this research was to explore how field experience can be used to increase understanding and researcher behaviours in young adults who are blind or visually impaired. This study probed effective teaching methods and solutions to accessibility issues through high-level participation in a field ecology research setting involving marine mammals. The study involved creation of a "Whale Research Program" for students who are blind and visually impaired in Clayoquot Sound, British Columbia, by integrating a suite of multisensory activities that fit into the real day-to-day research activities of an established, ongoing whale research facility.

Currently, there are several marine field research stations in North America; however, none have ever included targeted instruction for students with visual impairments. For this research, instead of creating a marine field setting specifically for students who are visually impaired, an existing field research program was modified and made accessible. In this way, alterations and adaptations to traditional research materials were kept to a minimum, based primarily on safety and sensory routes for students' understanding and participation.

The field research program run by the Whale Research Lab, Department of Geography, University of Victoria (UVic), allowed integration of this program within their active long-term ecological studies on the west coast of Vancouver Island. The UVic Whale Research Lab has been in operation for 20 years. Their program has overseen the training of over 20 graduate students, and several hundred interns, assistants and undergraduate students. Not surprisingly, they had not previously worked with students with visual impairments.

The "Whale Research Program" offered students who are blind or visually impaired a unique opportunity to experience a marine field research station, scientific field research and to experience wild whales as a member of an authentic research team. The central theme of this program was to teach students with visual impairments about marine science, through an intimate teaching group combined with field research activities, similar in structure to graduate training, except in terms of the depth of the material presented. Marine mammal science is a complex topic involving many spatial, distance and size attributes. For instance, marine researchers will use visual information such as the size of a whale to determine the whale's age, sex and species. The understanding of landmarks, distances and size needs to be broken into smaller units to develop a comprehensive "picture" of migration routes, feeding sites and behaviours. It is likely that the conceptual basis of whales and marine settings for students who are blind or visually impaired is underdeveloped. Throughout the course of the field experience, students were expected to begin to identify themselves as researchers and become integrated members of a team conducting field research.

Whales are large wild animals and few people are fortunate enough to experience whales in their natural habitat. Seeing whales requires money and proximity to the ocean. There are only a couple of aquariums in Canada, in locations such as Vancouver and Niagara Falls that display marine mammals. Whale watching is the alternative, but the costs are high and the accessibility options for an individual who is visually impaired are uncommon. The "Whale Research Program" allowed students direct access to the ocean and whales using research lab vessels, and equipment not typically available to them. The conceptual and educational aspects of the program to allow students to develop and enhance their framework for thinking about whales and marine environments was evaluated with focus on the following research questions:

1.) What was the impact of the Whale Research program for building students' understanding of marine mammal research?

2.) Can the whale research program increase students' self-evaluation of their role and potential as a researcher?

3.) Will the whale research program increase students' confidence in being members of research teams?

4.) Are all aspects of the whale research program equally accessible for all participants?

Definition of Terms

Fieldwork. The term fieldwork is defined as spending time in the outdoors, also known as the field. The experience of fieldwork cannot often be replicated in the classroom or in other learning situations. Much of the work that students participated in during this research program was in the field; in this instance, on a boat in the ocean.

Researcher behaviour. This term refers to tasks, activities, verbal exchanges and attitudes that students use, which indicate they are embracing skills related to research data collection and scientific exploration.

Marine Ecology. This term refers to the relationship between the environment and a group of living things existing in or near the ocean. It refers to climate, prey and predators in the coastal waters of the Pacific Ocean, more specifically within Clayoquot Sound.

Chapter 2

The Whale Research Program for individuals who are blind or visually impaired in Clayoquot Sound used a variety of teaching methods to allow students to gain access to and learn about marine mammals. Four research questions shaped this program and determined if it allows students who are visually impaired to become marine field researchers for a week. Teaching methods were based on literature regarding best practices in science for students with visual impairments.

Experiential Learning Models

There is evidence in the literature that Experiential Learning increases student engagement (Boyatzis & Kolb, 1991; Hopkinson & Hogg, 2004). Experiential Learning theory was developed from the work of John Dewey, Kurt Lewin and Jean Piaget. The theory is based on the principle that we are learning when participating in a concrete experience. According to Kolb's 1981 paper, which defined experiential learning as "...the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience (Kolb 1984, p. 41)." The theory has four phases, which explained the process of learning from experience: concrete experience, reflective observation, abstract conceptualization and active experimentation (Boyatzis & Kolb, 1991). Thus, it is activity oriented and student centered. Hopkinson and Hogg (2004) stated there is significant evidence that student-centered approaches to learning using experiential activities significantly enhances students' understanding and aids in the acquisition of transferable skills.

Educators routinely incorporate experiential learning into the classroom and into science teaching. The benefits of doing so are well-documented (Mabie & Barker, 1996;

Hopkinson & Hogg, 2004). Students taught using the principles of Experiential Learning Theory are more engaged, ask more detailed questions and recall the lesson and experience more easily. A link has been established between experiential instructional strategies and improvements in science process skills (Mabie & Barker, 1996).

A large part of experiential learning enhancement should also include adaptive technology for students who learn using different mediums. The benefits of having adaptive technology in the classroom are numerous for any student, including those with visual impairments. Adaptive technology allows students who are blind or visually impaired to be more independent and learn new skills while performing similar activities as their classmates. In recent years, technology has become more advanced, and allow students who are blind or visually impaired to participate in science in new ways.

For instance, the Vernier LabPro is a device that connects to a computer while collecting data. The computer, updated with Job Access with Speech (JAWS), a text-to-speech program, will read the information collected from an instrument through the LabPro. Similarly, a Vernier Salinity probe can be placed in a glass of tap water. Once the device has been attached to the LabPro, the text-to-speech program reads the salinity level aloud. This type of technology allows students with visual impairments to determine information independently.

Tactile graphics and models are another type of adaptive material important for experiential access. In biology, because so many aspects of the curriculum are highly visual, a student who is blind or visually impaired can be offered a number of models to explore, build and disassemble to learn about an object. Tactile graphics can be used effectively if models are not available. For a student, who is visually impaired being able to trace an object and feel different textures and the overall structure of something is an added support for descriptions and concept development. Studies into tactile representation by D'Angiulli (2007), Fritz, Way & Barner (1996), and Bin & Chuen-Jiang (2010) all discuss the use of tactile pictures to aid comprehension for individuals who are blind or visually impaired.

Barriers to Science Instruction

Science is a discipline in which students who are visually impaired experience barriers to learning. Three areas have been identified as contributing significantly to students who are visually impaired from experiencing science to the fullest. First, there is inadequate teacher training to know how to instruct a student who is visually impaired effectively. Fraser and Maguhuve (2008) found that post-secondary institutions were doing very little to bridge the gap between regular and special education training, leaving educators inadequately prepared. A national survey conducted by Stefanich and Norman in 1996 found that "teacher education programs reflect little commitment to preparing or in-servicing science teachers to work effectively with students with disabilities " (p. 51).

The second barrier is overcoming the belief that students who are visually impaired cannot be competent members of a science class because of safety issues. Stefanich and Norman (1996) also reported, based on the same survey, "that most teachers often hold stereotypical views of what students with disabilities can and cannot do" (p. 51). The third barrier is the lack of high-quality multisensory equipment for students with visual impairments to assist in their learning. According to Beck-Winchatz and Riccobono (2008), accommodations made to support the learning of a student are often viewed as too challenging and costly for school thus leaving a student who is blind without critical classroom resources. They further believe that important graphical information, which is ubiquitous in science, is not made available in alternative formats accessible to students who are blind.

Science as a subject is highly visual, and the information delivery is often through visual discrimination and recognition. Teachers working with students with visual impairments are not prepared to address their unique learning requirements, and often information and participation in the class is hampered. In a paper prepared for the National Center for Blind Youth in Science, the following statement was made (2006):

> Low expectations of students, lack of available training in non-visual teaching methods for regular educators, and fragmented resources for blind students in science have all contributed to the attitude that science is simply an area in which it is too hard for blind students to develop competency and be successful. Furthermore, career opportunities for blind students in scientific fields have been limited by a false perception that they could not perform the lab tasks, data analysis, and direct observations required by scientific endeavours…(p.1).

Erwin, Perkins, Ayala, Fine & Rubin, (2001) stated that "[O]ne of the most important responsibilities of teachers of students who are visually impaired is to create a climate of inquiry that is both accessible and meaningful for all students" (p. 351). Students who are blind or visually impaired entering the field of science will need to be relatively self-determined. Algozzine, Browder, Karvonen, Test and Wood (2001) defined self-determination as the combination of knowledge, skills and beliefs that enable a person to engage in goal-directed, self-regulated and autonomous behaviour. This is required to combat the pre-conceived notions held by instructors and employers about the abilities of students who are visually impaired. A study by Field, Sarver and Shaw (2003) found that some students reported that a few of their instructors attempted to discourage them from some academic goals solely based on their learning disabilities, which in turn led to students lowering their own expectations. The same could and does happen for students with visual impairments. The student who is blind or visually impaired who is hoping to pursue a career in the discipline of science must develop own sense of self as a researcher and a scientist despite possible contradictions from others.

Science Instruction of Students with Visual Impairments

A major component of science is based on a particular way of thinking that uses scientific reasoning. Thinking is not ruled by sight. The creative aspect of science, particularly theory creation, is conceptualized in the mind. If we examine Charles Darwin's greatest contribution, evolution by natural selection, he based his conceptualization of the underlying process on the collection of small, dead finches. In fact, he himself did not clearly see what was staring him in the face. John Gould, a friend of Darwin's, pointed out to him that the finches were indeed different species. It was Gould who pointed out to Darwin that some of the Galapagos birds, previously thought to belong to several groups, were in fact all highly variable species of finches (McComas, 1997). The role of vision is very important to science, but an example as given above clearly illustrates that the role others play, with or without vision, is crucial.

Clearly, much of what has been done in field science research work has strong visual elements (Barker, Slingsby and Tilling, 2002; Hinton, 1984; Shepherd, 2001). Ecologists collect owl droppings, geologists examine rock strata, hydrologists place stream gauges, geomorphologists measure and grade fluvial deposits and marine mammalogists spot whales on the horizon. However, there is a large component of most science research that involves computing, data entry, tape transcription, sample sorting, lab routines and other tasks. All of these activities can be accomplished by an individual with a visual impairment. For example, the geomorphologists can measure with their hands and use auditory readings whereas a marine mammalogist can spot whales by listening to exhalations on the water's surface. Granted some of these activities rely on vision, but many can be completed by an individual with a visual impairment using other senses and new assistive technology. The key is to refocus attention away from the primarily visual aspects of science to put primacy on conceptualization, where the reliance on vision is secondary. The concept of team research is especially important in allowing scientists who are visually impaired to contribute their unique perspectives. Often members of a team will collect different types of data and then collectively pull all the pieces together, allowing for meaning to be created. An individual with a visual impairment can directly contribute and analyze the data being reported by other team members while contributing their own data, which may not be sight reliant. Similar to Darwin and Gould, by collaborating and collectively working together, individuals can reach strong conclusions.

Field Work as a Learning Experience

When experiential education is designed in a manner that is both thoughtful and considerate of students' visual disabilities, they can enjoy the activity and thrive in the setting. The act of fieldwork is experiential in its design (Healey & Jenkins, 2000). Shepherd (2001) noted that the field functions as a kind of laboratory for students to acquire and practice various skills including investigation, observation, data collection and recording. The students are taken into the field to study nature and the interactions that take place. This experience offers the student a chance to interact with concepts and ideas in ways that are multi-sensory. While fieldwork is largely made up of visual observations, many activities are open to senses other than vision. According to Hinton (1984),

> "Fortunately there are many clues by which living organisms can be recognised and appreciated, and sight often takes a short cut, leaving many of these clues unused or redundant. It is the job of a biology teacher working with blind students to be as aware as possible of this 'redundant' information, and to help the students to make use of it to compensate for lack of sight" (p. 41).

Fieldwork provides opportunities for students to learn new skills that may not be acquired in a laboratory setting. Groups of students working together in the field develop a new appreciation for the study because there they can connect immediately to the 'why' questions. An event takes place in the process they are observing, and almost immediately students will ask "why did that happen?" That, in turn, encourages higher-level reasoning, because the student is faced with a literal "world" of possibilities. They encounter a range of possible answers and it hones one of the scientist's most useful skill sets: judging the likelihood of cause and effect. This leads to the crucial aspect of science learning, the creative component, where the student discovers a path to find the best answer.

These skills are then transferable from the field into the classroom. In fact, Cachelin, Paisley and Blanchard (2009) conducted a study with 99 children of whom only 49 attended a Wings and Water program offered by The Nature Conservancy. Through open-ended questions, guided imagery and species identification, she found that field-based participants demonstrated greater cognitive understanding than classroom-based participants. Cachelin et al. continues,

> [T]his suggests that field education experiences are not only better for eliciting conservation sentiments but also for lasting learning overall. Further, we noted

> that students who visited the wetlands told their friends something to do at the wetlands more often than those who did not (p. 13).

Working in the natural setting is arguably the best place to examine the relationships between the environment and living things, the heart of modern ecology. Even theoretical scientists rely on the observations gained in the field to generate the foundation of theory, and then later to test predictions.

Fieldwork is crucial in the study of natural sciences such as biology, geography and environmental science. Moreover, it is an effective teaching tool that offers a deep connection to the content of the real world for the student. Most of all, it should be borne in mind that the laboratory for the study of the field sciences is the 'field'; anywhere else the experience becomes second-hand, out of context and has less meaning (Fisher, 2001). There is evidence in the literature that fieldwork performed in schools is in decline (Bradbeer & Livingstone, 1996; Fisher, 2001; Tilling, 2004; Boyle, et al., 2007). It is becoming an infrequent part of the curriculum, in part due to the increasing costs and student enrolments, despite recommendations from experts (e.g., Penrod, Haley & Matheson, 2005). School districts supporting field programs have a financially and logistically arduous task. According to Boyle et al. (2007), "it is argued that the growth in student numbers, combined with declining unit-funding, makes fieldwork too expensive" (p 300).

