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I, Ivan G Carabajal, hereby submit this original work as part of the requirements for the degree of Master of Science in Geology.

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Understanding Field-Based Accessibility from the Perspective of Geoscience Departments

Student's name: **Ivan G Carabajal**

This work and its defense approved by:

Committee chair: Christopher Atchison, Ph.D.

Committee member: Craig Dietsch, Ph.D.

Committee member: Warren Huff, Ph.D.

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Understanding Field-Based Accessibility from the Perspective of Geoscience Departments

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Ivan G. Carabajal

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Thesis Committee

Christopher L. Atchison, Ph.D. – Committee Chair

Craig Dietsch, Ph.D.
Warren Huff, Ph.D.

ABSTRACT

Many traditionally-designed geoscience courses and field-experiences are unintentionally presenting barriers to active participation for students with disabilities (SWDs). As such, these barriers are potentially contributing to the under-representation of persons with disabilities in the geoscience discipline. Although geoscience organizations are calling for more inclusive approaches to geoscience education, departments have been left to independently develop inclusive curricula with little insight or pedagogical training. In order to encourage geoscience departments to implement inclusive instruction, we must first understand current practices on promoting accessible field experiences.

This document reports the findings from a study on the conceptions that geoscience instructors and U.S. geology departments have regarding field-based accessibility. This study collected survey data from 160 two-year and four-year geology departments and follow-up interview data from three geoscience instructors from different institutions. Data collected included information on departmental practices when attempting to provide adequate field experiences for SWDs, department confidence in assessing field site accessibility, and the culture of access and inclusion in their own geoscience department. Reported practices were thematically analyzed according to: (1) modifications, (2) accommodations, (3) adaptations, and (4) accessible options. Interview data revealed instructor insight on accessible instructor practice, strategies for student success, the challenges associated with accessible instruction, and department-wide inclusivity. This study promotes inclusive field-based instruction through critical insights on current departmental practices.

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CHAPTER 1: INTRODUCTION

Study Overview

This study investigated the experiences and perceptions of post-secondary geoscience department faculty when providing accessible field-course instruction for students with disabilities (SWDs). The goal of this research was to fully understand accessibility in geoscience field curricula from the perspective of instructors across the United States. The researcher identified and coded common practices reportedly by geoscience instructors with the goal of providing more inclusive in-field learning experiences. Respondents reported the confidence of their department's ability to offer students with mobility and/or sensory disabilities inclusive field-based education and assess field-site accessibility. A variety of instructors from both 2-year and 4-year geoscience departments were interviewed to gain a deeper understanding of geoscience academic culture and their perceptions of inclusive field instruction. Implications from this study may aid geoscience departments in the development of accessible field-based learning experiences which may help dismantle physical, social, and institutional barriers to participation.

A phenomenographic approach was taken to understand the differing perspectives that geoscience instructors have regarding the implementation of accessible field techniques. A short survey with both closed and open-ended questions was developed to help understand the status of accessibility of each survey respondent's geoscience department Follow-up interviews were conducted with two of these survey respondents. Semi-structured interview protocols were grounded in survey data and thematically analyzed to interpret the ways in which geoscience instructors influence the accessibility of a department's field component for students with mobility, visual, and hearing disabilities.

Statement of the Problem

Geoscience education research dedicated to broadening participation has increased over the last two decades (e.g. Cooke et al., 1997; Hall et al., 2004; Locke, 2005; Atchison, 2011; Atchison and Martinez-Frias, 2012, Gilley et al., 2015; Stokes and Atchison, 2015; Huntoon 2016; Sherman-Morris and McNeal, 2016). Much of this work has focused on ways to increase retention rates of racial and ethnic minority students (McCune, 2001; Huntoon and Lane, 2008; Baber et al., 2010; Huntoon et al., 2015; Huntoon, 2016; Sherman-Morris and McNeal, 2016). Since 2010, research focusing on access and inclusion for individuals with disabilities has become more prevalent in geoscience education (Adams et al., 2010; Adams et al., 2011; Atchison, 2011; Atchison and Martinez-Frias, 2012, Gilley et al., 2015; Stokes and Atchison, 2015; Hendricks et al., 2017). Individuals with disabilities are found across all majority and minority racial and ethnic groups, creating the largest minority group in the United States (Olkin, 2002). Including this population in the discussion of broadening geoscience participation is necessary for developing a more diverse community of geoscientists.

Diversity has been widely recognized as a necessary component of building a strong, innovative science workforce (Velasco and de Velasco, 2010; Atchison and Libarkin, 2013; Huntoon et al., 2015). Individuals with disabilities are not entering the geoscience workforce at rates on par as those without disabilities (NSF, 2017) and as a result, the geoscience workforce still remains as one of the least diverse in all science, technology, engineering, and mathematic (STEM) fields (Huntoon et al., 2015; Atchison and Libarkin, 2016). According to the National Science Foundation (2017), individuals with disabilities comprise just 9% of the geoscience workforce, below the percentage of people with disabilities in the US population (12.6%).

In post-secondary institutions, individuals with disabilities represent 11% of the undergraduate population (NSF, 2017). However, Newman et al. (2011) state that only 28% of all students with disabilities (SWDs) request accommodation services in higher education. These statistical data on SWDs are potentially skewed due to laws (i.e. HIPPA) that protect individual health identity (NSF, 2017). In other words, data are only reported on students who self-disclose their disability in order to receive academic support services. A number of reasons potentially prevent this self-disclosure, a few of which are discussed later in this paper.

Laws and policies that are intended to support SWDs only support those who self-disclose a disability. These laws are also often vague and left to the interpretation of academic officials. The Americans with Disabilities Act of 1990 (ADA), Section 504 of the Rehabilitation Act of 1973, the Higher Education Opportunities Act of 2008 (HEOA), and the United Kingdom's Special Education Needs and Disability Act (2001) are examples of provisions that guarantee equal educational opportunities for SWDs in federal and privately funded postsecondary institutions.

The ADA requires that institutions make reasonable accommodations to individuals on a case-by-case basis. By law, educators in the U.S. must provide accessible learning experiences for SWDs (Cooke et al., 1997; Atchison, 2011; Newman and Madaus, 2014). These accommodations should extend the opportunity for an individual to make adequate progress without fundamentally altering the program (McLaughlin, 2012). In the case of the geosciences, many instructors are unaware of how these laws affect departmental policies for providing equitable access to both laboratory- and field-based instructional settings (Miner et al., 2001; Locke, 2005). Thus, the determination of "reasonable" and "necessary" accommodations is left to instructors rather than to those creating institutional policy. This level of interpretation can create inconsistency across courses, programs, colleges, and even institutions.

The purpose of this study is to understand and discern the strategies used by geoscience instructors when creating/modifying course curricula so that the course is more accessible and inclusive for students with mobility and sensory disabilities. Many publications dedicated to promoting field accessibility for SWDs are articles that detail how field opportunities were provided for particular SWDs. These articles are important for learning more about field-based accessibility, but no study has attempted to understand how geoscience departments as a whole are actively promoting accessible field-based curriculum.

This project was initially designed with an end-goal to create a series of accessibility guidelines based on field course practices implemented and described by study participants. Initial data analysis revealed that there was insufficient information on "best-practices" used by departments. Several faculty members were unsure on how to make field experiences more accessible and doubted their ability to improve access and inclusion. This study occurred over the course of three phases, all of which helped build an overall understanding of how geoscience departments alter or create accessible field curricula. The guiding research questions used for this study were the following:

- What are the experiences of geoscience instructors who have provided accessible field opportunities for students with disabilities (SWDs)?
    - In what ways do instructors provide accessible field course experiences for SWDs?
    - What are the conceptions that geoscience instructors have in regards to providing SWDs with accessible and inclusive in-field learning opportunities?

By understanding the ways in which diverse geoscience departments promote an inclusive field program, the researcher hopes to offer the geoscience community at large the opportunity to reflect on the status of accessibility of their discipline. The researcher hopes to highlight the efforts made by inclusive geoscience departments so that other institutions may emulate or expand on their endeavors.

CHAPTER 2: LITERATURE REVIEW

All students are faced with challenges when negotiating certificate and degree programs, but SWDs face additional barriers (i.e. lack of role models, less access to accommodations, misconceptions of student ability by teachers) that further impede in their participation at the postsecondary level (Alston and Hampton, 2000; Alston et al., 2002; Bargerhuff et al., 2010; Lee, 2011; Newman and Madaus, 2014). This can result in reduced involvement in career preparation in Science and Mathematics when compared to their able-normative peers (Lee, 2011). Disciplines with field-based study requirements for degree completion exacerbate these barriers (Hall et al., 2004; Locke, 2005; Atchison and Martinez-Frias, 2012; Atchison and Libarkin 2016). Physical barriers (i.e. field sites and laboratories) and non-physical barriers (i.e. social and institutional) directly impact the participation of SWDs in the geosciences as well as other field-focused disciplines (Cooke et al., 1997; Healey et al., 2001; Miner et al., 2001; Healey et al., 2002; Hall et al., 2004; Hall and Healey, 2005; Locke, 2005; Atchison, 2011; Atchison and Martinez-Frias, 2012; Atchison and Libarkin, 2016).

Physical Barriers

The educational benefits of classroom and field-based learning experiences have been well documented in geoscience literature (i.g. Mondlane and Mapani, 2002; Elkins and Elkins, 2007; King, 2008; Pyle, 2009; Mogk and Goodwin, 2012), yet these instructional environments often present many challenges to students with physical and sensory disabilities (Cooke, 1997; Asher 2001; Healey et al., 2001; Healey et al., 2002; Hall et al., 2004; Locke, 2005; Supalo and Mallouk, 2007). Physical barriers are particularly apparent in field-based learning experiences (Healey, 2001; Healey et al., 2002) they can also be pervasive in laboratory and classroom environments (Miner et al., 2001; Norman, 2002; Babic and Dowling, 2015). Educators have attempted to dismantle these physical barriers from instruction by implementing Universal Design for Learning (UDL; CAST, 2012).

UDL is a framework for creating a flexible curriculum that enhances the learning experience for all students (Silver et al., 1998; Rose and Meyer, 2002; Dunn et al., 2012). The main principles of UDL extends access and inclusion to all students by providing multiple means of content representation, opportunities for everyone to participate and engage in the community of learning that best fits their abilities, and diverse strategies of evaluation that enable students to effectively express their knowledge and understanding (CAST, 2012). These principles can be found in the inclusive instructional design and accommodation techniques presented in the literature from many geoscience education researchers (Cooke et al., 1997; Asher, 2001; Greenberg, 2002; Atchison, 2011, Wild et al., 2013; Atchison and Gilley, 2015; Stokes and Atchison, 2015). Inclusive instructional design generates many innovative instructional strategies (i.e. tactile field maps, audio-recorded field guides, multiple representations of content, alternative field access) to increase the participation of students with hearing, visual, and mobility disabilities and enhance the learning experience of all students (Cooke et al., 1997; Asher, 2001; Gardiner and Anwar, 2001; Wareham et al., 2006; Coughlan et al., 2010; Atchison, 2011; Horowitz and Shultz, 2014; Atchison and Gilley, 2015; Gilley et al., 2015). UDL is particularly useful in designing instructionally accessible and inclusive field studies (Bowe, 2000, Atchison, 2011; Gilley et al., 2015), although the principles have also been used extensively in classroom and laboratory instruction across science and engineering (i.e. Asher, 2001; Miner et al., 2001; Greenberg, 2002; Calderone et al., 2003; Benison, 2005; Duerstock, 2006; Thompson, 2008; Horowitz and Shultz, 2014; Supalo et al., 2014).

While UDL aims to provide universal access to teaching and learning, accommodation strategies that circumvent physical barriers and support student engagement are not "one-size-fits-all". For example, a field site that is assumed to be accessible for a student who uses a wheelchair may still present physical barriers for students with other types of mobility disabilities (Cooke et al., 1997). Physical barriers present a variety of challenges, and therefore inclusive instructional planning must be integrated with personal support according to the specific needs and abilities of the individual student. On-campus disability service offices may be able to provide some assistance with these obstacles, but geoscience department faculty must ultimately ensure that all students are able to participate in all course activities. Educators must be willing to openly communicate with their students about potential barriers in order to create a supportive and inclusive learning community (Cooke et al., 1997; Atchison and Gilley, 2015; Gilley et al., 2015).