Additional issues cited in the literature attribute the decline in fieldwork to a lack of teaching confidence while teaching outdoors and to time constraints. Barker, Slingsby and Tilling (2002) point out that "[T]he trend for a decline in fieldwork is also evident in initial teacher training; surveys of some courses have shown that a minority of trainee science teachers with a specialism in biology had biological field work experiences" (p. 4).

Field Work and Students with Disabilities

For students with disabilities, access to the curriculum can be difficult because of the students' unique learning needs. These difficulties can translate into the field, but they can also provide powerful opportunities for students to interact with nature. A fundamental teaching approach being used in more classrooms in North America, allowing students to learn in a way that makes information meaningful to them, is Universal Design for Learning (UDL). According to Howard (2004),

> UDL focuses educators on developing flexible curricula that provide students with multiple ways of accessing content, multiple means for expressing what they learn, and multiple pathways for engaging their interest and motivation. This, in turn, allows teachers a multidimensional view of their students as learners, and offers teachers unique insights into assessing student's knowledge, interest, and understanding (p 26).

Fieldwork fits very nicely into Universal Design for Learning (UDL) since students can understand concepts in a variety of ways in the field, based on sights, sounds, kinesthetic and tactile opportunities. Specifically, in the field, students are no longer using rote memorization to learn about topics; rather, they are observing the connections between living things and their environment. Barker et al. (2002) state that "biological field work provides one of the few places in a science curriculum where students quite literally observe the real world and use it as the basis for scientific enquiry" (p. 5). It has been firmly established (Lock, 1998; Barker et al., 2002; Boyle et al., 2007; Cachelin et al., 2009; Hinton, 1984; Smith, 2004) that well-organized fieldwork led to students absorbing and learning more because they enjoy the experience,

> Within geography, earth, and environmental sciences, fieldwork is anecdotally considered to elicit positive affective responses. It is thought to develop social capital through group dynamics, the breaking down of barriers between staff and students, and making friends. It is also considered to stimulate high levels of interest and motivation (Boyle, et al. 2007, p. 302).

Fieldwork is crucial in the disciplines of environmental science. Scientists will spend hundreds of hours in the field observing distribution patterns and behaviours of various animal and plant species. In fact, not all species and processes are amenable to study through controlled experiment, and some of those do not fit well into comparative study via model organisms or settings.

The current education delivery and curriculum development in science without fieldwork will lead to a shortfall in Canadian classrooms with considerable impact for students with disabilities. "In fact, standards-based instruction and the high-stakes testing that drives it can often feel like a locomotive rolling over everything in its path, including individualized learning" (Tomlinson 2000, p. 6). More to the point, when classroom teachers are not differentiating their lesson plans to include or encourage all learners, the students are inevitably missing out. This is precisely why the need for experiential learning such as fieldwork is so crucial in a learning environment. Students can experience learning in ways that are meaningful for them, which is the major premise of UDL. The goal is to connect the students to the curriculum and to make meaning out of the world around them' without fieldwork and experiential learning, reading from a textbook is a mere shadow.

Curriculum Issues

In addition to the above-mentioned barriers, the way that curriculum is delivered is also a barrier for students with visual impairments. Science is regularly taught to children in classrooms through auditory and visual means. Sahin (2009) stated that the areas of mathematics and science have traditionally been inaccessible to students with visual impairments. Traditionally, the delivery of concepts and information lies in textbooks, and is then read and discussed in the classroom. Videos are shown followed by a classroom demonstration conducted by the teacher to reinforce the material. Unless the students are able to participate in a full laboratory, there is no opportunity for hands on. Once finished, the topic is reviewed and the students are tested to see what they have retained, and can apply to other subjects. Many classrooms still follow this model. For some students, this approach is easy to understand, and interesting and meaningful. For others it is not; the hands-on aspect of science is what makes the entire class interesting and meaningful. It can be argued further that if science is taught by a read-and-recite method, students may not be learning the science. Teaching science without opportunities to ask why and delve deeper into subjects, students are merely learning how to recall and repeat information about science. Fraser and Maguvhe (2008) state, “any curriculum that is not learner-based and learner-paced will hinder the blind and visually-impaired learner from learning and actively participating in the learning mediation to her or his full potential” (p. 85).

Science textbooks are filled with information that is to be learned by students. Today’s textbooks and learning materials are as inaccessible to students with visual impairment as old buildings were to wheelchair users (Pisha and Coyne, 2001). Blosser and Heglesson (1990) stated “[T]extbooks have been criticized by many science educators as being too encyclopedic, of perpetuating misconceptions, and of not reflecting current knowledge both about science and about how children learn” (p. 4). The textbook content has originated from field research and laboratory studies. Some of that curriculum material makes good use of the links between the students and real-world examples. To enhance the textbook content, laboratory exercises are suggested so students can learn about life inside the classroom. For a student who is visually impaired, science concepts often require more than words on a page. For instance, talking about the complexity of a plant cell in a book will allow a student who is visually impaired to understand that this structure is complex. Contrastingly, by providing a student who is visually impaired with a 3D tactile replication of a plant cell that they can take apart and re-assemble offers greater concept reinforcement to the student. Blosser and Hegleson (1990) state “To improve the science curriculum, we need to change some of our traditional practices. We need to become more focused on helping students think scientifically rather than memorize facts” (p.4). A textbook approach to science may not be enough to capture the interest and imagination of many students. Opportunities to listen, smell and touch the concepts, ideas and components of science create deeper meaning for all students, not just those with visual impairments.

Concept Development

An important aspect of learning that requires direct attention when working with a student who is blind or visually impaired in any setting is concept development. For a child who is congenitally blind (with little or no vision from birth), exploration of the world occurs through use of senses other than sight. To ensure that concepts are understood, teaching methods must be multisensory, and provide comprehensive and detailed explanations. According to Wolffe (2000), "children and youths without functional vision or with severely limited eyesight have great difficulty acquiring a 'whole-picture' perspective" (p. 141). When subtle differences occur in two objects that are easily distinguished by vision and are difficult to describe, it is vital to offer sufficient information to discriminate between the two non-visually.

This may mean multiple explorations and the use of other senses to enhance the concept. When a child with little or no vision encounters only a portion of the environment with their hands, they may not understand the broader picture or concept. It is important to provide individuals who are visually impaired with a large-scale perspective to facilitate learning. Therefore, to merely touch something and use one's tactile sense does not necessarily provide a concrete understanding of the object. Wolffe (2000) stated, "This is the challenge, in a nut-shell, for students who are blind-how to know the whole when they have the opportunity to come into contact with only a part of something" (p. 141).

To work at the theoretical level, especially in science, strong concept development is important. A lack of concept development can be problematic for a student with a visual impairment. Educators can teach an individual with a visual impairment to conceptualize things they have never seen, or may have only limited experience. Therefore, it is plausible that higher elements of science and creativity will result from exposure to, and enjoyment of, field experience.

Accommodation for Students with Visual Impairments

Various science programs are available to students who are blind or visually impaired to learn outside the classroom. These programs attempt to supplement the lack of experiential opportunities, including a lack of fieldwork, in the classroom as well as other barriers in providing classroom access. A few of the programs are uniquely designed to offer students who are blind or visually impaired direct exposure and experiential learning opportunities in science. The program delivery focuses on different skills and senses such as auditory or kinesthetic learning. The few published articles highlight the importance and benefit of having students who are visually impaired participate in programs, camps and learning that is experiential by design. In the following section, I will highlight a few such programs to situate my research plan.

Fraser (2008) in “Oceanography for the Visually Impaired” describes a program created specifically for students who are visually impaired to learn through experiential opportunities about oceanography. The professor, who is legally blind, from Woods Hole Oceanographic Institute, invited students who are blind or visually impaired and provided them with hands-on experiences in oceanography. The continued collaboration between the teacher and students resulted in a research cruise where the students conducted their own experiments from a vessel. The experiments included using depth-finding equipment and collecting water samples to compare salinity rates from various locations. Only one accommodation was made in order to allow the students to participate, which was the addition of knots being tied in the rope lines in order to measure the depth of the equipment when lowered into the sea.

Witchanz and Riccobono (2007) provided details about the partnership between the National Federation of the Blind and National Aeronautics and Space Administration (NASA) to make astronomy accessible to students who are blind or visually impaired. The partnership resulted in the creation of a center that aims to advance science through the development of targeted camps. They offer students the opportunity to work and engage in science with accessible technology and multisensory opportunities. Even though examples of experiential learning opportunities for students with visual impairment is limited, they do exist. For example, Space Camp is a science camp that is designed for students who are blind or visually impaired and has resulted from partnership with NASA.

The Whale Research Experience

Of the programs available at this time, none exist to study marine mammals. Certain areas of marine mammal research can be adapted so that students who are blind or visually impaired can experience actual field research. For many students, their understanding of marine mammals takes place in a classroom through a textbook. Marine mammals within the classroom setting cannot be easily experienced non-visually thus limiting the direct opportunities to develop concepts in this area. Whales are large, wild animals. The larger species of baleen whales range between 30 to 100 tonnes, and their sheer size and resource needs preclude most study in captivity. It even makes most kinds of data collection difficult. When it is not possible to study phenomena in a controlled environment, then research can only occur in the field.

In marine mammal work, it is common to spend decades to gain levels of understanding comparable to terrestrial species. Much of the work done on the biology of cetaceans over the past century has been based on studies of carcasses from the whaling industry, and population models that have been devised have real shortfalls. Ecological research is far behind (Nelson et al., 2008). Therefore, long-term ecological studies present challenges for researchers both in time and commitments of long-term funding. Any research in marine mammalogy is tenuous, involving teaching is rare and involving students with visual impairments has not yet been done.

On the surface, it would appear that most of the cues, data records and information that a marine mammal scientist collects are visual. A survey of recent theses at the University of Victoria Whale Research Lab (WRL) indicates that to be the case. Studies by Short (2005), Olsen (2006) and Feyrer (2010) highlight the range of information-collecting methods; they are highly visual. Data streams, such as spatial location, whale behaviour, prey species identification, sonogram analysis, spatial autocorrelation mapping and whale photo-identification are based on visual capacity. However, in each of these research techniques, there are opportunities for a student with a visual impairment to join a research team in a meaningful way.

In most cases, at least one member of the team is engaged in some task that, with proper equipment, could be carried out by a team member with a visual impairment. From team member to team leader is a small step; once the student is ‘in the boat,’ a good team can be led by a good leader, sighted or not.

A typical transect of the WRL’s Flores Island study site covers approximately 16 nautical miles. As whales are encountered, it is important to record the number and behaviour. A geographical coordinate is required to pinpoint the location of the whale. This allows the researchers to map the location of the whales accurately. Onboard the boat is a Global Positioning System (GPS) device that is constantly updating the latitude and longitude. Formerly, GPS units all required vision to read and record the data. With the creation of the Trekker Breeze and other accessible models, auditory GPS devices, a researcher who is visually impaired can listen to and record correct geographical coordinates.

Another important aspect of marine research is determining what behaviours are being displayed by the whale: is it travelling, resting or feeding? This information is usually derived visually, but a very important aspect of behaviour monitoring is the timing of the whale's exhalations. An individual with strong auditory skills would be an important part of the team because quite often, a whale is heard before it is seen. This is caused by the tides, colour of the animal, reflection off the surface and also the distance the whale has travelled from the last recorded location.

All of the equipment used by the University of Victoria Whale Research lab can be made accessible. For instance, plankton nets that allow the researcher to determine what the whale prey is can easily be tossed into the water and retrieved by someone who is visually impaired. The instruction required would be no different than teaching an individual with sight.

Summary

As pedagogical technique evolves, the concept of viewing each student as an independent learner is central to the teaching profession. Theories such as Gardner's Multiple Intelligences (Gardner & Hatch, 1989) and Kolb's Experiential Theory of Learning (Kolb, 1984) are well accepted in educational practice (Healey & Jenkins, 2000). Gardner's view of intelligence is "the capacity to solve problems or to fashion products that are valued in one or more cultural settings and detailed a set of criteria for what counts as a human intelligence" (p. 5).

The definition of intelligence is no longer defined as a mere numerical value such as those generated by Intelligent Quotient tests. Gardner formulated seven types of human intelligences: Logical-Mathematical, Linguistic, Spatial, Musical, Bodily-Kinesthetic, Intrapersonal and Interpersonal Intelligence. According to Nolen (2003), teachers should structure the presentation of material in a style that engages all or most intelligences. The purpose of this research was to explore how field experience can be used to increase understanding and researcher behaviours in young adults who are blind or visually impaired. This study probed effective teaching methods and solutions to accessibility issues through high-level participation in a field ecology research setting involving marine mammals.

Chapter 3: Research Method

This exploratory research used several methods to assess the change in participants' understanding of science, and their confidence as a part of a research team during their experience at the UVIC whale research lab. The methods are exploratory, qualitative and based on four research questions:

1) What was the impact of the Whale Research program for building students' understanding of marine mammal research?
2) Can the whale research program increase students' self-evaluation of their role and potential as a researcher?
3) Will the whale research program increase students' confidence in being members of researcher teams?
4) Are all aspects of the whale research program equally accessible for all participants?

Three individuals participated in the whale research program. The methods of data collection included interviews, questionnaires, behavioural observations and a case study that the participants worked on collaboratively. These methods were used to establish a baseline of students' knowledge of marine mammals before the program in order to compare it to knowledge gained during the program. Baseline was considered the starting point from which to gauge new skill creation, concept development and a new outlook on their ability to conduct science. The methods were also used to determine students' self-evaluation regarding how the students felt about their skills and abilities before and after a week of fieldwork. Were the students feeling confident in their abilities as scientists and researchers? Were they answering questions that have arisen from the field and laboratory work? Input from the students and other members of the team about activities and learning practices were collected to find out what worked well and what did not. Interviews were conducted with the students to delve into deeper topics, their concerns and thoughts about the program, and their opinions of themselves. Specifics about the methods used are provided in the research methods section in relationship to each research question.

Layout of the Program

The University of Victoria Whale Research Lab has been based in Ahousat on Flores Island, British Columbia, for 12 years, hosting a variety of projects in both natural and social sciences over the years. The Whale Research Lab station is based in a turn-of-the-century house in Ahousat, a 40-minute boat ride from Tofino.