Nonphysical Barriers

Aside from the physical challenges that SWDs face engaging in higher education, non-physical barriers often place additional burden on the opportunities for participation in postsecondary activities (Cooke et al., 1997; Locke, 2005; Healey et al., 2001; Atchison 2011; Milic Babic and Downling, 2015; Atchison and Libarkin 2016). Non-physical barriers such as prejudice, discrimination and limited financial resources, are more prevalent than the physical barriers described above, and are not unique to the geosciences (Miner et al., 2001). While all barriers are detrimental to student participation, non-physical barriers can greatly affect student retention and lead to the marginalization of an individual or group within a department or institution.

Social barriers can be described as any discrimination, bias or stereotype directed towards a marginalized population. These barriers are common and can be very damaging, even if unintentional (Pivik et al., 2002; Locke, 2005). SWDs have reported that social barriers are not only the most common barriers faced in educational settings, but they are also “the most deleterious of their school experiences” (Pivik et al., 2002, p.104). The most prominent social barrier in the geosciences is the judgement of individuals based on their physical ability (Locke, 2005; Healey et al., 2001; Hall et al., 2004; Atchison 2011). This leads to the misconception that the geosciences are only for those who are physically fit and able to engage in rigorous field-work activities (Locke, 2005, Sexton et al., 2014; Atchison and Libarkin, 2016). This ableist perspective places undue social discrimination on SWDs (Lynch and Gussel, 1996; Ash et al., 1997; Holloway, 2001; McCune 2001; Barnard-Brak et al., 2010; Huntoon et al., 2015; Atchison and Libarkin, 2016). Social discrimination causes many with non-apparent disabilities to refrain from publicly disclosing their need for accommodation services in order to fit in and avoid stigmatization (Taub et al., 2004; Barnard-Brak et al., 2010; Newman and Madaus, 2014; Libarkin and Atchison, 2016). This innate prejudice, which undoubtedly persists in campuses across the U.S., causes students to often downplay or deflect attention away from their disabilities in order to circumvent social bias and stereotype (Goffman, 1963; Taub et al., 2004; Barnard-Brak et al., 2010).

Prejudice toward disability is not uncommon in the geoscience community (Locke, 2005; Atchison and Libarkin, 2016) and can lead SWDs to decide against participating in course activities (Healey et al., 2001) or even pursuing geoscience certificate and degree programs altogether. In a study by Atchison and Libarkin (2016), professional geoscientists were surveyed to describe their personal perceptions about individuals with disabilities. Findings from this study suggest geoscience professionals perceive that persons with hearing disabilities have the most opportunity to engage in geoscience careers. Alternatively, the same geoscience practitioners feel those with physical disabilities would have limited opportunities to engage in field-work, and persons with visual disabilities would be unable to effectively participate in a geoscience career altogether (Atchison and Libarkin, 2016). These perceptions reflect an inherent cultural bias against SWDs by assuming that they are unable to perform tasks because of their disability, underestimating the contributions they can make in the discipline, and ultimately the workforce. To dismantle these social barriers, educators must work together to redefine the skills necessary to participate in the various geoscience disciplines. By providing more accessible learning opportunities and promoting access and inclusion in the geosciences, the geoscience community may change the negative perceptions regarding people with disabilities.

Institutional barriers include any policies or administrative decisions that impede the full participation of SWDs in a program of study. For example, policies driven by departmental practice (i.e. requisite completion of undergraduate field studies) can place financial burden on that department (i.e. renting accessible transportation or hiring sign language interpreters for field trips). Limited departmental funding may indirectly become a barrier to the student (Healey et al., 2001; Miner et al., 2001), thus revealing institutional support system failures (Fuller et al., 2004; Jenson et al., 2010; Gabel and Miskovic, 2014). In addition, a general lack of cooperation from faculty and administrators is often cited by SWDs as a common institutional barrier (Greenbaum et al., 1995; Barnard-Brak et al., 2010). Unless institutional policies and practices are able to provide safeguards to support students with specific accommodation needs, marginalization will persist for students who don't fit the able-bodied model (Locke, 2005) and an exclusive culture will permeate the educational environment (Holloway, 2001; Day, 2012).

Physical Geoscience Accessibility

Over the last twenty years, education researchers have been investigating ways to make indoor and outdoor geoscience learning experiences more accessible to students with mobile, visual, and hearing disabilities. As the percentage of college students with disabilities continues to rise, educators will need to provide reasonable accommodations to ensure that SWDs obtain equal educational opportunities in field, laboratory, and classroom settings. Reasonable accommodations can be defined as the deviations in instruction presentation, assignments, or environments that enables individuals with disabilities to participate in a course in a manner equal to their able-normative peers (U.S. Department of Education, 2007; McLaughlin. 2012). Instructors should become aware of the barriers students face inside and outside the classroom and must work with students to create accessible curricula. There are a variety techniques and tools educators can use to design more accessible learning experiences; however, different techniques and tools may alter a particular course's content and social engagement.

Physical field studies present students with opportunities to integrate geoscience theory and practice in the natural context (Mogk and Goodwin, 2012). Through these hands-on experiences, students develop a particular set of skills and techniques that can be used to observe, collect, and interpret data (Maskall and Stokes, 2008; King, 2008). Research suggests in-field learning "should be process-oriented rather than context-oriented in order for students to gain knowledge" (Elkins and Elkins, 2009, p. 126) meaning that hands-on exercises performed by well-informed students promote better application and retention (Elkins and Elkins, 2009; Orion, 1993). Despite the importance of field work to geoscience education, ways to promote accessibility and to involve more hands-on learning opportunities for SWDs in the geosciences have not been quick to develop (Bennett and Lamb, 2016). One may create a geoscience field trip that is fully accessible for all learners that maintains a high level of academic rigor (i.e. Gilley et al., 2015). With thoughtful consideration towards site selection and the removal of unnecessary aspects that do not align with learning objectives, field trips can be designed that both support learning objectives and serve the needs of all students (Day, 2012).

The bulk of accessible geoscience field course literature has focused on promoting inclusive practices to better serve the needs of students with mobility disabilities (Cooke et al., 1997; Gardiner and Anwar, 2001; Gaved et al., 2010; Atchison, 2011; Atchison and Feig, 2011; Atchison and Gilley, 2015; Collins et al., 2015). Mobility disabilities include any condition that can limit of one's locomotive range-of-motion. Disabilities may be apparent (i.e. paralysis, amputation, multiple sclerosis, cerebral palsy) or non-apparent (i.e. arthritis, asthma, poor joints and ligaments).

Before designing a field course, instructors should enlist the expertise of their campus Office of Disability Services, or anyone with a mobility disability to present the instructional objectives of the learning experience, and discuss any potential barriers that would prevent a student's full participation (Cooke et al., 1997; Gardiner and Anwar, 2001; Hall et al., 2004; Gilley et al., 2015). Once the learning objectives, outcomes and course activities are designed, modifications can be made to accommodate specific student needs after students enroll. Then, the learning experience of any course or field trip will extend beyond access and become inclusive when students have ownership in the decisions being made. Cooke et al. (1997) describe the benefits of maintaining an open dialogue through the development of approximate access requirements for students with a variety of mobility disabilities.

To ensure field-based learning experiences are inclusive of all students, instructors must carefully select field sites that are accessible for students with diverse physical abilities. By developing or modifying field trips to visit accessible site localities, SWDs avoid the stigmatization of receiving preferential treatment in not fully participating or even slowing down the group by needing more time to navigate and explore the rugged terrain of the field site. Clark and Jones (2011) created a fieldwork audit tool that can help course instructors and coordinators recognize potential barriers that may exist in their field-based curriculum and can help improve accessible site selection.

Students with hearing disabilities may face fewer physical barriers than students with mobility and visual disabilities. Traditional in-field experiences may still present a unique series of challenges for students with hearing impairments (Wareham et al., 2001). Well before any fieldwork occurs, instructors are encouraged to initiate an open discussion that informs students of what is expected from them in the field and how aspects of fieldwork can be made more accessible (Healey et al., 2001; Wareham et al., 2001). In-field lectures may present some of the most common physical barriers for students with hearing disabilities. These barriers can be solved by practicing effective communication through highly descriptive handouts and face-to-face lecturing students (Wareham et al., 2001). An instructor's responsibility is also to ensure that students with hearing disabilities are fully engaged in the learning community and not alienated during group activities. Students should be briefed on best-practices for inclusive social interaction such as facing a student with a hearing impairment when engaged in conversation to facilitate lip-reading.

The geosciences have been viewed as a visually intensive discipline (Shepherd, 2001) that often involves the use of maps, drawings, and figures when representing data. A study by

Atchison and Libarkin (2016) revealed that geoscientists were unsure if persons with visual disabilities would be able to participate in the geosciences, students with visual disabilities can understand high-order scientific concepts at rates equal to their sighted peers after proper accommodations are provided (Wild et al., 2013; Jones et al., 2006). Geoscientists who previously participated in a course with a student with a visual impairment believed that persons with visual impairments certainly could participate in the geosciences (Atchison and Libarkin, 2016). Students who are blind or have low-vision may experience panic or disorientation when navigating through the unfamiliar environment of a field trip (Hall et al. 2004) and would have a more engaging learning experience if paired with a guide (Wild et al., 2013; Hall et al., 2004; Asher, 2001; Shepherd, 2001). Tactile geologic and topographic maps have been used in providing accessible visualization tools for students with visual disabilities (Asher, 2001; Shepherd, 2001; Wild et al., 2013; Horowitz, 2014; Atchison and Gilley, 2015) and are created using 3D printers or raised-line technology (Shepherd, 2001). Tactile geologic maps often use different materials such as sandpaper or felt to distinguish geologic units (Atchison and Gilley, 2015; Asher 2001). Tactile maps embrace the notion of multiple representation of the content, a tenant of universally-designed instruction, and can enhance the learning experience of all students regardless of a disability status.

Much of the literature reviewed are practitioner articles, dedicated to improving geoscience accessibility through the design and practice of an individual course and lacks an assessment of accessibility in geoscience education as a whole. Improving field-based accessibility and inclusion can be a nuanced task as disability falls along a spectrum, meaning that these instructional vignettes present solutions to improving accessibility in individual classrooms in unique situations. Despite their individuality, these articles serve as an important foundation for further study. By understanding what a wide-variety of geoscience departments are doing to improve inclusion, we may be able to better understand these nuances and how to best implement inclusive practices in all geoscience classrooms.

Chapters 3 and 4 of this thesis describes the methodology, theoretical framework, and research design behind this current study to address gaps in geoscience field accessibility literature. A detailed description of phenomenography, the qualitative approach used to answer previously mentioned research questions, and its use in geoscience education research are provided to justify why this particular approach was selected. The researcher also outlines their background as a geoscience student to address their own bias as well as study the validity and trustworthiness of data collection and analysis.

CHAPTER 3: METHODOLOGY

This study investigated the ways in which geoscience department faculty implement accessible field-based learning techniques. A phenomenographic approach was selected because this study focused on the experiences of individual geoscience faculty members about one particular phenomenon: providing accessible field courses that serve students with mobility, hearing, and visual disabilities. Demographic data from these surveys were also used to examine if any similarities or differences existed among different types of colleges or universities (two-year or four-year colleges).

Theoretical Framework

The research process was guided by the critical disability theory (CDT; Pothier and Devlin, 2006) and the transformative paradigm (Mertens and Wilson, 2012). CDT uses an interpretive lens to view disability not as defect of the human body, but simply as a characteristical difference of an individual's physical form (Pothier and Devlin, 2006; Creswell, 2013). Transformativism is rooted in addressing issues of power and inequality and is often used to challenge social injustice with the help of stakeholders or members of the marginalized community of study (Mertens and Wilson, 2012). One of the primary insights that reinforces CDT is the idea of power (or powerlessness), which focuses on who in a social system has the power and who is marginalized (Pothier and Devlin, 2006). Disability is a social construct created by the able-normative majority who have designed social and physical aspects of the world around them in ways that are accessible for themselves (Pothier and Devlin, 2006). These paradigms influenced this study's assumptions regarding ontology, epistemology, and axiology.

Ontological assumptions relate to the nature of reality and its characteristics (Creswell, 2013). The primary ontological assumption in phenomenography is non-dualist, in that the world and individuals in that world are studied in relation to each other (Marton, 2000; Coller-Reed, 2009; Yates et al., 2012). Transformativism also recognizes the multiple realities of individuals and how these realties are shaped by the status of one's power and privilege (Mertens, 2015). In this study, realities explicitly revolve around the experiences and perceptions of faculty members in creating accessible in-field learning experiences for students of all abilities. The majority of people employed at 2-year and 4-year colleges and universities do not identify as having a disability (NSF, 2017) and their able-normative status may shape what they perceive as accessible and inaccessible. Additionally, some instructional methods are more accessible to some SWDs than others and this discrepancy shapes whether or not an instructor is providing students with an inclusive learning experience. For example, Cooke et al. (1997) defined how different surface materials affect a student's mobility based on their physical disability. Accessible practices reported by faculty were analyzed with this particular mindset.

Epistemological assumptions relate to what can be classified as knowledge and how knowledge claims are justified (Creswell, 2013). The epistemological assumption associated with the phenomenographic approach is rooted in the principle of intentionality – another non-dualist viewpoint which states that knowledge and experience are established through relationships between people and the world (Coller-Reed, 2009; Yates et al. 2012). Intentionality concludes that individuals can experience or conceptualize a phenomenon of interest in a variety of different ways and that there are a multiple number of interpretations of meaning through the experience of people and their world (Marton and Pang, 2008; Yates et al., 2012). This current study's outcomes distinguish the differences between the lived experiences of each study participant. Results included in Chapter 5 reflect a summation of reported practices from respondents as a whole but recognize that instructor practices are individualized and dependent on a variety of factors that are described later in greater detail.

Axiological assumptions are defined as the values that the researcher brings into a qualitative study (Creswell, 2013). The transformative paradigm heavily influences axiological assumptions in that the researcher must be aware of the discrimination against individuals with disabilities that persists in the world (Mertens, 2015). The researcher argues that geoscience departments must provide equal opportunities in field courses for all students. However, ableism, bias, and stereotyping that persists in the geosciences (Atchison and Libarkin, 2016) may affect practices that encourage the participation of all students. Axiological assumptions influenced how the researcher categorized reported accessibility practices described in survey responses which are discussed in the Data Analysis and Coding section of Chapter 4.

Methodological Approach

Phenomenography is a qualitative research approach that explores the ways in which different people perceive or experience a particular phenomenon of interest (Marton, 1981; Richardson, 1999; Yates et al., 2012). This approach was initially developed to explore how students learn or experience understanding and knowledge (Marton and Booth, 1997; Yates et al. 2012). Phenomenography takes into account the differences between individual experiences and their relationships within the phenomenon of interest (Yates et al., 2012). This approach is closely related to phenomenology, a qualitative research method that employees a first-order perspective to investigate the essence of a phenomenon of interest as described by multiple individuals (Marton, 1981; Svensson, 1997; Richardson, 1999). The distinguishing feature of a phenomenographic study is to describe the accounts of a phenomenon through the perspective of other people (Marton, 1981; Marton and Booth, 1997; Yates, 2012). One of the outcomes of a phenomenographic study is to understand the variations in human experiences and thought and to provide descriptions of these variations (Marton and Booth, 1997; Yates et al. 2012). In the context of this study, the researcher used phenomenography to understand the various experiences that geoscience staff and faculty have regarding accessible field experiences and to understand the qualitatively different ways in which field access is provided for SWDs.

Phenomenography relies on in-depth interviews as the primary data source (Marton, 1975; Säljö, 1979; Marton 1988) although open-ended surveys and written reflections have been deemed as credible by researchers (Edwards, 2007; Stokes, 2011; Yates, 2012). Phenomenography lacks distinct steps for data-analysis often seen in other qualitative approaches (see Sandberg 1994; Säljö, 1997; McCosker et al., 2004; and Houlton, 2010), yet these variations in analysis often contain the following commonalities: (1) data is reviewed as an entire set as opposed to individual pieces of data; (2) the researcher attempts to search for variations in meaning across all data sources as well as the structural relationships between these variations in meaning (Åkerlind, 2005; Yates et al., 2012). The outcomes of the phenomenographic study are typically presented as *categories of description*, which relate to the qualitative differences in experiences or conceptions regarding the phenomenon, and an *outcome space*, which organizes these differences into some type of structure (Richardson, 1999; Marton, 2000; Åkerlind, 2005; Yates et a., 2012).

The use of phenomenographic inquiry in geoscience education was first described as a legitimate research tool by Libarkin, Beilfuss, and Kurdziel in 2003. Since then, several publications have used this method to explore a variety of research questions (Houlton, 2010; Stokes, 2011; Feig, 2013; Dohaney et al., 2015). In 2010, Houlton used the phenomenographic method to investigate the reasons why post-secondary students selected the geosciences as their major. The benefits of using phenomenography in Houlton's 2010 study allowed researchers to identify commonalities in student experiences of selecting a geoscience sub-discipline as their major. This study allowed Houlton to create a model of how various groups of students arrived into the geosciences. Stokes (2011) then explored the ways in which undergraduates conceptualize the geosciences as an academic discipline. Not only did this work highlight the benefit of using phenomenography in geoscience education research, but the findings also identified the distinct ways in which students and faculty conceptualize the geosciences. More recently, studies have used phenomenography as a way to influence the framework of a study (Feig, 2013; Dohaney et al., 2015), although those studies lack typical phenomenographic components such as categories of description and outcome space. The researcher for the current study argues that although he is not directly looking into how individuals conceptualize meaning, the phenomenographic approach is an adequate research method to identify commonalities and differences in pedagogic practices for field access.

Researcher as an Instrument

Qualitative studies recognize that researchers themselves are instruments involved in all phases of a study (Xu and Storr, 2012). Researchers have different perspectives and experiences which can lead to the injection of their own biases and past knowledge during data collection and subsequent analysis. These backgrounds can shape how a researcher views a particular phenomenon of interest and how qualitative data is interpreted, potentially influencing research outcomes. For this study, the researcher is a geology graduate from a research-university and participated in several physically rigorous field camps over his undergraduate career. The researcher is also good friends with an individual with cerebral palsy and is aware of how this person's ability status has affected his education in both elementary and postsecondary settings.

Both these experiences make the researcher aware of common field practices in geoscience field studies and how disability has affected a SWD's academic career.

This study required the researcher to create his own data collection instruments which included designing the Geoscience Field Accessibility Survey (GFAS) and semi-structured interview protocol as well as collecting, analyzing, and interpreting the collected data. In this study, the researcher questioned various departments on their inclusive practices regarding field studies with the mindset that some practices may be more beneficial for a SWD than others. The researcher developed this particular mindset after completing a literature review of inclusive field practices of STEM disciplines. Despite this outlook, the researcher attempted to categorize and describe reported practices as objectively as possible by bracketing any preconceived notions and developing a strict set of definitions for different types of practices during data analysis.

Validity and Trustworthiness

In phenomenographic studies, researchers are expected to address the validity of data collection and analysis (Coller-Reed et al., 2009). Coller-Reed and others (2009) describe how trustworthiness in phenomenographic research is aligned with credibility and dependability.

Credibility is dependent on multiple aspects of study design and include: content-related credibility, credibility of method, and communicative credibility (Coller-Reed et al., 2009). Content-related credibility relates to a researcher's familiarity and understanding of the study's phenomenon of interest (Coller-Reed et al., 2009). The researcher argues that their familiarity with geoscience field accessibility as described in the *Literature Review* in Chapter 2 satiates this aspect. His experience in geoscience field studies as detailed in the *Researcher as Instrument* section above again reinforces this credibility. Credibility of method is dependent on how research goals relate to study design including participant selection and instrumentation (Coller-

Reed et al., 2009; Booth, 1992). Credibility of method was met through soliciting the participation from geoscience instructors to understand how accessible field practices are implemented from various departments. The use of open-ended survey questions and anonymous, voluntary participation (as described in Chapter 4) strengthens credibility of method as written responses allow participants to report their own lived experiences without pressure from the researcher. Communicative credibility is related to a researcher's ability to argue for their study interpretations (Åkerlind, 2005; Coller-Reed, 2009). In Chapter 5, the researcher states that his findings are interpreted from the lived experiences of geoscience field instructors and may not necessarily represent a definitive truth, however established coding rubrics were analyzed for instrument dependability.

Addressing instrument dependability is important because data-analysis is an iterative process and coding represents how the data are experienced by the researcher (Åkerlind, 2005, Saldaña, 2016). Coding is the analytical process of assigning meaning to a portion of language-based data and often reflects the individual perspective of the researcher (Saldaña, 2016). For this study, Inter-Rater Reliability (IRR), also called a coder reliability check in Åkerlind (2005), was established by asking an outside researcher to code a subset of the data using the definitions and codes that were generated by the principal-investigator, and then comparing the subsequent categorizations. Afterwards, minor alterations to the coding schema were made after some discussion. The researcher then tallied the number of differences in coding made by the outside researcher and compared their code to his own data. The total number of coding instances recorded by the researcher were divided by coding differences to establish inter-rater reliability. For this study, an inter-rater agreement of 89% was achieved through this process.

CHAPTER 4: METHODS

Participants, Sampling and Setting

This study was conducted in three phases spanning from October 2015 through March 2017. Slight variations in participants and sampling methods were made in each phase to better understand the different kinds of experiences and perceptions geoscience faculty have in regards to accessible geoscience field instruction.

Phase I – Pilot Geoscience Field Accessibility Survey

Participants for Phase I were members from post-secondary geoscience departments who represented their department at the Main Exhibit Hall of the Geological Society of America (GSA) 2015 National Meeting in Baltimore, MD from November 1-4, 2015. Department representatives included graduate students, postdoctoral fellows, associate and assistant professors, professors, and professor emeriti. Most of the institutions at the 2015 meeting were geology departments at research universities from a variety of U.S. localities. Exhibit booths were approached and solicited to respond to the GFAS, a short pilot survey consisting of 9 questions (Appendix C).

Phase II – Electronic distribution of the Geoscience Field Accessibility Survey

For the purposes of this study, "geoscience" is broadly defined as a science that attempts to understand natural earth processes. This includes disciplines such as geology, geophysics, atmospheric science, oceanography, mining/economic geology, soil science, environmental science, and space/planetary science. Any experiences in field studies from a variety of earth disciplines would enhance the scope of the study. Alternative to using a preexisting listserve, study solicitations were manually sent to a total of 805 individuals from geoscience departments in all U.S. states and territories using the American Geoscience Institute's 2015 Directory of Geoscience Departments. This was to ensure that geoscience departments did not receive duplicate participation invites and to cast as wide a net possible to achieve data saturation.

Similar to Phase I, participants are faculty members from post-secondary geoscience departments. Respondents were from both two-year and 4-year colleges and universities throughout the United States. This included institutions that did not participate at the GSA 2015 national meeting or institutions who may have received a pilot survey, but did not submit their responses by the end of the meeting. The phenomenon of outdoor education in a postsecondary setting is not synonymous with geology alone and the researcher decided to constrain the population strictly to geoscience departments as the researcher is more familiar with geoscience field experiences from both two-year colleges and 4-year research universities.