The waters throughout Clayoquot Sound provide food for juvenile or older gray whales and cow-calf pairs that do not complete the migration to Alaska. In years past, local productivity has been sufficient for the whales, but things are changing. The dynamic ecological community in this area is only a small piece of a large puzzle that scientists are trying to piece together regarding coastal waters. It is in this area and for these reasons that research is being conducted with the whales and their prey.

The knowledge of the marine ecosystem is the culmination of years of work and dedication by the research team. The Master’s and Doctoral students that conduct their work from the University of Victoria (UVic) Whale Lab rely on volunteers, interns and other students to help with the daily data collection. This volunteer and intern structure already in place at the lab created a good atmosphere for bringing in students with visual impairments to conduct similar roles.

Throughout the program, students were taught about the role of field team members, the type of data being collected and the use of the data. Through structured activities and the case study, students were encouraged to think of other information that they would want to collect with the goal of assuming a stronger role in the field research by the end of the week. Modifications were made to some of the activities on the boat, but most activities were very similar to the current research work. Table 1 shows the progression of activities for the week.

Table 1

Lessons during the Program

Day	Lesson/Goal	Activities	Role of the students
1	Introduction	Lesson about gray whales in Clayoquot Sound; case study introduction; and familiarization with gray whales	The students participated in the lesson and were given a case study. They were asked to hypothesize what they thought was happening with the whales while formulating a testable hypothesis. The students took turns with the O&M instructors to familiarize themselves with the boat. Finally as a team, they built a life-size gray whale out of ordinary material to develop a concept of size and mass.
2	Transect & Data Collection	Students were taught about the role that the transect plays in the research. They also learned about data collection techniques and methods.	Students followed the transect route with the tactile maps. They took turns using the GPS to record data. When whales were spotted, the students used their voice recorders to record additional data, such as number of whales, direction of travel and time. This information was important on each and every boat trip because students were asked to remember and practice these steps every day.
3	Behaviour Analysis & Data Collection	Students were taught about the different behaviours of whales and what information researchers deduce from what they hear, see and smell.	The students were asked to recall the different data-collection methods they learned the previous day. Once whales were spotted, the students were taught what to look, smell and listen for. For instance, a rapid succession of breaths may have indicated a deep dive was about to occur.
4	Feeding & Data Collection	Students were taught about the role that the food supply in Clayoquot Sound plays in the presence or absence of Gray Whales.	The students were asked to recall the different data-collection methods they learned the previous days. They were also taught how to use two different types of data-collections units for measuring the presence of benthic prey. When whales were spotted, the students took turns using the equipment to understand and collect data on what the whales were feeding on.
5	Student-driven data collection and research	The students were encouraged to work as a team and decide what data they would like to collect.	The students independently used the data-collection methods. When a whale was encountered, the students decided on the type of data they wanted to collect, such as recording the locations, times and behaviours. At the end of this transect, students were able to take their data and previously collected data to present the findings during their case study.

A variety of research methods were used to enhance students' understanding of marine mammals and ecosystems. Emphasis was on providing sensory-driven lessons that allowed students to use senses other than sight to learn about the whales. The students worked with a variety of research equipment, which allowed them to learn about marine mammals and conduct field research (see Table 2). Some equipment was used without modifications, while other equipment required adaptations and additional instructions. Table 2 summarizes the main equipment used and any adaptations that were made.

Table 2

Equipment and Modifications

Equipment	**Role**	**Instructions**	**Accessibility**
Waterproof paper and pencil	Record the species, direction and behaviour of the animals	Keep records about the whales and update location every 15 minutes	The students recorded data on a voice-activated recorder. They were able to relay the same information faster than by pencil and paper
Plankton nets	Determine the prey sources of gray whales	Deploy a bongo-style net into the dive puddle of a feeding gray whale. Once the net has sunk for about a minute, pull the net back into the boat	Students used the dive nets with ease. The only adaptation was to orient the student in the correct direction of the dive puddle
Benthic Dredge	Determine the types and size of benthic prey of gray whales	Lower the device to the bottom; once it has made contact, it will spring open to collect a sample of the ocean floor. Monitor when the line becomes slack and recover the dredge	The device relies on the feel of the line once it has reached the ocean floor. Strength is required to haul the dredge onboard. The students dumped the contents on the collection bin and rinsed them with sea water
Survival Suit	Keeping the individual warm and safe	Single flotation body suit to be worn by everyone with no exceptions when on the water	No adaptations were needed for the body suit for students with visual impairments
Hydrophone	Allows students to listen to the noises of the whales and boats underwater	Deploy the hydrophone to about twenty feet. This is marked on the line with an elastic	The students took time to familiarize themselves with the boat and were comfortable dropping and recovering the hydrophone
Other	Braille copies of books about marine mammals were available along with a Perkins brailler for note-taking.	Students were shown the location of these resources to use as they required.	Braille was the primary medium the students used to read and write

The following section illustrates a typical day on the boat in which the lessons discussed in Table 1 and the equipment discussed in Table 2 together provided a multisensory research experience for the students, with students assuming increasing responsibility over the week.

On a whale transect, a Global Positioning System (GPS) provides the latitude and longitude when a whale is sighted. In our case, a GPS unit was mounted on the console and the latitude and longitude was read aloud every twenty minutes by a member of the whale crew for the students to record. For these students, we used hand-held voice recorders to record and organize information.

Once a whale is spotted, the latitude, longitude, time and direction the whale is travelling is recorded. After that, through verbal means, the students determined the behaviours in which the whale was engaging. Travelling, for example. is determined by the ventilation intervals and distance between surfacings. The students were given an auditory reading of the time as the whale dove and then the time when the whale surfaced. When the whales were foraging, the students were given the chance to sample what the whales were eating by deploying a plankton net or Ponar dredge. Each piece of equipment was explained and practiced dockside.

When the nets were onboard, the students emptied the cod ends (catchment containers) into Ziploc bags. The students' samples were pooled into one bag that the students explored through tactile means. The sample from each plankton net was examined back in the laboratory under a microscope. The Ponar dredge was similarly deployed, and once the student recovered the device, the contents were transferred to a sorting screen overtop a plastic container. Water was added to sift the sand and small particles into the container below, revealing the whales' prey. The students had the opportunity to use tactile senses and to feel the various food items.

A hydrophone was placed in the water to allow students to listen to whale sounds and boat noise. The students did not hear any whales communicating but were able to hear a gray whale exhale as it neared the surface. The sounds of the engines in the water are easily detected, and the students were asked to think about the impact this noise may have on the whales' activities.

Selection of Participants

The three students who attended the program were young adults between the ages of 19 and 25 who are blind or visually impaired. Since the research project was designed to evaluate multi-sensory methods, and in particular, non-visual methods of field research, preference was given to students who had little or no functional vision, provided they met additional criteria as stated below. The applicants were asked to write a letter introducing themselves and why they thought they should be chosen to participate in this program. They submitted a résumé of their previous jobs and reports from three referees (not family members). The referees were contacted to determine personality and assess the students' abilities and interests. The applicants needed to indicate a strong interest in science or be pursuing a post-secondary program in a science-related field. Participants were expected to enjoy teamwork, nature and learning about the natural world since this was a large part of the daily activities in the program.

In addition, the individuals were required to have strong orientation and mobility (O&M) skills, so they were comfortable navigating new environments. A letter from an O&M instructor was part of the application package. If one could not be provided, a letter from a Guide Dog school was used.

To succeed, applicants required good health and the ability to withstand the physical rigours of fieldwork, such as lifting, moving and withstanding four to six hours a day on a boat. Finally, it was suggested that the applicants were both hardworking, creative and willing to follow instructions. Documentation of these characteristics was part of the application process.

Table 3

Characteristics of Chosen Student Participants

Name	**Level of Vision**	**Orientation and Mobility Method**	**Age**	**Education Status**
Amy	Light perception	Letter filled out from an O&M instructor	19	Pursuing Bachelors of Science at University
Jeff	20/400 in left eye only low vision	Letter filled out by an O&M instructor	19	Applying for college undecided field
Rachel	Light perception	Letter from a Guide Dog School	20	Pursuing Bachelors of Arts at University

Once students were chosen, they were asked to fill out a consent form that acknowledged they were taking part in a research project. The form outlined the type of research that was being conducted and also the participant's rights to refuse at any time and without consequence (Appendix A). Each student signed and dated this form before arriving at the marine research facility.

Research Methods

A variety of methods were used to assess the program, the change in the students' self-perception and the students' understanding of marine mammals.

Methods for Question # 1. What was the impact of the Whale Research program for building students' understanding of marine mammal research?

A group case study and a vocabulary-usage checklist were the principal data-collection methods used for this research question to determine student comprehension and understanding of marine mammal research. For the case study, students were presented with a problem regarding marine mammals (i.e., understanding why whales are using the Clayoquot Sound waters less; see Appendix B). After an introductory lesson about the gray whales on this research site, the students were asked to make some assumptions in their case study as to what was happening and how they would go about testing these assumptions. The assumptions were collected and compared to the students' final presentation of the case study at the end of the program, and a submitted summary of their assumptions and methods after a week in the field on the final day of the program. The comparisons were used to determine growth of ideas, knowledge, awareness and higher-level thinking.

In addition, a vocabulary checklist was used while on the boat to document increases in the student's comprehension of the overall situation, by examining the change in the way they use terms. Specifically, the language used by the students was monitored. While five days was a short period of time, due to the intensity of the program, I expected students to increase their vocabulary and become comfortable with cetaceans, data and the research process. Each day on the boat, the primary researcher or an O&M specialist, trained and familiar with the checklist, recorded the terms used by the students. Even becoming familiar with the equipment and marine terms was noted (Appendix C).

Methods for Question # 2. Can the whale research program increase students' self-evaluation of their role and potential as a researcher?

For question two, interviews about the role of a researcher and a case study were the main data-collection methods used. It was hoped that after one week in the field, the students were exposed to a variety of novel topics, concepts and ideas. The case study that they worked on, the data they collected and the insights and questions they formulated reinforced this. As each lesson (Table 1) built to the next, students were expected to independently recall different data-collection techniques and carry them out. The change in the students' perception of their abilities was a major objective of this research program.

Interviews were conducted before and after the whale research program. The interviews were a unique chance to map growth in a very specific way. Participants were asked to describe the role of a researcher before and after the program experience. Responses were recorded and transcribed in order to compare the students' confidence in their ability to carry out high-level field research with a visual impairment. I expected a change in the participants' ability to discuss the role of a researcher, specifically the role that a researcher with a visual impairment can play after experiencing the past week. At the end of the program, the students were given a scenario about a fictitious Whale Research Facility in Alaska and asked to list in great detail the roles they could play as part of the team and the type of data collection they would want to start collecting (Appendix D).

Methods for Question # 3. Will the whale research program increase students' confidence in being members of researcher teams?

In order to investigate this question, a student self-assessment survey (Appendix E) and an internal characteristic ranking were used (Appendix F). Students were given the survey before and after the program. The answers were compared and examined to look for growth and change in the students' perceptions of their skills and abilities. As part of the survey, students were charged with making a proposition of how they would overcome their visual impairment. Depending on the responses, the teaching-delivery aspects would have been re-examined and changed if, for example, the students did not feel competent as researchers in order to address this for the next program.

In addition to the self-assessment, the participants were asked to rank themselves on a list of ten characteristics such as excellent sense of humour, highly dependable and very trusting of others and so on. The data was collected at the beginning and end of the program, and examined once the program was over. It is anticipated that after a week in the field, students' perception of the characteristics may change.

Methods for Question # 4. Are all aspects of the whale research program equally accessible for all participants?

This whale research program was established at a pre-existing whale research facility in Clayoquot Sound, British Columbia. Until this study, students had not worked or visited the facility. Through adapted equipment (Table 2) and unique lesson plans that focus on other senses than vision (Table 1), the program goal was to be accessible for an individual with a visual impairment.

The methods to determine accessibility were daily crew debriefing, personal journals and an exit questionnaire completed by participants. While on the boat, the participants were observed for their involvement in the lessons such as recording notes, asking questions and being willing to participate. The primary researcher gave a student-confidence checklist to other members of the boat crew to assess and monitor student behaviour (Appendix G). The data were collected each day and assessed at the end of the day through a staff and crew debriefing (Appendix H). This checklist was then compared to a crew discussion (see details of the crew debriefing in chapter four) and to make sure the students were maximizing their involvement through proper and well-organized teaching. The checklist was also confirmed by the crew during their discussions to further ensure reliability.

The primary researcher observed the discussions to assess the strength of teaching, lesson plans and accessibility on the boat. The discussions focused on how the day went, what could be improved, what teaching methods worked and what did not. The primary researcher would take notes and ask questions after items were discussed so that the conversations were not biased or coerced. The conversation of the crew members were the primary data on the teaching modalities. The data from the crew discussions were reviewed by the primary researcher each day and adjustments to the teaching were made. This helped shape the program over the week. At week's end, the data from the crew discussions were kept and incorporated into the suggestions to improve the program.

Another way to assess the students' impressions and what they were learning was to have them record their thoughts, feelings and impressions in a journal that was handed in at the end of the whale program. The data from the journals were analyzed for the language the students used such as “I learned” or “I was comfortable when” or “I didn’t like,” and emerging themes were noted and compared to the vocabulary checklist for triangulation of the data. A number of emergent themes were also identified and discussed in Chapter 4. Additionally, the length of the responses were also considered: Was there a lot learned one day? Was it a quiet day on the water and no whales were found? The journal was meant to gauge the broad perspective of the students’ feelings during the program. The journals provided an important narrative from the students’ perspective on what they learned, what was interesting and any difficulties they may have encountered. The students were informed that the program will continue in the future, so the more they are able to write the more helpful their feedback will be to improving future programs.

Finally, an exit questionnaire was given to the participants to review the program (Appendix I). It was vital to hear the students’ impressions about the effectiveness of the program. Student responses helped identify areas with the program that may require change. The students were asked to rate the activities overall in order to inform as to whether or not they were happy or unhappy with various aspects of the program. A member of the crew was present to answer any questions that the participants may have when filling out the questionnaire. The data were compared with themes emerging from the journal entries and will be used to help improve, modify or continue the program for future students.

Chapter 4: Results

Program Overview

Three students, one male age 19 (pseudonym Jeff) and two females ages 19 and 20 (pseudonyms Amy and Rachel, respectively), participated in a five-day research program in Clayoquot Sound, British Columbia, between July 2 and 9, 2010. All three participants were high school graduates, Amy and Rachel were attending post-secondary institutions, while Jeff planned to attend university. During the program, the students worked through lesson plans focused on marine mammal ecology at the University of Victoria's Whale Research Lab.