Phase III – Semi-Structured Interviews

Survey participants consisted of geoscience instructors who had completed either a paper-copy or electronic version of the GFAS. The researcher solicited the participation of geoscience faculty members who had provided detailed reflections on their experiences in creating accessible field courses for SWDs and who had agreed to be contacted for a follow-up interview. 12 participants from various types of colleges and universities were solicited to participate under the assumption that any common patterns that emerged from their experiences would be considered substantial and would aid in answering the central research questions (Patton 2002). Only two geoscience representatives agreed to be interviewed, and both were from research universities located in the western United States.

Data Collection

Each phase of this study contained different methods of data collection including the distribution of surveys and conducting interviews. Variations in data collection were to help ensure that a sufficient amount of rich data were collected. Interview protocols of Phase III were grounded in GFAS data from Phase II, and the survey used in Phase II was slightly altered, yet grounded in the survey used from Phase I.

Phase I – Pilot Geoscience Field Accessibility Survey

Pilot surveys (Appendix C) were used to gather several types of information from respondents' respective geoscience departments. This included demographic information (university/institution type via offered degrees and certifications), general information on the curricula offered (i.e. which classes have a field component, field trip duration), Lichert-type-scale data on departmental confidence regarding in-field accessibility and perceived support to accessible field opportunities, and information (if any) on how departments would offer inclusive field coursework. The survey was personally distributed to 62 geoscience department representatives at the 2015 GSA National Meeting. Appropriate consent forms (Appendix A) were attached to each survey and kept by respondents. Surveys were voluntarily completed and returned to the researcher during or shortly after the meeting. Twelve respondents voluntarily completed a survey and returned them to the researchers on the Exhibit Hall floor for a return rate of 19.4%. Questions from respondents regarding the clarity of the survey were also taken into account as pilot surveys were initially handed out. After surveys were collected, the researcher made minor edits to document in preparation for Phase II.

Phase II – Electronic distribution of the Geoscience Field Accessibility Survey

The survey from Phase II were nearly identical to that used in Phase I and had no major content-related changes. The updated version of the survey for Phase II (Appendix D) was edited to include a checkbox for respondents to mention if their department offers Associate's degrees and simplified a section requesting contact information. During Phase II, the survey was briefly hosted over the internet using Google Forms, a free and private survey/form creation tool that is free-to-use for Google users. The first wave of study solicitation emails and consent forms (Appendix A) were sent on January 11, 2016. In the following weeks, a total of 805 institutions were emailed by January 25th, 2016. A reminder email was sent on January 25th to all institutions indicating the response cut-off date of March 1st, 2016. A total of 149 respondents completed the electronic GFAS for a response rate of 18.5%. In total, 817 individuals were asked to participate in both Phase I and II of survey data collection and 161 respondents provided survey data and respondents were deidentified and given codenames of P1 through P161 for data management. After data were retrieved, they were subsequently deleted from Google Forms for privacy reasons.

Phase III - Semi-Structured Interviews

Interviews were conducted to allow survey respondents the opportunity to more fully describe their experiences in accessible field curriculum. Interviews were conducted over the phone at the convenience of each participant and were recorded using an Olympus voice recorder. Before conducting the interview, the researcher had participants audibly confirm that they had read the informed consent form and information sheet (Appendix B). A total of two survey respondents from a total 12 solicited agreed to participate in interviews that lasted between 45 minutes to an hour. Respondents were asked to discuss in detail how they created accessible in-field learning experience for SWDs and to comment on the inclusivity of their geoscience department as well as their perceived support from the university or college. Interviewees also had the freedom to ask any questions regarding the study and its outcomes at the end of the interview. A semi-structured interview protocol (Appendix E) was developed by the researcher and used for both interviews to maintain consistency and structure. After the interview, recordings were transcribed verbatim and participants were given pseudonyms of IP1 and IP2.

Data Analysis and Coding

Data analysis in qualitative studies are typically data-driven, iterative processes that are cyclical in nature. Coding, the process in which a researcher assigns meaning to text-based data, reflects this as codes and sub-codes are often reviewed and refined so that they express the essence of what is being investigated (Saldaña, 2016). For the purposes of this study, survey data were analyzed through several techniques. To gain a deep understanding of experiences surrounding accessible field education, open-ended survey data and interview data were thematically coded using qualitative methods described by Strauss and Corbin (1998) and Saldaña (2016). The coding process generated themes and sub-themes regarding accessible practices used by faculty. Data analysis for GFAS data was executed in three cycles: microanalysis, open coding and axial coding, and selective coding. In addition to analyzing the data for these instructional-techniques, responses were coded to understand the conceptions of faculty regarding accessible field experiences. Although the survey did not explicitly ask respondents to talk about their perceptions regarding accessible field practices, several individuals felt the need to express their views on accessible field experiences. In addition to the perceptions mentioned in open-ended responses, interview data were collected to supplement survey data and to further illuminate the process of creating or adapting a course for the purposes of accessibility. These data were viewed as supplemental and coded through using holistic coding as described by Saldaña (2016). The steps for both of these coding techniques will be covered in the following sections below.

Microanalysis

Microanalysis is the initial, line-by-line analysis of text-based data that aids the researcher in the generation of initial codes and relationships (Strauss and Corbin, 1998). Open-ended responses were read line-by-line to examine each respondent's account of providing SWDs with access to a field-portion of a course. This was performed to help the researcher familiarize himself with the data and gain a general understanding of the types of reported techniques for providing SWDs with in-field learning experiences. Brief notes and memos were made during this process that served as temporary codes or phrases. Initial codes attempted to group survey responses using the following questions:

1. Is a SWD assessed in a similar manner as able-normative students?
2. Is a SWD learning or participating in a similar environment as able-normative students?
3. In what ways via instruction are SWDs gaining field access?

These questions help address whether instructional practices are presenting or dismantling barriers to participation. The researcher assumed that by isolating a SWD to complete a field assessment away from their peers, the student may by vulnerable to marginalization.

Open and Axial-coding

Survey data was imported to Microsoft Excel for open and axial coding. Open coding is defined by Strauss and Corbin (1998) as an "analytical process through which concepts are identified and their properties and dimensions are discovered in data" (pg. 101) and axial-coding is "the process of relating categories to their subcategories" (p. 123) and involves linking codes into broader themes. The initial questions poised during microanalysis would eventually lead to the development of a coding rubric that covered the categorically different ways geoscience instructors provided SWDs with in-field learning experiences (which are explained in greater detail in Chapter 5). As the rubric developed, concise definitions for each code and sub-code were created so that the data could be efficiently coded. Additional columns were inserted into the Excel workbook for each sub-code so that the research could keep track of which method(s) were reportedly used by each respondent.

After checking for IRR, codes were further discussed, revisited, and refined. The entire data set was reanalyzed and the coding cycle was restructured and completed. Coded data were then transferred to Nvivo 11, a qualitative data software that provides researchers with powerful data visualization and organization tools. In addition to these features, Nvivo can also be used to quantitatively analyze data based on a classification scheme generated via demographic queries from the GFAS. The resulting tables from these frequency counts and the emergent themes (presented as "categories of description") will be further discussed in the following chapter.

Selective Coding

The researcher used selective coding methods as described by Strauss and Corbin (1998) to develop theory from collected data. Selective coding is the process of developing a theory based on analyzed data that revolves around one central category (Strauss and Corbin, 1998).

During this process, open and axial codes were reexamined and reflected on to understand the qualitative story that the data illustrated. This led the researcher to identify the central category and a resulting theoretical scheme. Afterwards, all codes and sub-codes that were generated from open and axial-coding were reexamined for internal consistency in relation to the central category. The resulting theory, as represented by the codes and sub-codes from the GFAS and their relation to the central category, will be further discussed in the following chapter under "outcome space".

Holistic Coding

Holistic coding is an exploratory coding method that allows the researcher to group broad topics from a variety of data sources into 'chunks' for further analysis (Saldaña, 2016). This coding method is used to grasp basic themes in data in instances where the researcher is unfamiliar of what codes to expect (Saldaña, 2016). For the purposes of this study, holistic codes were analyzed to generate the context regarding accessible practices and to understand the perceptions of instructors regarding inclusive in-field instruction.

In a process similar to microanalysis, the holistic coding process began by reading and rereading transcriptions to immerse the researcher into the subjects, contents, and topics discussed during each interview. Interview transcriptions were then read line-by-line to see if there were any emergent themes that were not previously revealed in the analyzed survey data. Afterwards, transcripts were imported into Nvivo 11 and coded by assigning short words or phrases to large groups of text. In holistic coding, these small words or phrases can become "codes" and applied to textual data the length of a word, sentence, or entire page. Coding schemes from both interviews were reviewed and used to note any similarities or differences. Codes were then refined for each transcription and combined until a concrete coding rubric was developed. Due to the limited number of interviews, some of the themes from this rubric only appear in only one of the interviews. The themes from the holistic coding process will be discussed in the following chapter.

CHAPTER 5: RESULTS AND DISCUSSION

The original aim of this phenomenographic study was to create a series of accessibility guidelines based on the survey responses. The researcher had planned to have guidelines reviewed by members of the geoscience community who identify as having a physical disability as a form of validation. During data analysis, survey responses were vague on accessibility practices while many other respondents stated that they never had to provide accessible field-practices. Because of this lack of data, the scope of this study was expanded to identify problems associated with access in geoscience field courses. Instead of providing a detailed series of guidelines, project goals were changed to broadly understand what geoscience departments were doing to provide field access and to identify any common themes instructors face when creating or adapting a field component so that it is more inclusive. Because the study was no longer aiming to create accessibility guidelines and include members of the disability community, this work was no longer guided by the transformative paradigm. Instead, the study focused on the lived experiences of geoscience instructors providing accessible field components for SWDs.

Analysis of the combined GFAS data and additional follow-up interview data revealed the qualitatively different ways in which geoscience faculty attempt to provide accessible in-field learning experiences for students with disabilities. Depending on the physical needs of a student, instructors would attempt to make field courses more accessible through implementing methods that the researcher later defined as Modifications, Accommodations, Adaptations, and Universal Access. Based on reported techniques, the researcher was able to create three distinct “pathways” that instructors used to provide field course experiences for students with mobility, visual, and hearing disabilities. The researcher also created a diagram that expresses the pedagogic practices used by instructors in relation to their hypothetical level of inclusion and difficulty-of-implementation.

Demographic Data

The GFAS asked respondents to self-report demographic data. This included the role of the respondent (e.g. professor, associate professor, etc.) and the types of degrees offered by their department (i.e. A.A., A.S., B.A., B.S., M.A., M.S., PhD). The researcher used the types of degrees offered to assign each department into one of four groups adapted from the Carnegie Classification of Institutions of Higher Education. The researcher was unable to use the official Carnegie Classification because that system is dependent on the number of degrees offered by an institution – a question that was not included in the distributed survey. Departments were classified based on the highest degree offered through their geoscience program. These categories included associate's colleges (or 2YCs), baccalaureate colleges, master's colleges/universities, and doctoral universities.

Of the total 161 responses, 145 respondents provided the appropriate information to determine their department type. Seventeen-percent (n=28) of respondents represented associates colleges, 27% (n=43) represented baccalaureate colleges, 12% (n=19) represented master's colleges/universities, 34% (n=55) represented doctoral universities, while 10% (n=16) respondents did not provide the appropriate information to determine their college/university type. Despite their small sample size, 2YCs seem to have more students or faculty members with a disability (Table 1), as consistent with current data that suggests students with disabilities are more likely to attend a 2YC (NSF, 2017). When asked to provide the confidence of their department's ability to assess field sites for accessibility, many departments (despite institution type) were not confident. This may be related to the limited support in the geosciences dedicated to help promote field-site access. Previous work on this topic has been published sporadically in recent decades (Gardiner and Anwar, 2001; Shepherd, 2001; Wareham et al., 2006; Clark and Jones, 2011) although efforts to expand on this subject have been increasing (Adams et al., 2010; Adams et al., 2011; Atchison, 2011; Atchison and Martinez-Frias, 2012, Gilley et al.,2015; Stokes and Atchison, 2015; Hendricks et al., 2017).

Table 1: Department reported instances of Students or Faculty with Disabilities in a Department

Question: Does your department have a student or faculty member with a disability?