Fieldwork was conducted every morning, weather permitting. In the afternoons and on inclement weather days, a series of group activities were completed to familiarize the students with the nature of the research. Students worked toward research skill building in both settings. During the weeklong program, students conducted fieldwork on the boat on five occasions. Each trip had a different marine field focus. For example, on the first trip, students conducted a “whale transect,” which involved the researchers following a pre-planned route through the study site, recording the location of each whale. On the second trip, students were taught to use plankton nets to collect mysids, a common gray whale food source. On the third trip, students used a ponar dredge to capture benthic samples. On the fourth trip, students continued to use the plankton nets and sonar dredge before going to listen to seabirds. On the final day, students travelled six miles offshore to observe and record dive times of a humpback whale. Finally, when students got back onto the transect route, they organized their own data collection so they could provide a sample for their required case study presentation. Each trip lasted between three and five hours.

While the students joined in the research activity in both the field and station, a number of techniques were employed using a variety of qualitative methods to address the four research questions. Methods included self-assessments, surveys, a case study and interviews. The results are presented by the research question below.

Research Question 1:

What was the impact of the Whale Research program for building students' understanding of marine mammal research?

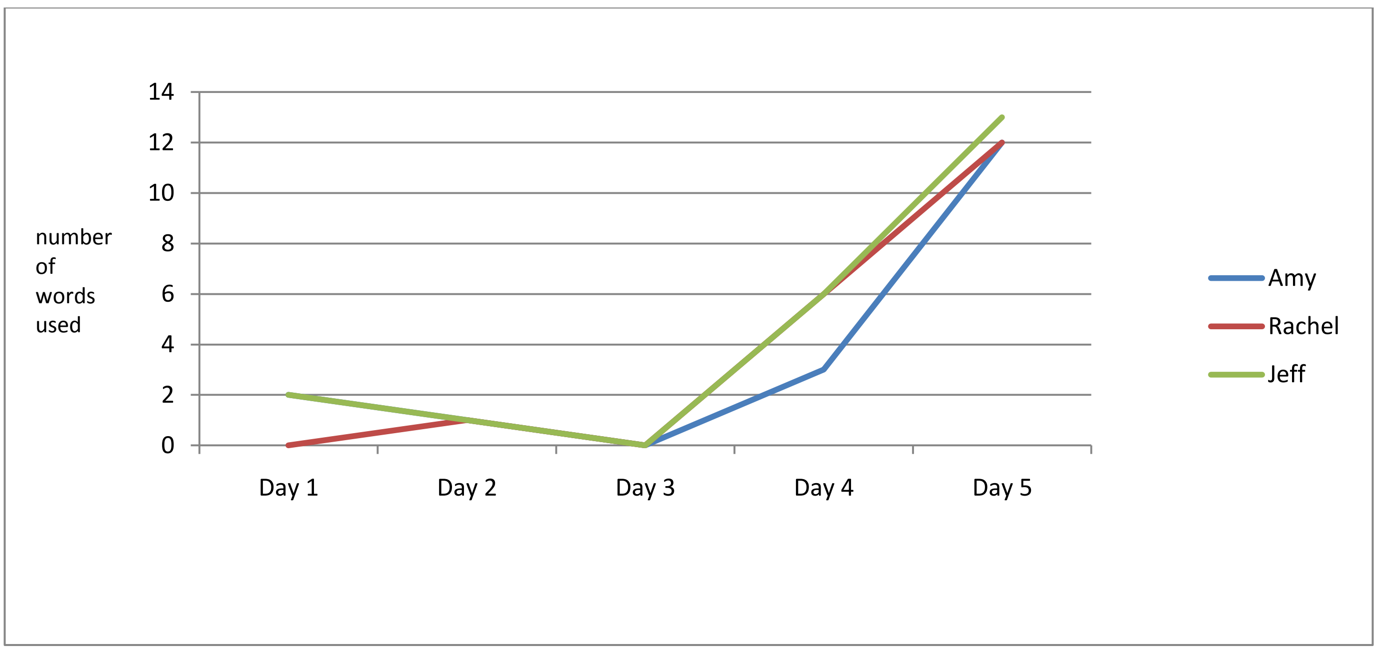
Simple classroom-style tests would not likely yield useful results in this setting, due to the short duration of the program and the large amount of novel material introduced. To answer this question, I applied two alternative methods to examine the change in students' understanding of the material: vocabulary usage and a pre- and post-group case study.

Vocabulary Use. The students' vocabulary was monitored during fieldwork on the boat. I introduced the students to a set of novel terms, the language of marine mammal research. For example, the word "ponar" or "benthic dredge" are not common in everyday conversations. A new checklist was used every day during field trips (Appendix C). Vocabulary words were shared with the all members of the research crew, and one researcher collected data on student use of specific vocabulary terms each day. The vocabulary words were monitored using a checklist and student observations. A member of the research crew was responsible for marking when they heard the student use each novel vocabulary word once while on the boat. The students' vocabulary words were then plotted in Table 4 to show the increase in usage. In order to verify that novel vocabulary was increasing, students' journals were used to support that vocabulary terms were being used correctly and to measure an increase in the frequency of the words. For instance, all three students' vocabulary usage of new and novel terms increased in their journal writings in the final few days.

The students showed a significant increase in the use of new terminology as their exposure to the words increased from day four to day five. On day four, students were recorded using three to five specified vocabulary words. Use of these specified words increased to 12 words on day five. The use of new terms increased after an initial period where the terms did not have much context, to the fourth and fifth days where the students began to function as part of the research team (see Table 4).

Table 4

Individual Student Vocabulary Use



Case Study. To assess student learning, comprehension and familiarity with concepts, ideas and understanding of new material, students were asked as a group to complete a case study (Appendix B). The case study was designed to guide student understanding of marine ecology by having students solve a problem after spending a week in the field and then presenting their findings to the rest of the research team. It also created an atmosphere of teamwork with students working together on a project. The students had a variety of tools at their disposal including books, samples, daily notes and discussions with crewmembers. Students were first asked to make a case-study assumption. This was done to show the growth from the students pre-program to post-program understanding. As the students' knowledge, vocabulary and interest grew, they were able to apply this information to the case study, which they presented on the final night (Appendix J).

Students' Initial Assumption. After receiving preliminary information about whales and being introduced to the case study on day one, the students recorded the following initial assumption: "Our assumptions are that the gray whales' food supply has been decreasing because of overuse by the whales over the past 20 years. To test that theory, we need to sample prey and devise a way to measure change."

Final Case Study. The students' final assumption (case-study report) presentation of the case study was recorded, transcribed and explored through a variety of means. For example, the entire research crew at the end of the presentation remarked on the level and depth of knowledge that was shown throughout the case -study presentation to the students. During the presentation, the students answered questions by the research crew about the whales, the research approach they would use and the hypothesis they chose. Furthermore, the next day, the crew discussed the depth of information the students presented about gray whales compared to how little the students knew about gray whales based on their initial case assumption. The initial and final case studies were compared to assess the growth and learning over the week. The students spent the majority of two days working on the case study. They discussed what they learned in the field, consulted various braille volumes and asked a number of questions of crewmembers to guide their understanding. Students took turns reading the information they compiled onto one computer, and used samples and tactile models to show their understanding of marine ecology. At the completion of the case study, students took questions from the crew that they answered with both enthusiasm and a high level of comprehension.

The students' understanding of marine mammals is quite obvious from their presentation and the depth of knowledge they discussed. For instance, the information they included came from multiples sources, such as crew discussions and reading materials that were available in braille. Use of multiple sources was evident in the presentation of historical information about whales, which was not discussed with students. The students highlighted information about the research process including how and why research was conducted. The group talked about the factors that could have an impact on the gray whale population in Clayoquot Sound. The section of the presentation in which the students formulate and pose potential research questions indicated the strength of comprehension by the group throughout the week. For instance, students recognized that there are multiple factors at work affecting gray whales, and they clearly understood this by highlighting the following: food sources, predators, interference of food sources and push-pull factors that may lead to a presence or absence of this marine mammal.

Research Question 2:

What was the impact of the whale research program for increasing students' potential to see their role as a researcher?

Role of a Researcher. Before the program began, each student verbally described the role of a researcher. Student responses were audio recorded, responding with unlimited time to the primary researcher. The question was revisited at the end of the week. The responses were then transcribed into print exactly as articulated. The intention of this activity was to assess change in the students' response, since they themselves had acted as researchers for a week and even run their own data collection. The transcripts of the audio responses at the beginning of the program were compared to those at the end of the program, and key phrases were identified and examined. For instance, the students seemed unsure in their initial responses with terms such as "I think," whereas the term "I think" were not present in the students' post-program responses.

The expectation was that the confidence the students developed in their ability to carry out field research would be incorporated in their responses. All three responses were much more concise in post- than pre-program responses. For example, Jeff and Amy used the term "I guess" in their first response, but neither of them used the words "I guess" the second time. Rachel used the term "I think" in her first response but did not use this in her second response. Also, Jeff stated he thought the role of a researcher is "to retrieve information on a specific species or organization I guess." In his second response, he stated that a researcher "goes out and collects data over a certain period of time and compares results with past and present data that they have collected." The students' post-program responses indicate they were able to explain that researchers roles are based on the activities they experienced and participated in during the program. The students clearly were aware and took note of how research was being conducted.

Pre-program Response

Question: Describe the role of a researcher.

Amy: They collect information on their subject by using different techniques like while it really depends on what they are doing, I guess. They analyze it [the information] and then try and make some conclusion to support their theories or reason they are doing that research.

Jeff: I think the role of a researcher is to retrieve information on a specific species or organization I guess, researching and studying the kind of like the behaviours and activities of whatever they are focusing on.

Rachel: I think the role of a researcher is not only to answer some questions or kind of study their topic of the questions they have but also to bring to light other questions that might also help to answer the initial ones and possibly bring up more. I believe a researcher also has a passion for what they do and since they love whatever it is that they're researching, they are very willing to teach people about what they are researching.

Post-program Response

Question: Describe the role of a researcher.

Amy: They usually have a hypothesis they want to study and they assemble their data and results from their testing, which is whatever test they're doing and they analyze to see what they can conclude out of their results.

Jeff: I think a researcher goes out and collects data over a certain period of time and compares results with past and present data that they have collected. They try and search for different behaviours and anything that's changing in their atmosphere.

Rachel: A researcher, a researcher takes or well what they do I guess is, they look at situation and take note of what is happening and they dig deeper into it to find more information about that situation and they watch and wait and take information in and monitor what's going on and compare the information they do get about the subject. It's not necessarily finding answers but just digging deeper into the situation in order to head in the direction of answering the question.

Whale Research Scenario. At the end of the program, students were given a fictitious scenario in braille and asked to answer several questions (Appendix D). The scenario was similar to the activities they might have encountered over the past week. Students were asked to respond to questions about the role they would play, the type of data they would collect and what they could offer as a team member who is visually impaired.

Each student worked independently with the primary researcher and used a braillewriter to record their responses. The students' only instructions were "read through the paragraph and answer as best you can." Observations of the students were that none asked questions and they took their time to respond. Responses were examined through reading, analyzing of key words and themes. For instance, one theme present in all three of the students' responses was the types of data collection they felt they could contribute to. The students listed various tasks they had been exposed to during the week, and that they felt they could continue to participate in similar activities at another research site. The identification of key terms or phrases in their responses was done in order to gauge confidence levels and their perceptions about whether vision poses a barrier.

All three students believed that they would be “good” or “fairly good” researchers. They all listed ways in which they could participate in field research based on what they had learned. For example, all three students said they could collect mysid and amphipod data, which is what the whales feed on. All three students said they could collect or record data. All students listed various equipment they had used and were comfortable using. The language and the confidence in all of the responses indicate that the students do feel they can contribute in a meaningful way. The students all stated in their response that they felt they could make a “relatively good,” “good” and “fairly good” researcher.

All of the students saw themselves as potential researchers. The students did not list roles that they could do that were different from what they learned during the week. One student did list different data-collecting activities that were not conducted by our team but were talked about in a large perspective such as cow-calf interactions. This indicates comprehension for what they did learn but not additional higher-level thinking. Also, from the responses the students gave, they felt their vision was not a barrier to being capable researchers in the field. The following excerpts illustrate the students' confidence:

> Amy: I think I could make a relatively good researcher. I know how to collect data related to whales such as getting mysids and amphipod samples by using dive nets and ponars. I could also play the role of the data recorder on the team

and use a voice recorder or note taker to take down useful pieces of information. I would also be able to provide a lot of moral support to my teammates. I have a pretty good memory and can help remember important facts.

Jeff: As part of the research team, there are many different things that I can contribute as a visually impaired person. I can help record data such as the latitude and longitude of the whale's location, the time of the spotting, the location of the spotting and the type of whale spotting. I can help listen for the blow of the whales. I can help collect data such as mysids and amphipods using technology such as bongo nets, ponar and the hydrophone, along with the rest of my team. I can help sort samples for further examining. I would first off begin by collecting samples of mysids and amphipods using the bongo nets and ponar. I think I would be a good researcher because I have a basic understanding of how to use the technology effectively, and when and where to search for the right data.

Rachel: As a part of the team in Alaska, I would take population readings, take samples in the areas that the whales have been foraging in, watch their behaviours within and without their own species, watch their migration patterns and take note of where they might divert from their usual migration patterns, duration of cow-calf interaction, take note of male and female interaction. Take note of whether the whales are left or right handed, record the time, date and location of the whales. All of this I would do as a blind researcher. I believe I would be a fairly good researcher as I am capable of accomplishing all of the above tasks. Some other support that I could give as a visually impaired researcher would be to input the data that has been collected.

Research Question 3:

Will the whale research program increase students' confidence in being members of research teams?

Two assessment tools were used to gather information about students' perceptions of themselves as researchers. The students completed these assessments, independently at the start and end of the program. First, students completed a self-assessment (Personal Self Assessment) containing likert-scale questions about being a researcher (Appendix E). The likert-scale questions were statements relating to the students' skills, abilities and self-perception. The students were asked to respond on a rating scale and specify their level of agreement or disagreement with how they viewed themselves based on each statement. The self-assessment was transcribed to braille with a five-point scale of disagreement-agreement as follows: 1=Disagree Strongly, 2=Disagree Moderately, 3=Unsure, 4=Agree Moderately and 5=Agree Strongly.

Second, students rated themselves on the Internal Characteristic Ranking on personal and work attributes (Appendix F) using a scale of one to ten with one being 'this does not describe me at all' and ten being 'this describes me perfectly.' The self-assessment was used at the beginning and end of the program to explore the change in the students' confidence and self-perception before and after working in the field. The students were not allowed to review their previous pre-test assessment scores. They were given the questions and a Perkins brailler to enter a numerical value for each question both times that they were asked to complete the self-assessment and list of characteristics.

Personal Self-Assessment. The self-assessment data were reviewed and pre- and post-changes were noted. Change was expected as the students' confidence built during the week and they became comfortable with the work, the terminology and their role as researchers. One student in particular, Jeff, did not finish the internal characteristics section in the post-assessment. The reason for his incompletion is unknown since the primary researcher was out of the room while the student answered the questions.

Each student's self-assessment questionnaire was examined to determine a change in agreement and disagreement to a statement. The scores of the students' pre-test and post-test were compared to indicate whether after a week in the field, the students felt more or less positive or the same about themselves and their abilities. The questions were written in both a positive and negative language. This required the students to consider the statements more carefully. For instance, a question that the student answered with a more positive number the first time and then a lower number post-program does not necessarily mean that the change was negative. In fact, the wording of the question is very important when examining the data. For instance, one question states, "In science experiments I need a lot of assistance." Every student chose a high number on the initial pre-test and a lower number on the post-test. Jeff and Rachel responded to this question with "five" or agree strongly, and Amy chose "three" or unsure. In the post-test, Amy and Jeff chose "two" or disagree moderately with this statement, and Rachel answered with "four" or agree moderately.

These changes indicate the students initially believed they required a lot of assistance, but after working for a week in a field station, they disagreed with the statement. Therefore, the students felt more independent, which is a positive response

(Table 5). This is also the same for another question that states, “I worry that the data I collect will not be adequate because of my visual impairment.” All of the students disagreed with this statement in the pre-program. In fact, both Jeff and Rachel chose number “two,” which is disagree moderately, and in the post-test both students selected “one,” which is disagree strongly. Again, this indicates that these two students felt their visual impairment was not a barrier to adequate data collection. Amy, on the other hand, chose “one” on the pre-program to this question, which was disagree strongly, but in the post-test she chose “two,” which is disagree moderately. This increase may indicate that Amy felt at times her visual impairment was a barrier to the data collection (Table 6). All of the students initially indicated that their visual impairment was not a barrier so the likert scale may not be sensitive enough to account for slight changes. It is important to note that all the students still disagreed with the statement ‘their visual impairment was a barrier’ after the program was complete. After a week in the field acting as marine researchers, students still felt their visual impairment was not a barrier, which may indicate that the program did not cause the students to feel less capable. If the students chose the same response, then it was considered no change.

Very few negative changes were indicated in the self-assessment. For example, Amy initially stated she agreed strongly that she would do well at the Whale Research Program in the pre-test, and in the post-test she stated she moderately agreed with this statement. In the pre-test, Amy chose ‘unsure’ when answering the questions “I have done some of my own research” and “in science experiments I need a lot of assistance.” In the post-test, she chose moderately disagree for both questions, which is a positive change.

Unfortunately, the limitations of the self-assessment do not allow the respondents to explain why there is a change in how they feel. The negative changes were much more infrequent compared to the positive changes seen in the self-assessment and the rating of internal characteristics. Overall, the students' responses to the self-assessment were positive. Each student showed increases in agreement throughout different areas after spending a week in the field. One question that all three students saw an improvement on their ranking was the statement 'with my level of vision, I am capable of collecting data in the field.' Two students answered this question with a slight increase after a week in the field while the third student answered the question with a dramatic increase.

Table 5

Positively Worded Questions

Question	Amy	Change	Jeff	Change	Rachel	Change
I see myself as a researcher.	pre 4 post 4	0	pre 3 post 4	+1	pre 4 post 4	0
With my level of vision, I am capable of collecting data in the field.	pre 4 post 5	+1	pre 2 post 5	+3	pre 3 post 4	+1
I think I will do well at the Whale Research Camp.	pre 5 post 4	-1	pre 5 post 5	0	pre 3 post 4	+1
I ask for help when I need it.	pre 4 post 4	0	pre 5 post 5	0	pre 5 post 4	-1
I enjoy teamwork.	pre 4 post 4	0	pre 5 post 4	-1	pre 4 post 5	+1
I have a good understanding of science.	pre 5 post 5	0	pre 4 post 4	0	pre 4 post 4	0
I feel I have a lot to contribute over the week.	pre 4 post 4	0	pre 2 post 4	+ 2	pre 4 post 4	0
I have done some of my own research.	pre 3 post 2	-1	pre 5 post 5	0	pre 5 post 5	0
I see myself enjoying field research.	pre 4 post 4	0	pre 5 post 5	0	pre 5 post 5	0
I will be able to participate because of the accessibility and equipment.	pre 4 post 4	0	pre 5 post 3	– 2	pre 3 post 4	+ 1
I see myself pursuing science in post-secondary.	pre 5 post 5	0	pre 3 post 3	0	pre 4 post 5	+ 1
I can do things independently in science.	pre 4 post 4	0	pre 4 post 4	0	pre 4 post 4	0
I have always had positive experiences in science.	pre 4 post 4	0	pre 2 post 4	+2	pre 2 post 4	+ 2
I am able to contribute meaningfully in group research over the week.	pre 4 post 4	0	pre 5 post 5	0	pre 3 post 5	+ 2
I have strong Orientation and Mobility skills.	pre 5 post 5	0	pre 5 post 5	0	pre 5 post 4	+1
I worry that the data I collect will not be adequate because of my visual impairment.	pre 1 post 2	+1	pre 2 post 1	-1	pre 2 post 1	-1

Table 6

Negatively Worded Questions

Question	Amy	Change	Jeff	Change	Rachel	Change
In science experiments, I need a lot of assistance.	pre 3 post 2	-1	pre 5 post 2	-3	pre 5 post 4	-1
My vision limits many of the things I want to do.	pre 2 post 2	0	pre 2 post 2	0	pre 4 post 4	0
I worry about how I can participate equally in a research team.	pre 2 post 2	0	pre 3 post 2	-1	pre 4 post 4	0
I worry about going on a boat since it is more unstable than regular surfaces.	pre 1 post 1	0	pre 1 post 1	0	pre 1 post 1	0
I will require a lot of help over the week.	pre 2 post 2	0	pre 1 post 1	0	pre 2 post 4	+2

Internal Characteristic Ranking. The internal characteristic ranking was used to help the students' awareness of themselves along with indicating growth to the researcher. Each day of the program, they worked as a team and their characteristics impacted this process. Once the week was finished, the students' reflection on their characteristics may have changed based on the activities and lessons they learned. Based on the pre- and post-program responses, the students' internal characteristic rankings increased after the time in the boat. There were ten items on the internal self-checklist, and for the majority of the students, initial rankings were high. Even so, the post-program responses did show a slight increase. This would indicate that after spending a week fully immersed in a science field opportunity that appealed to the students' learning needs, their perceptions of themselves had in fact changed more positively. For example, Rachel had the most significant increase from her pre-program to post-program response when answering the question “very trusting of others.” In fact, her post-program response showed a four-point increase from the pre-program to post-program. Unfortunately, Jeff did not finish answering the entire list of characteristics; therefore, we can only make broad conclusions based on two students`` responses.

Research Question 4:

Were all aspects of the Whale Research program equally accessible for all participants?

Qualitative questions were used to assess program accessibility. The three students as well as other staff attending the program, including the UVIC Whale Research Crew and two orientation and mobility instructors, were asked for verbal feedback. The skills and training of orientation and mobility instructors allowed them to guide, train and orient students through a variety of unfamiliar territory and terrain. When the students first arrived at the program, they were given a tactile map of the hostel. This allowed the students to feel the program layout and learn how to navigate around the facility. Also, time was spent allowing the students to familiarize themselves with the boat and marine safety equipment that they were required to wear each day.

Three types of qualitative methods were used. First, daily crew debriefings were used to gain a broad perspective (Appendix H). After each outing on the water, the crew were asked to discuss which aspects of the boat time and lesson pre-teaching and post-teaching activities were successful. Second, students were asked to write personal journals each day. They were asked to comment on the lessons, the accessibility of tasks and what they enjoyed or did not enjoy. Students were aware that the primary researcher would read the journals after the program was over so that they could be as honest as they would like. Finally, a written exit survey was given that contained a variety of questions about the program, the activities and accessibility of the program, and what recommendations the students had regarding these issues. Listed below are the results of each of these data-collection methods.

Crew Discussion Responses. The following is a summary of the feedback from the crew debriefing. The primary researcher was an observer to these discussions.

Daily Crew Discussion

What aspects of the lesson today were successful and why?

Day 1 – The transect was highly visual but students were learning through auditory means. The students became familiar with boat terms and a form of data collection.

Day 2 – The students were listening attentively and collected samples successfully. They were interested in nets, parts, and were thorough and attentive to information.

Day 3 – The students remembered lessons from the previous day and were willing to participate and take data on their voice recorders. They stayed on task during transect.

Day 4 – Today was a lot of hands on, lots of activities, and students were attentive to feeling the equipment and recording information.

Day 5 – Today the students worked as a team; they organized themselves and took down two types of data (exhalations and dive net collections) with minimal or no supervision.

Students spent the first two days learning the new terms, equipment and concepts involved in marine mammal research. Students were encouraged to participate by using equipment, but they were able to abstain if they so chose. After a very brief time, the students were beginning to think and act like researchers. It was noted by crewmembers that the students were beginning to take out their equipment, and record changes and other data that they deemed relevant. The students began to ask more questions, offer more answers to questions posed on the boat and ask to help. For instance, both Jeff and Amy, once they were in their survival suits, offered to carry equipment down to the boat. They volunteered to use the equipment and offered support to each other. On the final day, the students worked as a cohesive team requiring no intervention or support from the crew. They were able to cast nets and collect data largely on their own. They directed each other to help where they felt appropriate. This showed noteworthy growth in the time that the students went from being passive learners to active members of a research team.

Daily Crew Discussion

What aspect of the teaching and lessons could be improved upon and why?

Day 1 – The tactile map of the transect route needed to be given to the students as they left the dock.

Day 2 – The students needed more practice throwing the dive nets. This might be helpful for their accuracy.

Day 3 – More questioning by the students occurred today; they were active listeners and asking questions. Continue to encourage the students to record information.

Day 4 – It would be helpful to repeat parts of the ponar for additional practice such as the submerging and retrieving.

Day 5 – Nothing.

From the comments in the responses to question two, it is apparent that more practice time would be beneficial for the students, probably by repeating parts of the lesson and providing the students with the options such as tactile maps to promote further understanding. Also, remembering to have important items such as tactile maps the first time the students follow the transect line will help them become familiar with various landmarks and geography, which was brailled on the maps and discussed while on the boat.

Daily Crew Discussion

Were there any safety concerns and how were they dealt with?

Day 1 – No

Day 2 – No

Day 3 – No

Day 4 – No

Day 5 – No

There were no safety concerns during the students' time on the boat. Before the start of the program, the members of the UVic research crew initially indicated a level of apprehension about safety issues consistent with previous research findings regarding inclusions of students with visual impairments in science experiences (Winchatz & Riccobono, 2007). Once interacting with the students as indicated by the data, no safety issues arose, which may indicate the program was well executed and the apprehension on the part of the crew was unfounded.

In addition to the crew debriefings, data from student journals indicated that students felt safe and comfortable on the boat. As the students became comfortable, they would stand up when the boat was stopped and engines were in idle. Students also enjoyed being out on the boat and going to see the whales as was noted in their journal entries. For example, the students commented, “I really hope we can get out into the boat tomorrow.” One of the crew members mentioned that one of the students said “already?” when they were told the boat was heading back to the field station. None of the students were observed having safety issues in the boat, or getting in and out of the boat. They were also verbally asked to communicate difficulties, if they did have troubles, which none did.

Daily Crew Discussion

Was the amount of time adequate for the students to develop understanding and practice? Why or why not?

Day 1: Initial trip. More time and additional transects are needed but the timeframe was adequate as an introduction.

Day 2: Yes, everyone had an opportunity to try the data-collection equipment as they had all morning on the boat.

Day 3: The second trip was adequate and students were not rushed, which was good.

Day 4: Plenty of time. More practice of activities in general to continue to build students' confidence so that they can be independent and lead an activity in the future.

Day 5: Yes, all of the students used vocabulary and talked to each other and the crew. They monitored dive exhalations of a humpback whale and threw in dive nets in an area a gray whale was feeding. They worked independently and assisted each other in being a team.

The students had ample time on the boat. Each trip took two to five hours. The comments indicated that overall practice is needed to learn specific tasks, but as indicated by the data in day five, students were developing an understanding of marine ecology. On day five, students used their knowledge, worked independently and functioned as a team. This indicates a high level of understanding and comfort with their tasks.

Daily Crew Discussion

Additional Comments.

Day 1: Today was pretty awesome. It was very interesting for the crew having students onboard who were blind or visually impaired. Saw 26 whales so a very busy day on the water.

Day 2: Once the sample was collected within the study site and the skills were practiced, the students had a better rate of collection. We will go over samples collected to complete the activity.

Day 3–5: blank.

The additional comments indicate how enthusiastic the field crew was to have students who were blind or visually impaired as part of the team. They noted about how busy of a day it was out on the water. On day two, the comments indicated students needed more time to practice with the data-collection equipment. It also stated that examining the samples at a later time would allow the team to complete the learning activity, which meant analysis at the laboratory.

Personal Journals. Students were asked to reflect on their days on the water through journal writing. Each student used a personal laptop. Journal writing time was offered to students after an activity, and they could go to their rooms and write. They were asked to write honestly about what they had learned, thought and any questions they had. I expected the students' journals to be thoughtful with reflective opinions about what worked and what did not. The students were also informed that their journals would not be read until after the program had ended, thereby allowing them to write freely.