Students or Faculty with a Mobility Disability

	Associate's College	Baccalaureate's College	Master's College/University	Doctoral University
Yes	13	3	0	16
Institution Total	28	43	19	55
Percentage	46.4%	7.0%	0.0%	29.1%

Students or Faculty with a Hearing Disability

	Associate's College	Baccalaureate's College	Master's College/University	Doctoral University
Yes	4	6	0	10
Institution Total	28	43	19	55
Percentage	14.3%	14.0%	0.0%	18.2%

Students or Faculty with a Visual Disability

	Associate's College	Baccalaureate's College	Master's College/University	Doctoral University
Yes	5	1	2	9
Institution Total	28	43	19	55
Percentage	17.9%	2.3%	10.5%	16.4%

Categories of Description

The GFAS attempted to understand the numerous ways in which geoscience departments promoted access to in-field learning experiences. Reported practices were grouped into 13 distinct subgroups which defined four major categories: modifications, accommodations, adaptations, and universal access. The definitions for each of these categories stem from the researcher's understanding of Critical Disability Theory (CDT). CDT views disability as an ordinary human feature similar to skin or hair color. To reflect this mindset, reported practices were viewed from the perspective on whether the content or learning environments were the same for all students. Each major category represents fundamentally different methods of instruction that affect academic content, learning environment, or student responsibility.

Modifications

The Individuals with Disabilities Education Act (IDEA; 2004) does not formally define accommodations or modifications at the federal level, which can be troublesome as these terms may have alternate definitions depending on their use in each U.S. State. For this study, the researcher relied on work by McLaughlin (2012) that defined modifications as a practices, devices, or interventions that allows a SWD access to instruction. When relating this definition within the context of in-field learning, the researcher defined a modification as an alternative method of instruction, tool, or learning environment that enables a SWD to complete a course assessment (Table 2).

Table 2: Modification Strategies for Geoscience Field Accessibility

Modifications - When an instructor provides a student with a disability an alternative instruction, assessment, or learning experience that enables a student to complete a course requirement.

Code	Definition
Virtual Field Experience	A student with a disability uses technology to virtually simulate a project that is comparable to an in-field assignment that is completed by able-normative students. This can use Google Earth, satellite photography, GigaPan photography, etc.
Alternative Field Localities	A student with a disability attends a fieldtrip with able-normative students and completes assignments based on field localities separate from the entire class. A student may be left at camp or at a vehicle while the rest of the group leaves to view a particular field locality.
Alternative Assignments	A student with a disability is assigned additional assignments in lieu of completing a field course. Alternative assignments can include a research paper, additional pen-paper laboratory assignments, or assignments based on previously-collected field data.
Alternative Field Trips	A student with a disability is attends a field trip separate from their able-normative peers.

Virtual Field Experiences.

Virtual field experiences offer students with disabilities the ability to complete assessments related to field work. Instructors often rely on software such as Google Earth and other forms of satellite imagery that give students the ability to make field observations from an indoor environment. Instructional methods that were also deemed to be virtual field experiences included videos taken during field trips or the use of both paper-based and computer-based data that expresses landform relief (e.g. stereoscopy, DEM data, topographic maps). When offering these virtual field experiences, instructors do not necessarily guarantee SWDs the opportunity to interact with students as they are required to complete an alternative assessment away from their peers who presumably participate in a traditional field trip. While there are benefits of virtual field experiences in terms of gaining knowledge and understanding, having SWDs only complete such courses may alienate them from their peers.

Alternative Field Localities.

Alternative field localities included practices where geoscience instructors would allow SWDs to attend a field trip with their peers, but these students would complete an assignment in a different field area. Alternative field localities allow SWDs the chance to discuss geology among their peers, but in some instances, a SWD would be left behind while faculty and other students continued to explore the field environment. This practice is evidenced in two survey responses that stated the following: "I don't require [SWDs] to go on all the hikes with the rest of the class. Usually we have another person who stays with them while the rest of the group is away, (P126)" and "…if we go to a place that is inaccessible, I have an alternative 'assignment' that they can do while waiting for the rest of us" (P107). Instructors depended on accessible localities such as roadcuts, or less-physically-demanding routes around the major field area so that a SWD would still have the chance to complete field work. Isolating SWDs to participate in accessible environments allowed students to experience the field, albeit in a manner slightly different than, and more-importantly away from, their able-normative peers. Nairn (1999) discusses the implications of missing out on field-trip localities because of disability status and how SWDs unfairly miss out in learning opportunities. By not fully participating in the field, students fail to meet unwritten requirements on what it means to be a geoscience researcher and are subjected to marginalization (Nairn, 1999).

Alternative Assignments.

Alternative assignments were the most widely reported method used by faculty. Typically, these were in the form of paper-based labs, reports, or term papers a student can complete in lieu of missing the field portion of a course. In some instances, students would receive data collected either from students or faculty to answer questions – "We don't have an alternative to an entire field course, but we have alternate exercise wherein students who missed a trip would be required to analyze the structural data or use maps, photos, and figures to answer field questions" (P15). These assignments are meant to replicate concepts learned in the field, however, they do not actually provide SWDs with an in-field learning experience. Instead, alternative assignments were ways in which SWDs could complete required assessments needed towards earning a degree. In several cases, alternative assignments were offered so that students with temporary disabilities (e.g. injuries that prevent field participation) could complete a course.

Alternative Field Trips.

Alternative field trips were coded as instances when a SWD is required to attend an accessible field trip separate from their able-normative peers. Destinations for these trips included accessible parks, museums, or local-based projects both near or on campus. Similar to virtual field experiences, SWDs would often complete these field trips without their peers. In some cases, these were also completed without the presence of an instructor. Several respondents reported that such trips were self-guided, and in one instance, that the experience was insufficient and that it had "…not been very satisfactory. Going to the field without a mentor is hard for a rookie" (P128). If an instructor is offering self-guided, alternative field trips, they must ensure that students are able to receive in-field support.

Accommodations

McLaughlin (2012) defines accommodation identically as modifications with one important distinction. Accommodations are practices, devices, or interventions that allows a SWD to access to instruction, but their implementation does not result in a change of academic content or a reduction in student expectation McLaughlin (2012). For example, a braille textbook allows a student with a visual disability complete access to learning material. Accommodations are based on the needs of individual students. For this study, the definition for accommodations is as follows: tools, instruction, procedures, or assistance that allows a SWD to fully participate in an in-field learning environment with their able-normative peers (Table 3). When providing an accommodation, there are no changes to course content or reduced achievement expectations of the student with a disability.

Table 3: Accommodation Strategies for Geoscience Field Accessibility

Accommodations - Tools, instruction, procedures, or assistance that allows a SWD to fully participate in an in-field learning environment with their able-normative peers. When providing an accommodation, there are no changes to course content or reduced achievement expectations of the student with a disability.

Code	**Definition**
Instructor/Department Provided Tools and Assistance	An instructor or department provides a student with a disability with assistance so that they are able to participate in an in-field learning environment with their peers.
Field-Trip Alteration	A special type of instructor provided tool/assistance when an instructor alters and entire field-trip so that all localities are accessible SWD can participate in the same areas as their peers.
University/Office of Disability Services Provided Tools and Assistance	An instructor relies or uses an on-campus office for disabilities services office to provide a student with a disability with tools or other methods of assistance (e.g. computer software, sign language interpreter, field assistant, etc.) so that the student is able to participate in a field course.
Peer-Provided Assistance	Students with disabilities are paired with able-normative students to provide in-field assistance. Typically, an able-normative student would be responsible for completing tasks such as data collection in an inaccessible environment.

Instructor/Department Provided Tools and Assistance.

Instructor/Department Provided Tools and Assistance were identified as situations when an instructor or department provides a SWD with personalized assistance so that they are able to participate in an in-field learning environment with their peers. These are accommodations that provide field access by assessing the needs of individual SWDs. This may include driving students directly onto outcrops or retrieving samples and allowing the student to make direct field observations. To accommodate a student with a mobility disability, respondent P63 disclosed the following: “We were able to pull his accessible van up very close to the outcrops and give him images and samples of the materials the students were examining.” In cases for students with visual disabilities, this would include providing the student with a field-guide to accompany them during the trip or provide the student with accessible materials (e.g. braille guidebooks, tactile models, etc.). One respondent (P91) used “3D plastic maps in lieu of topographic maps to help the student understand relief, landforms, etc.” to help a student with a visual disability. For Deaf or hard-of-hearing students, instructors may have one-on-one discussions with the student so that they are able to understand field-based information or communicate to students through an accessible medium. One geoscience instructor used “a portable large writing tablet (paper) into the field for written instruction” (P145). These numerous examples show that instructor provided tools/assistance widely vary in their difficulty of implementation and are dependent on the individual needs of a student.

Field-Trip Alteration.

The survey revealed that in some instances, instructors would completely alter an in-field learning experience so that every student could access every locality. As reported by one instructor, the route was designed with a particular student in mind “so that they don't feel singled out” (P107), thus granting the SWD the ability to participate in a field-trip with their able-normative peers. One instructor mentioned their displeasure with this method and claimed that it “increased and included disability student [sic] but slowed and decreased the experience for other students” (P6). The instructor did not report any specifics on how the experience was “decreased” for other students, but one can postulate that the group moved at a more gradual pace to include the SWD. Changing an entire field-course so that is it accessible for all students can be difficult if an instructor is unaware of how to assess field-site accessibility and may result in a poorly designed course that is deficient when compared to traditional field experiences.

University/Office of Disability Services Provided Tools and Assistance.

These are cases when an instructor relies on or uses an on-campus disability services (ODS) office to provide accommodations for students in the field. Typically, this would involve acquiring an accessible van, hiring a sign-language translator, or providing additional field guides. In one case, P132 reported that "a mobility-impaired student in a fieldtrip [ODS] hired a student to be his companion (including going to the outcrop to fetch rock samples". Although several instructors relied on ODS to provide services for SWDs, many were dissatisfied with their ability to provide accommodations in the field citing that they primarily helped in classroom settings. Simply providing tools or assistance from ODS may not result in full-accessibility and that a combination of accommodations is often necessary to full include a SWD into a field course. For example, a field assistant for a student with a visual disability would help in field-navigation, but an instructor must ensure that the student, and by proxy their assistant, are making the correct observations in the field. To further illuminate this point, an instructor must be aware that jargon may be a barrier to participation. One instructor reported that this was an issue writing "Students have access to ASL interpreters through Disability Services; these have come on field trips in the past (though this has generally proven challenging because of the specialized vocabulary)" (P152). Often, discipline-specific vocabulary does not have standardized signs in American Sign Language (ASL) and requires tedious finger-spelling to communicate (Cavender et al., 2010).

Peer-Provided Assistance.

Some instructors relied on the help of other students so that a SWD could be included in a field experience. Able-normative students and SWDs often confront similar challenges in learning and assessment (Madriaga et al., 2010) and pairing the two cohorts may improve relationships and dissuade stereotyping (Pettigrew, 1998; Anderson, 2000). Judging by the survey responses, instructors relied on student help due to convenience. For example, one instructor presented peer-provided assistance as “an added bonus” because “one of the students in the class (different section) was taking sign language and was able to practice as she paired up with this student during one of the field trips” (P130). In one situation, an instructor “paired visually impaired students with sighted students and had them work as teams” (P161). To accommodate a student with a mobility disability, P32 “had students in the geomorphology course who have limited mobility partner with students who can do the field portion of the project.” Students cannot be exclusively relied on to provide access over instructors and disability-service professionals for it places a burden on both SWDs and their peers.

Adaptations

Situations where a SWD is responsible for including themselves in the field were classified as “adaptations” (Table 4). These tend to place an undue burden on SWDs as they are required to advocate for their own participation in a field course while able-normative students do not face the same the same burden. The same burdens may also effect students with temporary disabilities (e.g. twisted ankle, in a cast, etc.) as they may be expected to travel to a field site independently or at a later date when the trip can be offered again.

Table 4: Adaptation Strategies for Geoscience Field Accessibility

Adaptations - A student is expected to overcome their disability in order to participate in a field experience among their peers.

Code	**Definition**
Student-Provided Tools and Assistance	A student with a disability is responsible for providing the tools and other methods of assistance in order to participate in a field course (e.g. bringing in a field assistant, providing a sign language interpreter, or securing accessible transportation to and from a field locality).
Temporary Conditions	A student is inflicted with a temporary disability from an injury or illness (e.g. twisted ankle, flu, etc.), that student must complete a field requirement after they have recovered a later date.

Student-Provided Tools and Assistance.

These are instances when a SWD is responsible for providing the tools or other methods of assistance in order to participate in a field course. One instructor mentioned how a student, on her second attempt to pass the course, "found her own companion… and brought the woman she lived with" (P102) to complete a field course. Another department required SWDs to "drive their own vehicles separately, or have a friend or relative drive them with the additional vehicle following the bus" (P131). Based on survey responses, the tools or assistance that were expected from a student were typically those offered by an institution or ODS. Several respondents mentioned that they depended on Deaf or hard-of-hearing students to use skills such as lip-reading in a field setting. Many Deaf individuals are not able to lip-read, which can be compounded during instances of note-taking. Forcing SWDs to adapt just to participate in a field course places a huge burden on a student population who has already overcome much adversity just to be enrolled in a post-secondary institution. Instructors must consider whether or not it is fair to expect so much from SWDs when similar expectations are not made for able-normative students.

Temporary Conditions.

Instructors reported that students inflicted with a temporary disability from an injury or illness were required to attend a field component at a later date either alone or with another class. One instructor “prepared a self-guided version of the physical geology field trip which students have taken later in the semester once they are no longer disabled” (P131). Similarly, another instructor mentioned that a “student excused from Grand Canyon trip one year went the following year on his own initiative to make sure he had some experience” (P6). Both instructors did not comment on how well the self-guided field trip was for the student. As mentioned in a previous response by a different department representative, students who attend trips without the guidance or an instructor often have difficulties in the field. If a student was injured during an in-field learning opportunity, instructors provided ad hoc solutions and included the student in an active field course.

Universal Access

Instances where an instructor designed a field course with the intent to remove barriers to participation or when a course did not have mandatory field component, were classified as Universal Access (Table 5). Many of the responses regarding these practices were not detailed and do not include specifics on creating fully accessible field courses. In one instance, students with disabilities were advised to participate in another department’s accessible field study.

Table 5: Universal Access Strategies for Geoscience Field Accessibility

Universal Access - A department or instructor's practices that allow students with disabilities to learn and participate in a field environment without barriers to participation or did not have mandatory field component.

Code	Definition
Multiple Degree Track	A department offers multiple degree tracks that do not have a mandatory field component. All students, regardless of disability status, are offered multiple tracks.
Non-Mandatory Field Trips	A department does not require the completion of field components for degree completion.
Accessible Field Course Design	Offered field courses are already designed to be accessible by all students or allows all students to navigate the field within their own ability.

Multiple-Degree Track.

Geoscience departments that offer separate paths to degree completion (with a limited focus on in-field participation) were considered as offering "Multiple-Degree Tracks." In these situations, all students, regardless of disability-status, are able to self-select into different degree tracks. Offering multiple degree tracks may eliminate the social stigma of being forced to accomplish separate coursework because of one's disability-status and will help promote an inclusive environment that welcomes students of all abilities and backgrounds to earn a degree. As reported by one respondent, multiple-degree tracks may lighten the physical exertion related to traditional geoscience courses and adjust the academic focus – "one degree track that does not include the field mapping course; it emphasizes education skills and climate change" (P30). In other cases, the degree difference simply eliminated a field camp requirement – a staple in geology and other related disciplines.

Non-Mandatory Field Trips.

Studies have shown that field experiences improve student learning (Garrison and Endsley, 2005; Whitmeyer et al. 2009; Mogk and Goodwin, 2012), although some geoscience departments allowed SWDs to miss field trips. Several reported that field trip participation was not grade dependent but that they were "strongly recommended" (P110) to students. In some cases, key concepts that are learned in the classroom may not be fully grasped by those who miss such field opportunities. Instructors must work diligently to eliminate any gaps in understanding among their students and ensure that those who miss a field opportunity are able to learn the appropriate course material. Non-mandatory field experiences allow SWDs to complete coursework towards degree completion and eliminates the difficulties on an instructor to improve field-site accessibility.

Accessible Design

Several respondents offered field courses that are designed to be accessible by all students or allowed all students to navigate the field within their own ability or comfort. Other departments knew of accessible field-courses offered by other institutions and recommended students to attend those. There are plenty of logistics involved in the creation of a universally accessible field experience. Many outdoor environments contain uneven terrain that are generally inaccessible for individuals both with and without disabilities. Other logistics such as accessible transportation and the need for field guides further complicate course design. One respondent designed a field trip that depended on ADA compliant public transportation and had presented topics and guidance through multiple formats stating that "the field guide is presented in text or audio file, or a screen reader can read it" (P127). Field trip stops included areas that were accessible such as museums and parks. Instructors also helped create an inclusive environment by focusing on the abilities of all students allowing them to navigate the field at their own comfort. P145 reported that such a practice “restricts some activities, but allows students the opportunity to conduct field work.” Participating in a field course may be uncomfortable for a variety of individuals and encouraging all students to physically challenge themselves at their individualized level reduces stigma. There are limitations from these reports as instructors did not comment on student learning in various areas of a field.

Outcome Space

The outcome space in this study attempts to connect the categories of description as they relate to the central category. Outcome space helps portray the complexities of individual lived experiences of geoscience instructors regarding field-accessibility and education. Instructors provided SWDs with opportunities to either experience the field in an accessible manner, assigned separate work that replaced a field component, or allowed students to complete a degree without the need to participate in a field course. At first, the central category was thought to be field-based access, however data show that many departments did not offer accessible field experiences. Instead, respondents provided information on how SWDs were able to complete coursework related to field courses as they progressed towards a degree. Department faculty shared the numerous ways in which their departments created a pathway for SWDs towards degree completion.

Code frequencies were used to create a figure that represents instructor-based methods of accessibility (e.g. modifications, tools and assistance, universal field course design) as they relate to inclusion and difficulty of implementation (Figure 1). *Pressure on the Instructor* was primarily established under the assumption that the frequencies of codes from GFAS analysis are directly related to the difficulty of reported practices implementation. Code frequencies from 161 survey responses were as follows: Alternative Assignments (66); Tools or Assistance (58); Virtual Field Experiences (37); Alternative Field Trips (19); Alternative Field Localities (9); Field-Trip Alterations (5); Accessible Field Course Design (7). Variations regarding "Pressure on the Instructor" were also established via interpretations on reported practices. For example, for Virtual Field Experiences, some instructors relied on the use of Google Earth to replace a field course while others used more complex computer simulations. The various ways in which departments reported these instances were distilled into visual guides described below.

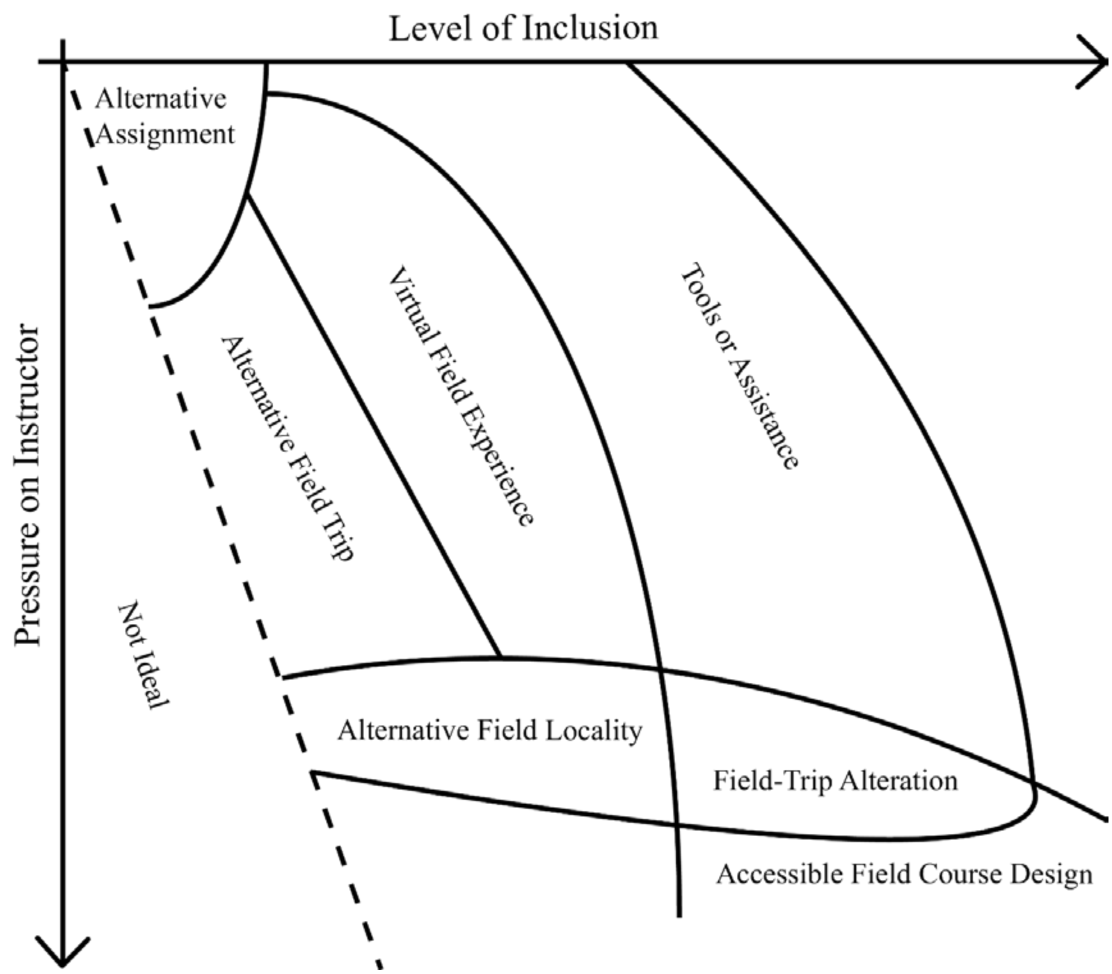

Figure 1: Accessibility Practice Facies Diagram
Figurative representation of instructor-reported methods for field-access. The X-axis represents the level of inclusion for each reported method for providing access. The Y-axis represents the assumed difficulty of implementation that is based off the frequency of each code from the GFAS.

Visual Guide for Degree Completion: Students with Mobility Disabilities

Students with mobility disabilities were provided access towards a degree through the use of modifications, accommodations, adaptations, and universal access (Figure 2). In-depth analysis revealed that many geoscience departments did not necessarily offer SWDs an accessible experience in the field. Instead, these departments depended on alternative, lab-based assignments or virtual field trips to provide SWDs with access to academic content associated with a field experience. A student with a mobility disability has several options towards completing or replacing a field component. Through modifications, students can be assigned alterative coursework, can navigate separate-yet-accessible field localities designed by an instructor, or can complete virtual and alternative field trips to replace an in-field learning experience. By using accommodations, instructors, peers, or ODS can provide SWDs with the tools and assistance needed to enable a SWD to complete an in-field assignment., SWDs can also be expected to adapt and self-provide tools or assistance so that they be involved in a field course. Accessible field course designs allow students to fully participate in a field trip. Depending on departmental resources students may be offered one or several of these options. Practices such as not requiring field trips or offering multiple degrees completely sidestep the need for an in-field learning experience.