The students' journals were used to triangulate data collected such as vocabulary usage and exit surveys.

In my analysis of the journal entries, I found examples of occurrences of novel words and enduring themes. The students' journal responses were broken into the following themes: research and data collection, on the boat, frustration, case-study, modifications and new knowledge. The most frequently occurring themes included the research and data-collections techniques the students learned. For instance, Jeff used the language "to further extend our knowledge" and Rachel commented "this gave us an opportunity to collect data using voice recorders." Each of the students wrote about the research being performed and some aspect that he or she found interesting. Each student remarked on how interesting the research was, and all of them commented how much they looked forward to seeing the whales. One student wrote about how using a handheld recorder felt as if he was contributing to the research being conducted. All of these written thoughts are positive and indicated that the students felt confident and part of the team.

Furthermore, for a student to comment that he or she felt they were contributing to data collection by using a voice recorder directly addresses program accessibility since the voice recorder was an adapted piece of equipment. One emerging area of frustration as noted in Jeff's journals was the use of the voice recorders. He wrote about how important recorded data is to marine researchers, but he also stated "Although the voice recorder was extremely helpful, I sometimes found it a little difficult to sometimes get it to start up, and would sometimes miss some information." This feedback is important because it may mean different voice recorders need to be explored or other data recording.

The second most common theme throughout the journals was about the activities and events while on the boat. The students listed activities and commented how they were "finally able to go out on the boat" — this was after two days of inclement weather. Rachel wrote about how she was initially unable to stand up in the boat, and by week's end was able to throw her own plankton net successfully. This indicated a growth in her skill and an increased level of confidence in her own abilities. For example, the students talked about how interesting the whales were, and when they were unable to go out on the water expressed disappointment in not experiencing whales. For example, Amy wrote, "We couldn't go out on the boat at all today because the weather conditions didn't allow for it. It was rather disappointing; I would have liked to see more whales." This indicates that with or without vision, these animals hold our fascination.

The students were asked to write down any questions that arose during the day or that they thought of while writing their journals. During the lessons, the students were asked verbally if they had questions. Often the students would ask a variety of questions to aid in their understanding. However, in their journal, students did not ask many questions.

Another theme that was prevalent in all three journal entries was the new information the students learned. The information themes were examined separately from the research/data collection to look for additional concepts and information not solely based on marine ecological concepts. For instance, Amy wrote, “we then each take turns learning how to cast a net off the side of the boat and each one of us caught a number of different sea life forms.” The sea life forms included seaweed, starfish, porcelain crabs and jellyfish, which are all vital to the marine life in Clayquot Sound. Another of the activities the students participated in was to bait a crab-trap and drop them to collect Dungeness crabs for food consumption. Rachel wrote, “we then checked up on the crab trap, and found that there was a small Dungeness crab in it. I learned that there is a restriction on what you can actually take from your capturing.”

The journals were also examined for comments about the lessons in order to gather information to support program improvement. A major indication of students’ learning was the use and assimilation of the new vocabulary. It was interesting to note how often the students explained the new terms that they learned without prompting. In almost every journal entry, by all three students, they incorporated new terminology.

One student, Rachel, wrote questions in her journal more often than the other two students. The questions that she wrote were often looking for additional information about concepts they encountered such as catch regulations of Dungeness crabs and how plentiful this species is in Clayoquot Sound. It is interesting to note that her questions about whales and marine mammals are scarce, which may indicate that she was asking those questions during her time on the boat or in the follow-up sessions in the laboratory. The students were told that their journals would not be read until after the program was completed. Consequently, the primary researcher was unable to answer the questions that the students had written in their journals.

The students did not comment on many difficulties they encountered even though they were asked specifically for comments related to accessibility.

One student, Rachel, wrote at the end of her journal, "I really enjoyed my time with the whale research team. I now have and know a lot of information about different sea life that I had no idea about before! At times it was a little frustrating in having to use my white cane again, as I haven't used it in five years, but I got around that and my technique came back." Rachel primarily uses a guide dog for orientation and mobility, and was challenged by using a cane in unfamiliar environments. It is very helpful to hear that Rachel enjoyed her time with the team, indicating that she felt comfortable with the crew and that she has learned a lot. The comments about her frustration with the cane should serve as a reminder to make sure it is explicitly clear to all students attending that they must have strong orientation and mobility skills, in particular cane skills. This was addressed in the application by asking for a letter from an orientation and mobility instructor. Rachel's letter came from a Guide Dog School.

Exit Questionnaire. The students were given an exit survey on the final night of the program. They were asked individually to read through 16 questions in braille and circle a response (Appendix I). Students were then asked open-ended questions to which they brailled a response. The primary researcher was not present for this so the students were able to answer the questions on their own and ask questions without worrying about filtering their answers. The students did not talk to each other during this experience. A likert scale was used to determine the students' agreement or disagreement with statements relating to how organized and accessible the program was, and various aspects of the instruction and learning materials. The answer responses to the exit survey were very positive as most students assigned a higher numerical value, which represented a positive response to the questions.

The students' responses could be interpreted to reflect that the program was well organized, and there was adequate time to familiarize themselves with the boat and the safety procedures. Some areas where feedback was undecided included strengthening information provided ahead of time, providing more maps and offering students a variety of data-collection methods. These are areas to work on and improve in upcoming programs. This feedback encourages a further review of the case study and offering students additional options for a presentation at the end of the week. All three strongly agreed that other students with visual impairments should be offered the opportunity to attend this program. The exit surveys were also compared with the journals to look for similar themes. In fact, two students wrote in their journals how thankful they were for the opportunity and would like to come again. This reflects the responses the students chose in the exit survey as well about how much they enjoyed their time in the boat and in the program.

The students were also asked to respond to two written feedback questions. The first was, “What was your favourite part of the whale research program and why?” All three of the students said they enjoyed being out on the boat, encountering wild whales. They enjoyed learning about and participating in the research aspect of the program. The students did not list or write about difficulties they encountered or adaptations that could be enhanced. Although this is a broad conclusion, the absence of student complaints could indicate that the students felt comfortable working as part of a research crew, and that the activities were accessible and enjoyable. The last question of the exit survey asked students, “What suggestions or changes would you suggest to improve the whale research program and why?” The students felt that the expectations of the case study needed to be communicated earlier along with more time to work on it. This was also reflected in Amy’s journal when she expressed concern the day before presenting the case-study findings; she wrote, “I’m not sure we’ll be ready; I feel like there are many things we don’t know.” Since the same theme is emerging in more than one area, the case-study introduction and timeframe need be addressed when planning for additional programs.

One student felt that more time was needed to familiarize with the different environments, and she felt the orientation and mobility expectations were inappropriate. Part of the application process was to ensure students had strong orientation and mobility skills since a variety of new terrain was constantly being encountered. Throughout the week, this individual’s cane skills needed to be supported by the orientation and mobility instructors on-site, which may have left her feeling a sense of frustration. She did like building the whale and did feel that the verbal descriptions used during all activities were very helpful. Since none of the students commented on the difficulty with the program, the accessibility or the time on the boat, it appears that the research program was successful in allowing students to learn about and thrive in a field-setting environment studying wild whales.

Chapter 5: Discussion

Science Opportunities?

"Student learning of science and mathematics has grown increasingly more critical in recent years" (Johnson, Fargo, & Kahle, 2010, p. 144). This is especially true for students who are blind or visually impaired and are interested in science. The need for additional learning opportunities, access to high-quality resources and enhanced teacher training exacerbate this situation. Currently, there are a few options available to students who are blind or visually impaired to learn about science in unique settings that address their learning needs. Unfortunately, these opportunities do not occur regularly. Therefore, an emphasis on science-related opportunities is required outside of the classroom. This is also known as fieldwork.

The shortage of science programs for students with visual impairments and also the need to offer more field biology opportunities drove the development of this program. In an effort to offer overlooked students a unique opportunity to address their needs through curriculum and universally designed learning opportunities, a pilot whale research program was developed. Opportunities for individuals who are blind or visually impaired to learn about marine mammals in the wild have not been available to date. Thus, I created a scenario that took a pre-existing field research program and developed learning activities specifically tailored to students who were visually impaired.

The focus of this study was to determine if a field station could be made accessible and to show a high degree of functioning, learning and enjoyment on the part of the students with visual impairments. During the five days in the field, a variety of qualitative research methods were used to assess the effectiveness of the camp along with positive changes in the participating students. The anticipated changes included those of self-perception, confidence and an increase in understanding of marine mammals and marine ecology of coastal British Columbia. The results will be discussed along with the implications for future Whale Research Programs for students who are blind or visually impaired.

Understanding of Marine Mammal Research

The methods to evaluate this research question included a vocabulary usage checklist and a case study. The students' working vocabulary was assessed on a daily basis. As the students learned new data-collection methods, they were exposed to new and important vocabulary. They heard other members of the boat crew using the terms in various contexts, and their own usage increased dramatically between the initial trip and the final day. The vocabulary use also transferred into the case study that the students prepared during the week and presented on the final night. The increase in vocabulary and the transfer of the vocabulary from the boat to the research assignment means the students were both comfortable and competent using these words. It indicates learning as well as a greater conceptualizing of marine science. The confidence with which the students used this vocabulary is such that they would use the words when describing the camp to others. Moreover, further research could examine potential use of this new vocabulary in other scientific disciplines, particularly those based in field research.

A case study was given to the students when they first arrived at camp. The students were asked to work as a group and create a research question related to the ecological scenario, based on the information they had at hand. They were also asked how they would carry out data collection to address the question to test their hypothesis. The students discussed their thoughts, asked questions and read material for their case study presentation. They then wrote and submitted their initial plan in braille. Once this was done, the students spent time on the boat learning terminology, practicing data-collection techniques and exploring how marine researchers' formulate and test hypotheses.

The students were then asked to re-examine the case study, and to think about and work collectively on a presentation throughout the week to attempt to answer in detail the questions that arose from the case study. This before-and-after comparison was intended to gauge the students' progress. The results clearly indicate that advanced learning and thinking had taken place.

In the initial formulation, they did not use complex terms, or even have a strong hypothesis. In the final case study, the students addressed the limitations of fieldwork and used concrete examples of how to collect data, and devise and test their hypothesis. For example, in the first iteration, the students said that whales were disappearing possibly due to invasive species. They did not specify what type of invasive species, indicating they were likely unaware of potential gray-whale population structure or ecology. In the final case study, the students stated that the whales are disappearing from a potential lack of food, which could be caused by predator-prey scenarios or a decline or change of the gray-whale population. This conceptualization is similar to the longitudinal studies being conducted by marine researchers in this area. This was not surprising based on the students spending a week on the boat, learning about research methods and data-collection techniques, and talking with the research crew. Initially, students were only given the pieces of the puzzle; they ultimately were able to put these pieces together in a remarkable manner on their own (Appendix J).

The students' case study included a history of whales, information about data-collection methods, sampling, findings and reflections. The presentation was provided to the other members of the marine research crew, primary researcher and additional program staff. The presentation was almost 30 minutes, and each student took a turn to share information they felt was relevant to the study.

Of the three students, one student, Amy, felt that the case study was not interesting or challenging. She communicated this in her feedback at the end of the self-assessment. In light of this, more information such as books on a variety of marine mammals should be available. Also, the opportunity for students to choose from a variety of topics should be available. A further option that could be examined would be to have students work independently on their own project, allowing them to present in any way they would like. This would attend to universal design for learning considerations and probably appeal to students by allowing them to present from an area of strength.

I did expect the students to question the change in the global climate and the pollution affecting the world's oceans. Throughout the week, we discussed the changing ocean currents, which have shown a warming trend in recent years affecting predator and prey variations around Clayoquot Sound. Also, marine scientists have been warning for years that global warming will have adverse effects on the ocean, and yet the students did not touch upon this in their presentation.

This structural criticism aside, the key issue from my viewpoint is that the students' visual impairment presented no barrier to their integration of readings, discussion and fieldwork. Except for what I would consider minor adaptations on the part of the research team members to spend more time going over instruction and practicing use of new equipment, these students were not much different from any group of interns or new students involved in the same program. All that was required was braille resources and some additional practice of safety measures to get the students to the boat.

Potential as a Researcher

The two methods used to evaluate the students' perception of their own potential as researchers included a pre- and post-interview about the role of a researcher and an application of their learning when applied to a fictitious situation. The first was the pre- and post-interviews about researchers and their role.

The language used by two of the three students in the initial pre-program responses contained the phrase "I guess." This would indicate that these two students were not very confident in their responses. The second response by the same two students was much more succinct since both students' responses did not include use of the phrase "I guess." The post-program responses by the students showed that by spending a week working and learning from marine researchers, they were able to identify the roles of a researcher more clearly. Post-responses that showed growth were expected since the students themselves acted as marine researchers, working as a team to collect their own data and even formulate a case-study hypothesis.

For instance, Jeff's pre-program response was, "I think the role of a researcher is to retrieve information on a specific species or organization I guess, researching and studying the kind of like the behaviours and activities of whatever they are focusing on." Whereas his post-program response was, "I think a researcher goes out and collects data over a certain period of time and compares results with past and present data that they have collected. They try and search for different behaviours and anything that's changing in their atmosphere." It is clear that the first response is more vague and could encompass a variety of research goals. Jeff states in his post-program response that researchers collect data over a certain period. This indicates he has learned that marine mammal research does take time to collect after doing this himself over the course of the week. More importantly, Jeff quickly grasped the concept of time series in this kind of research, that things change and can be compared over time. This is an important aspect of ecological research in general.

The students were able to identify the roles of a researcher more accurately. They did not expand much beyond what they learned during their week, but they were able to identify a researcher's role far better than in the pre-program assessment. I attribute this to spending a week in the field working as members of a marine research crew. This was their first exposure to researchers, fieldwork and marine science at this level. Providing students opportunities to learn about science and experience science firsthand allows for greater understanding, which are the same results Cachelin et al. (2009) found with their study as discussed in chapter two.

The second assessment presented to the students was a fictions whale research scenario set in Alaska. Each student was asked to read through the scenario and respond to a set of questions. What was evident in the students' response to the Alaska scenario was to articulate what they did during their time in the research camp. I drew two conclusions from this. First, they felt comfortable in the activities they were participating in, and I did get a sense of how they felt they could be part of a similar team.

Unfortunately, the responses from the students did not really tap into how well they could apply the information, probably because of the similarity of the scenario to this pilot project. It would have been very interesting if the students had attempted to list additional skills they may not have learned about during the week. This could have included what research they thought they could support on other types of whales, or simply expanded some of the concepts we had discussed during the week. In retrospect, the task was actually easy for the students because it directly paralleled their experience. However, the expectation of expanding on what they learned may have been too difficult because of the timeframe and newness of the experience.

Increased Confidence

To assess if the students had developed an increased confidence after spending a week in the field, a self-assessment and a rating scale was given to the students on two separate occasions. The first assessment was given once the students arrived and had not yet participated in the research. This was to determine a starting point for how they perceived themselves and their abilities. The second assessment was given after a full week of the program to determine what changes had taken place. The results of this assessment quite clearly indicated that the students' self-perception changed. For instance, the students felt moderately capable that they were able to collect data with their level of vision after the program.

One particular question that all three students answered where they saw an increase in their confidence level was, “With my level of vision, I am capable of collecting data in the field.” When they were given the self-assessment the second time, all three students increased their responses. In fact, one student stated they ‘disagreed moderately' the first time they answered this question to 'agree strongly' the second time they answered the survey a week after working in the field. This suggested that when the students first arrived, they felt their visual impairment may affect their ability to participate in the field conducting whale research. After a week of research activities designed to meet their needs, they felt they were capable of collecting data in the field after having done so first-hand. This result was the most surprising. By the end of only one week of work, albeit intensive work, the students were competent in using the techniques we developed for them. However, their mobility, attitude and demeanour caused at least one onlooker to doubt they were visually impaired. It is difficult to determine whether these were simply three gifted individuals, or whether they were exceptionally capable of accommodating their visual impairment in new and unique situations, and/or the program was well designed to support any vision needs.

Program Accessibility

Three qualitative methods were used to examine how accessible the marine field program was for the students who were visually impaired. Two methods solicited the students' direct feedback through journal writing and an exit survey. The third qualitative assessment relied on the feedback of the crew along with two orientation and mobility instructors. The results will be discussed in turn.

Students wrote in their journals each night about what they encountered that day, what they learned, what they had questions about and what concerns they had. The students were able to write freely in private with no time limitation. They each wrote on their own laptops and did not submit their journals until the last day.

The conclusion from the journals was that the students thoroughly enjoyed their time at the marine field station. They wrote about what they learned, how they could not wait to get out and see the whales when bad weather forced the cancellation of the trips. They talked about the additional learning opportunities they were given and how they enjoyed those. Finally, an enduring theme in all of the journals was to say thank you for this unique opportunity. Two students expressed their interest in attending another year.

One of the driving forces behind this project was my knowledge that students with visual impairment received few opportunities to engage in science, fieldwork and marine mammal research in any serious way. Students' journals consistently contained statements indicating their strong interest and enthusiasm about this opportunity to be involved in activities that had previously been unavailable to them. This reiterates Willoughby and Duffy's (1989) quote in chapter one about children who are blind or visually impaired being left out of science opportunities.

The exit survey also solicited feedback directly from students asking them to rate a set of statements. Enduring themes from this assessment were that all three students felt the opportunity to learn about marine mammals should be provided for other students with visual impairments. The students also had a chance to respond in braille to two open-ended questions. Again, the students wrote positive comments about how they enjoyed their time on the boat and enjoyed seeing wild whales. They made a few suggestions for more time on the case study, and also to have had the case study communicated earlier. Generally though, the students used words such as "I enjoyed" or "I really liked" or "I thought everything was very successful," which is positive language. This is also reflected in Frasers 2008 account of the Oceanography program in

Woodshole, Massachusetts, in which she acknowledges the students' enthusiasm and enjoyment while participating in field research activities.

The crew debriefings occurred every day once the students returned from the field sessions. The crew got to together to talk about lessons, teaching, accessibility and growth they observed in the students. My role as primary researcher was to listen, take notes and solicit more feedback. The most common theme from the crew discussion related to the belief that some activities required additional time and practice.

On the last day of the program, students were asked to organize and conduct their own research as a group with minimal input from the researchers or crew onboard. The students collaborated together, and one student, Amy, took charge of the assignment immediately. She delegated tasks and independently tied the net-collection device to the boat without any prompting or assistance. She then tossed and retrieved the net in an area with many feeding gray whales that students had visited earlier in one of the initial training sessions.

Amy instructed the second student, Rachel, to record data while Jeff readied the plastic bags for her to place her data sample in. It was incredibly rewarding to see the growth of the students, their ability to work independently as a research team and with confidence. One senior member of the marine research crew commented while watching the students in action, "I cannot believe how well the students are executing this activity."

The crew was asked if there was anything that needed to be changed or adapted in order to make this program most effective for including students who are blind or visually impaired. The answer was no. In particular, feedback was sought from the orientation and mobility instructors whose career it is to help students navigate and become more mobile in areas that are both accessible and inaccessible. They felt the program was well organized, well executed and accessible for students in all areas. The marine field crew, who have worked with many people, although none being blind or visually impaired, also had no concerns for the students or themselves. This highlights how successful the students were during the program, and how, through adapted learning and meeting accessibility needs, the program functioned at a high level.

Limitations of the Study

There are three limitations to this current study. First, this study was limited to three participants, and until greater numbers can be generated, results are not generalizable. Second, to assess the long-term impact of the camp on the students, longitudinal studies are required. This would allow the researcher to monitor the change in students' perceptions a few months and even a few years after the experience, and to determine if the impact was long term. Finally, since this was exploratory research, the results can only serve to generate more questions and additional study rather than elicit conclusions or offer recommendations.

Future Research

Additional research needs to be conducted to engage the long-term implications from this program. What can be gleaned from this project is that more scientific opportunities need to be available for students who are visually impaired. The opportunity for these three students to attend a remote marine field station and by week's end conduct their own research highlights how limitless the possibilities are for these students.

Conventional science programs can be redesigned without extensive overhauls to incorporate a larger group of learners. In fact, future research initiatives should consider how to make a variety of science-based camps equally accessible for all students, especially for students who are visually impaired. This in turn will allow researchers to assess the programs' long-term impact and influence on students' self-perception and understanding of their abilities as scientists. Findings from research could be translated into teacher education programs. This information is vital to encourage and expand new teachers' perceptions of the science capabilities of students who are visually impaired.

Additional science learning opportunities will hopefully perpetuate the prospects for all students with a movement toward more science programs, more opportunities and more enhanced learning opportunities. Similar to the inclusive classroom movement, future research focus should be on opportunities to incorporate all learners.

Conclusion

Science is an area where students who are visually impaired should have every effort be made for their inclusion. A student's visual impairment is not the only factor that influences his or her success in the science curriculum. Lack of opportunities to learn outside the classroom, inadequate preparation of general education science teachers, and access to high-quality tactile resources can influence a student's confidence and ability to be fully included as a member in a science class and laboratories.

This program explored whether or not students who were visually impaired could participate, learn, build confidence and work as a team in a marine field station. Data gathered through various assessments indicates that participants in this research were highly successful in all areas. More projects need to be undertaken involving students who are blind or visually impaired so that long-term programs can grow based on the success and growth of the students who participate in the programs. In addition, results of accessible science programs need to be shared with university grad programs, high school science teachers and other educators to display how capable students with visual impairments are when given appropriate support. If it is possible to have three students who are visually impaired participate in one of the most visually dominant aspects of science, then their inclusion into other areas including fieldwork should never be overlooked.

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Appendix A: Primary Participation Consent Form

The University of British Columbia
Department of Educational
Psychology and Special Education

Primary Participant Consent Form

Whale Program: Multi-sensory Experiences of Young Adults with Visual Impairments

Study Rationale and Consent Form

Principal Investigator: Dr. Cay Holbrook, Associate Professor
Educational and Counselling Psychology and Special Education, University of British Columbia (UBC), 604-822-2235, cay.holbrook@ubc.ca.

Co-Investigator: Ms. Lynn Kent, MA Student, Department of Educational Psychology and Special Education, UBC.

Dear Participant:
Congratulations, you have been selected to participate in a program that will study the multisensory opportunities for individuals who are blind or visually impaired while attending a Whale Research program. By participating in this program, your personal experiences will aid research in making science more accessible and multisensory for a variety of individuals. In addition, the information gained from your participation will guide future interventions in this small field of study.

This research project is part of the completion of a graduate degree from the department of educational psychology and special education at the University of British Columbia (UBC). Information gained through this study will be documented in a final Master's thesis and a professional journal article.

Purpose of Study:
The purpose of this research was to explore how field experience can be used to increase understanding and researcher behaviours in young adults who are blind or visually impaired. This study probed effective teaching methods and solutions to accessibility issues through high-level participation in a field ecology research setting involving marine mammals.

The principle behind this study is to examine how young adults with visual impairments participate in a science-based field research program built upon a pre-established Whale Research Station.

This research will explore if accessibility options will offer participants who are visually impaired the ability to enhance their understanding of marine mammals and marine ecosystems and will observe if there is a change in participants' self evaluation of their capacity as a member of a field research team and as a scientist.

Study Procedure:
As a participant in this research you will be asked to be involved in the following:

Interviews before and after camp activities: You will complete a face-to-face interview using a tape recorder and timer before the camp activities begin and again after the camp is completed.

Questionnaire: You will be asked to fill out a questionnaire about Science, your opportunities for involvement in Science, and your perceptions of Science.

Behavioural Research: You will be observed when at camp and while collaborating in a group marine mammal case study. You will also be asked to record your thoughts, feelings and impressions in a journal that will be given to the secondary researcher at the end of the whale program. The notebook will be returned to you after it is used for the research.

Participant Program Review: We will be very interested in your impressions about the effectiveness of the camp and so, you will be asked to fill out a questionnaire and provide verbal suggestions and feedback about the methods, accessibility and success of the program.

Case Study: As a part of the camp experience you will be working with two other participants on a Marine Mammal Case Study and you will have the opportunity to will present their findings related to the case study on the final day of camp.

Time Allotment:

The total amount of time that you will be participating in the whale program is approximately 5 days (more or less depending on travel schedules).

Confidentiality:
The researcher will not disclose the your identity in any written document. You will be given a pseudonym for use in written documents. You will have the opportunity to chose your own pseudonym if you'd like. Your gender and age will be included in written documents but your name will not be used. Once data has been collected from the your journal, your notebook will be returned to you or destroyed.
Even with the above measures in place, it is important to note that the field of blindness and visual impairment in Canada is quite small and there is a chance that your identity may be known by other individuals students or teachers of students with visual impairments. In addition, your participation will include involvement with other

participants who may discuss their experience once they have returned home. Therefore, it is not possible to ensure confidentiality for this study.

Contact for Information about the study:
If you have any questions about this study, you may contact the researchers directly either through email or phone.

Primary Researcher: Dr. Cay Holbrook

Graduate Student Researcher: Lynn Kent

Contact for concerns about the rights of research subjects:
If you have any concerns about your treatment or rights as a research subject, you may contact the Research Subject Information Line at the UBC Office of Research Services at 604-822-8598.

Consent:
Your participation in this study is entirely voluntary and you may refuse to participate or withdraw from the research portion of the study measurements (questionnaires, interviews, etc) at any time without any ramifications. If you choose to withdraw from the program, it is the individual's responsibility to arrange transportation from Tofino to Vancouver. It will also be the individuals responsibility to cover any additional costs of the transportation including flight changes. If you wish to participate in this study, please sign this consent form and send it back to the Co-Researcher, Lynn Kent within five days.

Your signature below indicates that you have received a copy of this consent form for your own records.

Your signature indicates that you understand the conditions of this research project and consent to participate in this study.

____

Subject Signature Date

____

Printed Name of the Subject

Appendix B: Case Study Outline

Whale Ecology in Clayoquot Sound

Research conducted in the last few years indicates that Gray Whales are not remaining in the waters around Clayoquot Sound during the summer months. In fact the numbers have been steadily decreasing since the late 1990's. The researchers have also noticed that the Gray Whales available food sources are also decreasing. The question that researchers are working to answer is why is this happening? In your group you are asked to spend the next 5 days answering this question. To help you with this Case Study you will learn about whales through the following activities;

1) The basic life history of gray whales (lecture setting)
   a) population, migration, basic biology of the baleen whales
   b) basic ecology, what do the whales consume, what consumes gray whales
   c) local bio-physical systems

2) An introduction to field work in coastal waters (dockside discussion)
   a) our toolkit for data collection
   b) our research boat and its operation
   c) limitations on ocean work-safety and data limitations

3) The research process (lecture)
   a) how do we go about setting questions-the scientific process
   b) lets plan the data collection and sampling
   c) then lets plan the analysis-form of the argument

4) Research (field data collection)
   a) assessment of whale use of the study site
      1) whale counts
      2) behavioural assessment
      3) data collection teamwork process

   b) assessment of whale prey
      1) two or three collection methods for different type of prey
      2) sampling handling and data extraction

   c) working with the data (lab work)

5) Reflection (discussion)
   a) context of our scientific endeavours
   b) refinement of our questions and methods
   c) putting our thoughts in the context of recent and historical events

Appendix C: Vocabulary Checklist

Student Acronym: Dates:

Student vocabulary use:

- ☐ Mysids
- ☐ Identification photo
- ☐ Latitude and Longitude
- ☐ Dive time
- ☐ Ponar
- ☐ Currents
- ☐ Benthic level
- ☐ Salinity
- ☐ Ecosystems
- ☐ Transects
- ☐ Crab Larvae
- ☐ Baleen Plates
- ☐ Balenopterids
- ☐ Orcas
- ☐ Echolocation
- ☐ Transients
- ☐ Bow or
- ☐ Stern
- ☐ Exhalations
- ☐ Kelp beds
- ☐ Tide changes
- ☐ Cow Calf pairs
- ☐ Breach
- ☐ Tail Slap
- ☐ Migration Route
- ☐ DFO regulations
- ☐ Spy Hop

Additional Terms used____
____
____

Appendix D: Scenario of a Whale Research Centre

You are a researcher for a newly organized Whale Research Facility in Alaska. As a member of the team you will be studying Gray Whales and their foraging behaviours from May until September. Please list in great detail what roles you could play as part of the team? What type of data collection would you want to start with? Do you think you'd be a good researcher? Why or why not? What other support do you think you could offer as a team member who is visually impaired?