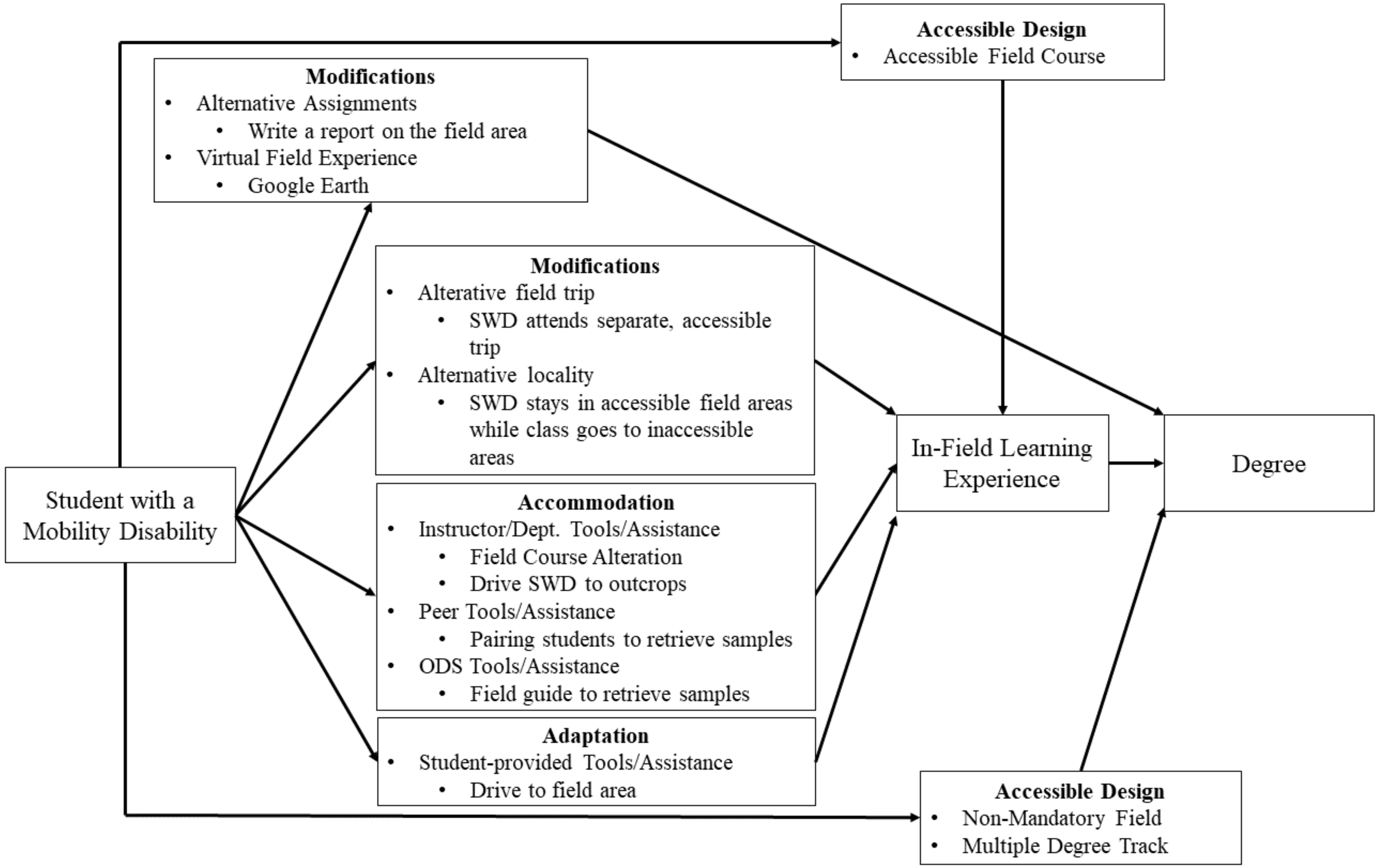

Figure 2: Visual Diagram for Degree Access for a Student with a Mobility Disability
Researcher interpretation of the pathway to degree participation for a student with a mobility disability. This flowchart is based off instructor-reported practices from the GFAS.

Visual Guide for Degree Completion: Students with Visual Disabilities

Similar to students with mobility disabilities, students with visual disabilities were provided access towards a degree through the use of modifications, accommodations, adaptations, and universal access (Figure 3), with several slight differences. Instructors do not offer students with visual disabilities virtual field experiences or offered alternative field trips. Instead, geoscience teachers were primarily concerned with the ability of a student to navigate the field. As a result, students with visual disabilities were paired with other students, or provided with a field guide for assistance. In one instance, a student brought their own field guide. Other instructors relied on tactile-based models and other alternative information sources so that students could understand the natural environment in their own way. Although there was no reported case of an instructor creating an accessible field-trip to suit the needs of a student with a visual disability, it can be argued that a field course designed for accessibility for all students would satisfy the needs of a student with a visual disability.

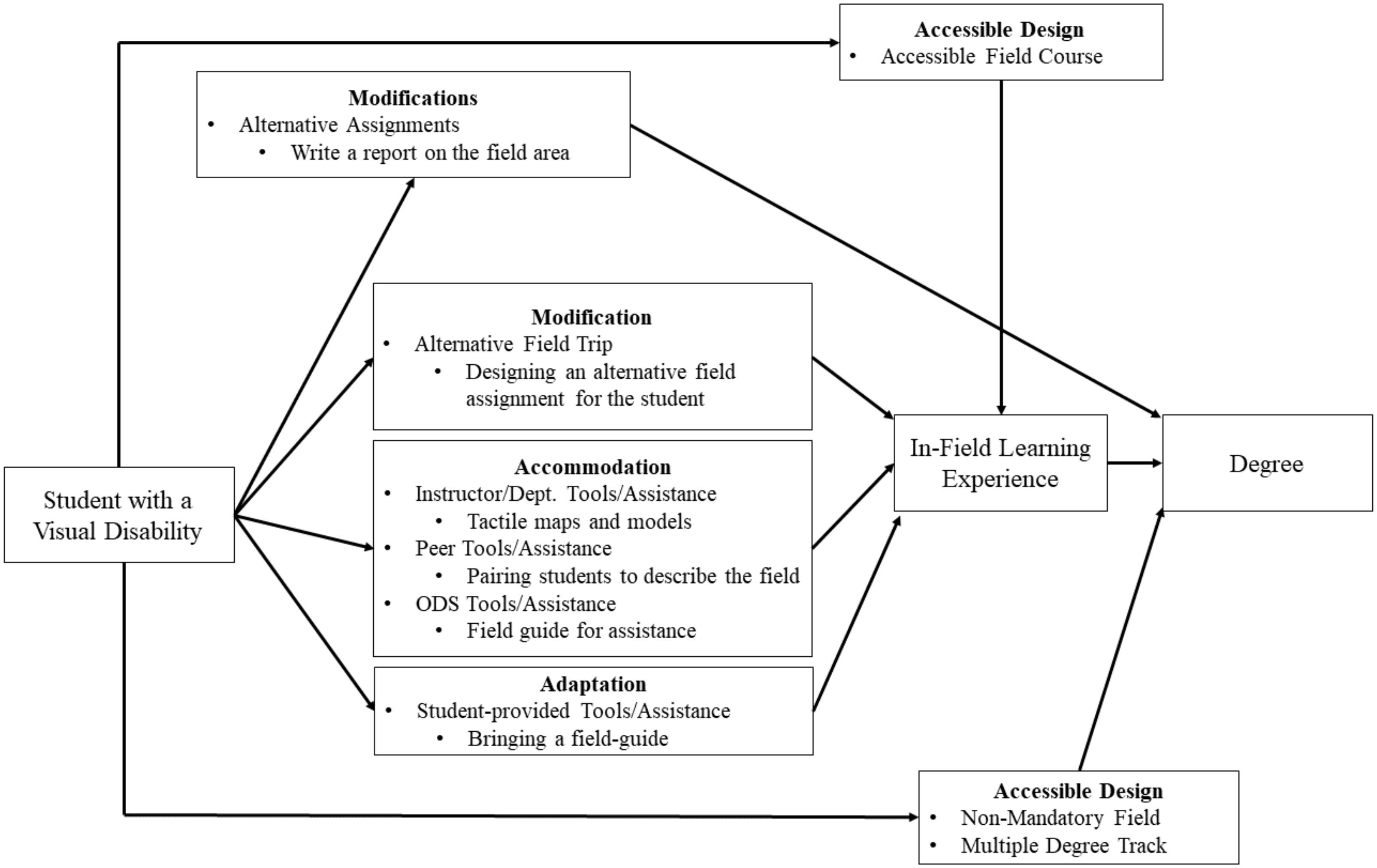

Figure 3: Visual Diagram for Degree Access for a Student with a Visual Disability
Researcher interpretation of the pathway to degree participation for a student with a visual disability. This flowchart is based off instructor-reported practices from the GFAS.

Visual Guide for Degree Completion: Students with Hearing Disabilities

Many instructors believed that students with disabilities were the “easiest” to accommodate. This belief was represented in collected data and corresponds well with findings from Atchison and Libarkin (2016) which found that geoscientists felt that Deaf or hard-of-hearing individuals are most viable for a geoscience career as compared to other disabilities. The developed guide (Figure 4) shows that students with hearing disabilities were not offered trip modifications such as alternative assignments or virtual field experiences. Instead, students were accommodated through the provision of tools or assistance from several sources. One skill that several instructors reportedly depended on was a Deaf student’s ability to lip-read in the field. Lip-reading is an incredibly difficult skillset to have since many deaf individuals do not have the ability to do it. Despite that, many instructors think that Deaf students would operate well in the field. Deaf students face many challenges at the postsecondary level. Many scientific words do not have standardized signs in ASL and Deaf individuals have difficulties of being included into the social aspect of learning.

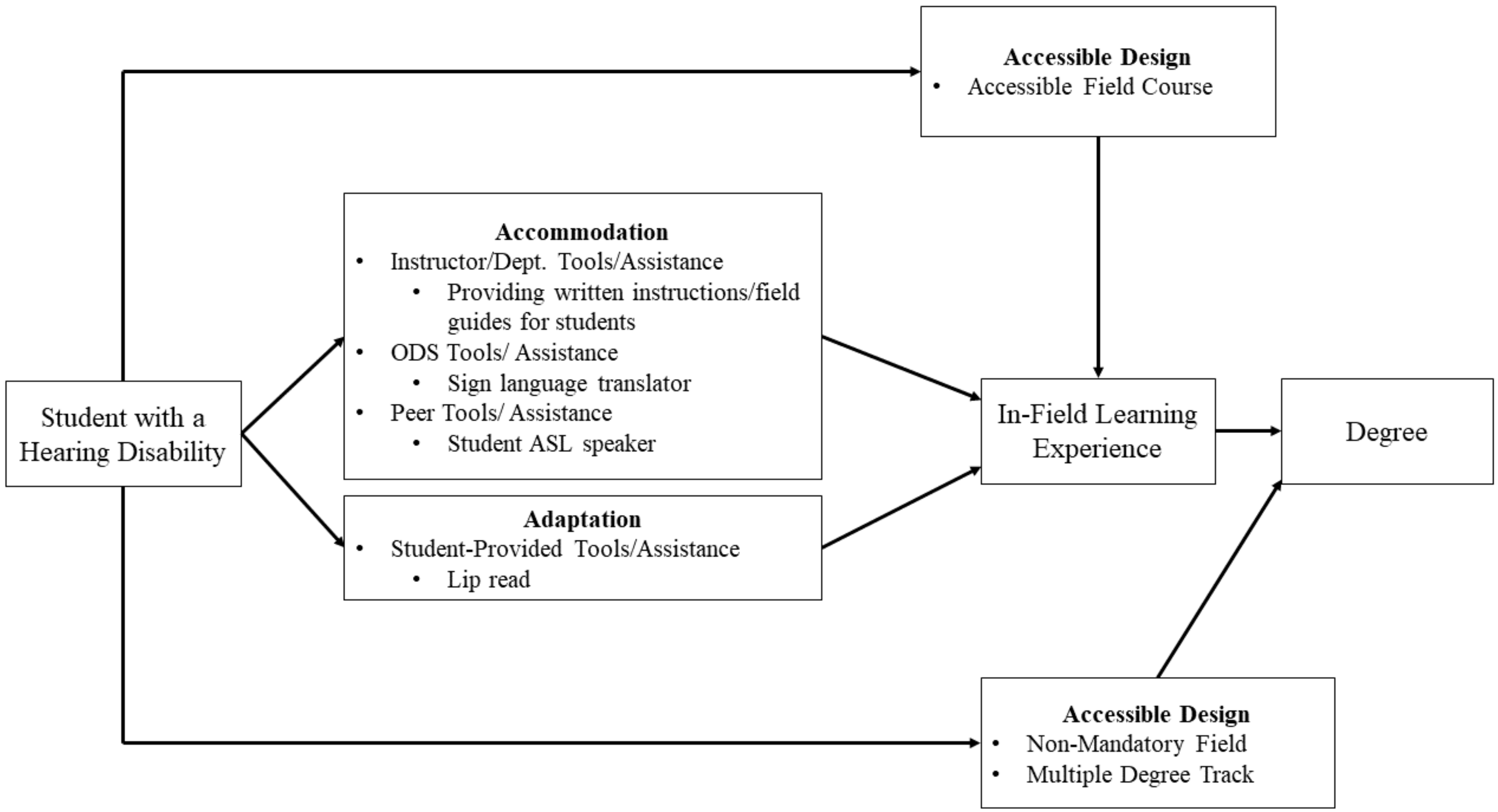

Figure 4: Visual Diagram for Degree Access for a Student with a Hearing Disability
Researcher interpretation of the pathway to degree participation for a student with a hearing disability. This flowchart is based off instructor-reported practices from the GFAS.