Appendix E: Whale Research Program: Personal Self Assessment

1 =Disagree Strongly
2= Disagree Moderately
3= Unsure
4= Agree Moderately
5= Agree Strongly

	Circle one
1. I see myself as a researcher	1 2 3 4 5
2. With my level of vision, I am capable of collecting data in the field	1 2 3 4 5
3. I think I will do well at the Whale Research Camp	1 2 3 4 5
4. I ask for help when I need it	1 2 3 4 5
5. I enjoy teamwork.	1 2 3 4 5
6. I have a good understanding of science	1 2 3 4 5
7. I feel I have a lot to contribute over the week	1 2 3 4 5
8. I have done some of my own research	1 2 3 4 5
9. I see myself enjoying field research	1 2 3 4 5
10. I will be able to participate because of the accessibility and equipment.	1 2 3 4 5
11. I see myself pursuing science in postsecondary	1 2 3 4 5
12. I can do things independently in science	1 2 3 4 5
13. In science experiments I need a lot of assistance	1 2 3 4 5
14. My vision limits many of the things I want to do	1 2 3 4 5
15. I have always had positive experiences in science	1 2 3 4 5
16. I worry about how I can participate equally in a research team	1 2 3 4 5
17. I am able to contribute meaningfully in group research over the week	1 2 3 4 5
18.I worry about going on a boat since it is more unstable than regular surfaces	1 2 3 4 5
19. I have strong Orientation and Mobility skills	1 2 3 4 5
20. I will require a lot of help over the week	1 2 3 4 5
21. I worry that the data I collect will not be adequate because of my visual impairment	1 2 3 4 5

Appendix F: Internal Characteristics Ranking

Rate yourself on the following characteristics (1-10 one being this does not describe me at all and 10 being this describes me perfectly):

1. Highly Adventurous
2. Highly Self-Confident
3. Takes Initiative on my own
4. Highly Responsible
5. Highly Resourceful
6. Excellent Sense of Humour
7. Highly Dependable
8. Excellent Problem Solver
9. Very Trusting of Others
10. Highly Trustworthy

Appendix G: Student Confidence Checklist

Acronym:____________________

Date:___________________________

Activity or Lesson:_________________________

- ☐ Student records accurate and detailed information
- ☐ Asks questions and clarification
- ☐ Willing to participant
- ☐ Accepts feedback and suggestions
- ☐ Refers to team members

Appendix H: Crew Daily Discussion Outline

Daily Crew Discussion Outline

Daily Crew Discussion

Date: ______________________________Time: ________________________

______Crew Members present: ____

______

1. What aspects of the lesson today were successful and why?
2. What aspect of the teaching and lessons could be improved upon and why?
3. Were there any safety or concerns and how were they dealt with? What modifications should be made to avoid these issues again?
4. Was the amount of time adequate for the students to develop understanding and practice? Why or why not?
5. Additional comments?____

____

____

____

____

____

____

Appendix I: Exit Questionnaire

Rate 1 –strongly disagree, 2-disagree, 3 –undecided, 4 –agree, 5-strongly agree

1. Did you find this a good learning experience?

    1 2 3 4 5

2. Was the camp well organized?

    1 2 3 4 5

3. Did you feel you had adequate time to familiarize yourself with the boat?

    1 2 3 4 5

4. The background information was sufficient.

    1 2 3 4 5

5. The field activities provided a greater understanding of whales and their environment.

    1 2 3 4 5

6. The activities on the boat were accessible.

    1 2 3 4 5

7. The Case study was interesting and challenging.

    1 2 3 4 5

8. The instructor took time to explain information and answer questions.

    1 2 3 4 5

9. The safety procedures were covered and consistent.

    1 2 3 4 5

10. Any questions I had were answered in a timely and informative response.

    1 2 3 4 5

11. The equipment available to help me record my thoughts and data was appropriate.

    1 2 3 4 5

12. This opportunity has amplified my interest in Science.

    1 2 3 4 5

13. The feedback to the instructor gave me a good opportunity to voice my thoughts.

    1 2 3 4 5

14. Building the whale helped me develop an idea of a whales size and mass.

1 2 3 4 5

15. The Tactile maps allowed me to determine/understand the transect route.

1 2 3 4 5

16. This opportunity should be offered to other students with Visual Impairments.

1 2 3 4 5

Please write a few sentences:

What was your favourite part of the whale research program and why?

What suggestions or changes would you suggest to improve the whale research program and why?

Appendix J: Student Case Study Presentation

Students Case Study Presentation as transcribed by the voice recorder

Some Gray Whales are not consistently returning to the water around Clayoquot Sound in summer months. Researchers have also noticed the Gray Whales available food source are either decreasing or their absent in certain areas. The question researchers are working to answer is why is this happening?

History of the Gray Whale

The size of a gray whale is between thirty and fifty feet long and they can weigh forty to fifty tons. The females are usually larger than the males. Their life expectancy is usual thirty to forty years but they can live up to sixty years. Gray whales have a light gray color but are heavily covered in white due to the natural pigmentations and the barnacles on the whales. They have blowholes that are eight inches long and have no dorsal fin but instead knuckles on the dorsal ridge of the tail. The average movement of a Gray Whale is two to four knots. They have a top speed of ten knots and a normal dive depth of one hundred and twenty feet. The can last underwater without coming up for air for three to five minutes long but can occasionally reach up to fifteen minutes. They have a low tone frequency that allows them to communicate with other whales and allows them to find their way through darkness or water with barely any light. They do have echolocation but people are still not sure exactly how it works with the Gray Whale. The population of

Gray Whales is about sixteen thousand and supposedly increases by 2.5 % every year. The migration period for the southern migration happens between Oct and Feb. The pregnant females usually migrate first followed by the non pregnant females, males and juveniles usually follow afterwards. The can travel up to twenty hours a day. The pregnant females travel in groups of two or three. The non-pregnant groups travel up to groups of twelve. This is the time where the whales usually mate and the complete journey usually takes up to six to eight weeks. The female birth cycle can take up to twelve months which is a long time so females only give birth about every two years. They are considered mature in six to eight years. The northern migration takes place in two batches the first one is February to June and March to July. The second one is a lot longer of ninety to-one-hundred days. Predators of the Gray Whales and there obviously isn’t many but are Killer whales, large sharks and humans. Gray whales are known as bottom feeders. Their diets are made up of amphipods, Mysids and sometimes schools of fish. The way that they feed is they dive to the bottom of the sea and often most of them roll onto their right side but some are left sided and roll on to their side and use their mouth as a vacuum cleaner and they suck out the sediment off the bottom of the sea. They use their tongue they squeeze out the water leaving amphipods and Mysids to eat. They can consume up to one to two tons daily

The methods we used to collect data on the whales.

2. A) our main piece of data collection material was a voice recorder which we used to record the locations of where the whales were spotted, the number of whales, the time they were seen and any other information we deemed to be useful. We also recorded the

procedures that we learned for sample collections. We also had tactile maps which we could use to follow the transect route and locate certain regions.

B) WE have been conducting our research on a boat names Drifter which is 22 feet long and equipped with good research supplies including a GPs system which can give us latitude and longitude recordings. It also has strong engines in order to be able to keep up with the whales and is quite sturdy.

C) The main limitation for work safety and data collection is the weather. It must be very cooperative in order to go out to sea. It is very easy to get uncooperative weather because the wind and waves are not always what they seem just by observing from the shores and docks. Also, there could be limitations when it comes to technology. There could be malfunctions or the technology might not be as advanced as we would like.

4. A) 1) To do a consistent whale count, researchers have to set up a transect which is a straight line to follow out on the water. We then try and spot all the whales along and around that line. We do this systematically every day to make sure our data is consistent. We then input the data in to a database for referencing.

2) WE can also assess the whale’s behaviour. For example, how they feed, how long they dive for which we can see by the position of their tail and also try to listen to the sounds they make with the hydrophone.

b) 1) A couple of methods we used were the dive nets and the Ponar. With the dive nets, you hold the caught ends in your right hand and the yoke of the net in your left hand. There are usually thrown in to rocky bays and kelp bed to filter out Mysids. We threw ours in east cow bay on Tuesday. The Ponar must be dropped in a sandy bay because it has to go and clamp down on the bottom of the ocean floor in order to pick up a sample of sediment. It's a giant metallic jaw-like contraption which will clamp shut when it reaches the bottom of the ocean. We then filter out the sediment on screens over plastic bins and observe the sample which contains mostly amphipods. We can then analyze the samples we collected.

The research process

Basically the first thing you want with your research process is a question to ask. For instance with our case study we are trying to figure out what might be happening with the Gray Whales since we are finding that some years there's a great number whales while other years there isn't. That's the first thing you want to figure out is what you're looking at or what you're looking for.

So for instance with this case study is it their food source, is it a predator is there something that's interfering with their food source? Is there just low population of their food source that year? Is it a push or pull factor essentially what is happening? Also within that you want to break that question up into sub-questions food source, animal itself, so really with any case study you want to start with a question or an idea as to what you're trying to figure out.

Sampling

Over the last couple days we collected some samples of Mysids and amphipods in different locations. The Mysids we found in East Cow Bay and the amphipods, well the few we found were in Ahous Bay. You can see the ratio of Mysids to amphipods is much larger. Again that could be one of the questions, is one food store decreasing compared to another or are they all decreasing? With data collection and sampling it really helps if you have the appropriate equipment. For instance with collecting the Mysids, we used dive nets. Whereas with the amphipods we used the ponar to collect them. Since with the Mysids you find them in a rocky area compared to the amphipods which are found more in the sediment of the floor bed of the ocean. If you don't have the right equipment, then what good is that going to do you? For instance using the ponar to gather to the Mysids is going to be absolutely useless. Same with the sampling, if you are not collecting the proper data then what is that going to give you? If we had collected herring for instance, that is not going to do much good for the Gray Whales. Of course, obviously planning out what you are going to be using is the best idea before you go out and find that you don't have the right equipment with you. Some data that you have collected, may or may not agree with what you have initially questioned. Most times modification is necessary in any kind of science. Sometimes having to adjust what you're looking at is necessary and once you have done that you can basically continue with your study.

Findings

More details about the field work and how we applied the techniques.

First of all there is counting the whales. So we plot a straight line with the GPS called a transect and follow that straight line consistently everyday or every couple of days and we count all the whales that we see. After awhile you find that hopefully your results are consistent. For example, the first transect we did there were twenty six gray whales and then second one there were twenty one. There was a little bit of difference but not that huge. You do that consistently for many years to find out what the trend is really like. Comparing to the previous years and the statistics, we can see that some years there are high number of whales and some years there are low number of whales and usually it alternates. It usually alternates because the whales they eat a lot of food so they pretty much deplete the food source one year and amphipods take a long time to recover and Mysids are fasters so they recover more quickly. The next year you see a lower count of whales because there is not as much food as there was and the other species didn't quite have all the time they needed to remain in their full numbers.

Another part is to assess the whale behaviours. For example if the whales dives with their tails in the air that means they are going for a deep dive to feed for quite awhile. Usually it is around five to ten minutes. Similar to what we calculated today for a humpback whale. Its average dive duration for a deep dive was 5.6 minutes and 328.2 seconds. That was the average for nine dives over the course of an hour and a half. It also did a bunch of smaller dives for reventalation. Those are a lot shorter, the average was 0.8 minutes. It doesn't have anything to do with the case study but we thought it was interesting.

If we were lucky we could have listened to them quote on quote talking. But unfortunately we didn't hear them do anything. The hydrophone is an underwater microphone that allows us to hear the sounds that go on under the surface of the ocean. A couple days ago we heard a gray whale exhaling before it even reached the surfaced. That was about all we heard, along with boat engines.

Methods to collect the samples

To collect the Mysids we used dive nets. The dive nets have two round openings. At the bottom attached to the bottom are two plastic cylinders called cod ends. So you hold that with one hand and you hold the top part with the other end and throw it into the ocean and it has to mostly be in an area with kelp beds and rocks because that is where Mysids live. Then you pull it back up and we found quite a few Mysids. The population of the whales in that area were higher at that time because that is a popular place for eating. If we don't find that many Mysids it could be because the whales ate them. To get the amphipods we use this other contraption called a Ponar. It is a metal jaw like thing that you put a pin in it attached to a string that holds it open and you drop it onto a sandy bay, not rocks because you will most likely break it or it will get stuck. It goes down to the bottom and it clamps shut and brings up a chunk of sand and when we pulled that up we found a few amphipods but not very many. Amphipods do not recover as quickly as Mysids so the last time the whales came through they ate all of them and the population has not quite recovered. You pull up the ponar which is quite heavy, it weighs a lot. You pull out these two screens and you open it up and empty the sand and the sample with a bit of water and pour it onto a bigger screen and all the water filters the particles and you are left with your sample of amphipods and anything else you are left with.

Reflections

Basically you are figuring out your scientific endeavors so with this case study we are trying to figure out the high and low years of whales are returning to Clayoquot Sound as well as what is going on with their food sources. As I said sometimes refining your questions or your methods may be necessary depending on what data you collect and what kind of samples you end up getting. In our case, there were very few amphipods compared to the number of Mysids. Some of the Mysids we found were gravid or pregnant. This could be a possible low year next year or there could be another big population of Mysids again. It's one of those waiting and watching games. You have to wait and watch because the data you collect or the samples you get may coincide with what you are doing or it may not. It just depends on what you are looking at. Historically the gray whale population was depleted due to whaling. The gray whale was known as the devil fish because they would fight back if they were harpooned. Then they started to repopulate and then actually began to disappear again. They were put on the endangered species list and just recently they started coming back and are not off that list. As I just said in recent years there have been a great number of gray whales in some years and then other years where there has been a low population of gray whales returning to Clayoquot sound.

We also found out that Gray whales are not the only things that eat Mysids. Last year there were a lot of jellyfish in this area and they eat Mysids. So the competition for the food may drive the Gray whale to larger supplies of food since they eat a lot. That could be another cause of where they whales are going to feed during their migration. In conclusion there are a lot of factors at play here so years of study is required to determine what is causing the population of Gray whales in Clayoquot sound to fluctuate.