Perceptions on Creating Accessible Field Options

Interviews offered a deeper understanding of the context surrounded the task of designing accessible field options for students with disabilities. The two instructors, IP1 and IP2, were from different doctoral universities and both attempted to provide field access for a student with a mobility disability through somewhat similar means. The coding tree for this data can be viewed on Table 6. Both instructors commented on instructional practice, challenges involved with creating such an accessible field-course, drivers of student success, and aspects of what makes an inclusive learning environment.

Instructional Practice

Both survey respondents and interviewed instructors commented on the use of ad hoc methods to tailor field courses to fit the needs of a student with a disability. Students would work directly with an instructor to ensure that the students' needs are being met and that the student is aware of what is expected from themselves. Both interview participants provided a SWD with modifications and accommodations without prior consultation of an on-campus disability support office. By working directly with the student, an instructor is able to effectively communicate their expectations of a student. IP1 mentioned that in some instances, awareness is needed when a student is attempting to "game" the system by having extra accommodations provided for themselves (this comment was directly related to a student with a learning disability). Of course, these ad hoc solutions come with their own set of challenges that an instructor may be facing for the first time.

Table 6: Coding scheme for instructor's conceptions on field accessibility

Code	Definition
Instructional Practice	
Ad Hoc	Tailoring accessibility to individual SWDs' needs
Field/Lab Combinations	Combining field and laboratory experiences for improving accessibility
Challenges	
Academic rigor	Maintaining similar course content and assessment for all students
Field safety	Ensuring field practices are non-threatening for a student
Limitations of alternative studies	When alternative experiences do not fully replace in-field learning experiences
Unfamiliar territory	Creating accessible field experiences are foreign to the instructor
Student Success	
Instructor initiative	A teacher's responsibility to advocate a student's academic success
Student initiative	A student's responsibility to pursue their own academic success
Student-instructor communication	Effective communication between the two parties and how it relates to a student's academic success
Department Inclusivity	
Social inclusion	Welcoming a student into the social dynamic of a field course
On-campus support systems	Having access to a variety of disability service offices to aid SWDs in post-secondary education
Understanding the disability perspective	Learning how barriers and an individual's disability status may affect their participation and inclusion

Challenges

Among these challenges were maintaining academic rigor, the unfamiliarity of providing accommodations and modifications, field safety, and the limitations of alternative experiences. Both interviewed instructors mentioned that they had provided alternative field options for SWDs in the past, but expressed that serving SWDs in the field was an unaccustomed challenge. IP2 felt that there would always be at least one or two students in a class of 30 who were unable to participate in the field despite sharing concerns that providing accommodations were rare. Perhaps the instructors felt that they were in unfamiliar territory because the students they served in the past were diversely-able and had different skillsets.

Academic rigor was mentioned by both survey participants. IP1 eventually offered his field alternative course for all students and felt that course content was "as academically rigorous" as a traditional mapping course. IP2 on the other hand did not have a standard rubric and felt that grading was "not always fair" as a result. IP2 admitted that the department "wants to do well" in terms of providing equal grading, although they "don't always do well" and are working on a solution. By having a standardized course, an instructor gains some stability in grading student work and does not have to reinvent the wheel each time they receive another student who is unable to enter a traditional field trip.

Another topic discussed at length with IP1 was the manner of field safety. The instructor designed an alternative field course that involved a lot of access to the field coupled with driving from locality to locality. Driving in extreme environments and exiting the vehicle on dirt roads was thought to worry on-campus risk assessors. Their solution was to simply not be open on the dangerous aspects of field studies with administration staff and that the department should offer courses on field safety to all students, graduate students, and faculty.

IP2 though that there were several limitations to alternative/virtual experiences. IP2's course relied on limited field access to create a model of an outcrop, and then analyze it further in a computer lab. Although students get to have some experience in the field, the instructor felt that virtual experiences did not allow for students to make many inferences on digitally presented data.

Student Success

Participants IP1 and IP2 discussed several methods of promoting student success when providing alternative field experiences. The most discussed method was strong student-instructor communication. As mentioned earlier, this is important when implementing ad hoc solutions so that instructors are able to understand the needs of a particular student. All students' wants, needs, and challenges are unique, and instructors must discuss with students how to best address these challenges. The student is aware of their ability – any one-on-one discussions with a particular student will show reveal their capabilities as students and may reduce bias on what one assumes they are incapable of doing. Both participants discussed the initiative of the instructor to promote student success and the initiative of the student. IP2 commented that they would allow SWDs to take an alternative course as an independent study to replace a field class, but that some students would stop coming to scheduled meetings. IP2 also revealed that as instructors, they need to have the initiative to remind the student to ensure their success and degree completion. This may be difficult, because as IP2 pointed out, "It's equally our fault as faculty members from doing this stuff because when you're on a one-on-one like this, it's easy to lose track of a student." It may be a unique or unusual experience to provide accommodations for geoscience SWDs. Instructors must be diligent in enabling student success through effective and continuous communication, especially when interacting with a student on a one-on-one basis.

Department Inclusivity

Both IP1 and IP2 commented on aspects of department inclusion. Topics included social inclusion in the field, on-campus support systems, and the ability to understand the perspective of individuals with disabilities. IP1 developed a field-based project that provided a SWD to provide their peers with unique insight to the aspects of the field. By allowing the SWD to share their findings with their classmates and engage in scientific discussion, the student was included into the social aspect of fieldwork. Often instructors attempt to include a SWD on a field trip, however social inclusion and an equal education for all students should be the ultimate goal for educators. Both IP1 and IP2 wanted to improve access and inclusion for in-field instruction and claimed to have robust support systems in place for all students with disabilities, but neither participant consulted an on-campus disability services office. IP1 was adamantly clear that their department as a whole was learning to understand on-campus accessibility from the perspective in individuals with disabilities. In one instance, the department had to educate a new faculty member that it was not permissible to tout field courses as a “trial of strength” (IP1).

Unintended Findings

In addition to analyzing survey data for the categorically different ways in which department faculty believe they are providing accessible field experiences, responses were coded to understand the conceptions of faculty regarding accessible field experiences. Although the survey did not explicitly ask respondents to talk about their conceptions regarding accessible field practices, several individuals felt that the need to express their thoughts and concerns. Below are brief summaries of these thoughts.

Uncertain of Institutional Support

Many participants reported that the accessibility strategies they implemented for their field classes resulted from the efforts of department staff and were not reflective of university policy and that campus-wide offices of disability services (ODS) were not helpful when providing accommodations and recommendations for field trips. As one respondent said, “they do not understand (or care) about things like field trips” (P74). Other respondents went as far as to say that ODS “have little field-class experience” (P30) or “they're a little out of their depth with fieldwork” (P63). Thus, many of the implementations made by faculty were created within an instructor’s respective geoscience department as evidenced by the following quotes: “[assigning an aid as an in-field facilitator] is not an official or sanctioned accommodation” (P13); “these accommodations were not facilitated by my school” (P130).

Instructor Bias

Written responses also reflected various bias and ableism. One respondent felt that it was important to let the researcher know that “fieldwork is…not suitable for students that are mobility-impaired or sight-impaired” (P132) in a response section on how a student with a mobility disability was supported during a field course. Additionally, several other faculty members commented on how easy it would be to accommodate Deaf students, even when they have not had any experience in providing these students with accessible field opportunities. Respondents mentioned how it would be “easy to accommodate” (P42) these individuals and that there would be “no issues for a hearing disabled student” (P89) in the field. Survey respondent P132 even mentioned that “there is no reason why a hearing-impaired student could not complete the fieldwork.” Deaf or hard-of-hearing students face barriers to participation in STEM disciplines and often underperform when compared to their able-normative peers (Moon et al., 2012). Instructors should attempt to provide appropriate accommodations for Deaf or hard-of-hearing students and not trivialize their needs by assuming they are easy to accommodate. Several instructors reported in the GFAS that cooperation and field-assistance from ODS can be difficult to obtain.

CHAPTER 6: LIMITATIONS AND IMPLICATIONS

Limitations

There are several limitations to report with this study. All data was voluntarily provided and may have a positive skew due to its sensitive social implications. Geoscience departments may not wish to express negative opinions on accessible education or inclusivity for fear of insensitivity or anti-politically correct connotations and may choose to answer survey questions to reflect this correctness. To compensate for this problem, the researcher allowed all respondents the option not to answer any question they did not feel comfortable answering.

Interview data were collected from two separate research universities with similar demographics. Both IP1 and IP2 created or modified a field course to include a student with a mobility disability and used similar laboratory/field-study combinations. Due to the similarity of their demographic information, the possibility exists that both departments receive equitable amounts of support from their respective universities. The reader should be aware that data from just two interviews is not sufficient for drawing conclusions in a qualitative study.

Inter-Rater Reliability was achieved by comparing coding counts with only one researcher who was not involved with the study. By only having one researcher code the data to determine code agreement, the researcher recognizes the possibility that data may not be coded in a logical manner. To mitigate issues with IRR, the outside researcher coded the entire survey dataset as opposed to some smaller portion of data.

Implications

Students with mobile, visual, and hearing disabilities remain underrepresented in postsecondary geoscience departments for numerous reasons including the inaccessibility of field-based learning (Wilson, 2014). In order to adequately prepare for the expected workforce shortage, the geoscience community must diversify to include all who are academically capable and interested in studying geoscience (Gilley et al. 2015). For these reasons, the researcher for qualitative study wanted to understand how geoscience departments were actively addressing these concerns. This study has shown the numerous ways that geoscience departments have been offering field-based experiences, but it also reveals some department shortcomings.

Many geoscience departments reported to use alternative assignments in lieu of completing a field course. An alternative assignment is often easy to implement, and as a result, it was the most widely used method used by instructors. These assignments can help teach both students with permanent and temporary disabilities lessons learned in field-settings, but instructors must ask themselves if these assignments are effectively replacing field courses.

By sharing with the geoscience education community, the best-and-worst practices used by departments from different university types and different regions, the researcher hopes that geoscience faculty will begin to understand how to best promote access and inclusion, and to start a discussion nationwide on how to best serve students of all abilities and backgrounds. Promoting the geosciences as an accessible field-based discipline via accessible field instruction would encourage learners with disabilities w to pursue an academic career in the geosciences. Outcomes from this study may serve as a foundation for creating guidelines that would ensure an equal opportunity for all students to experience field-based courses in the geosciences.

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APPENDICES

Appendix A: Institutional Review Board (IRB) informed consent forms for voluntary participation in the Geoscience Field Accessibility Survey

IRB #: 2015-6385

Approved: 10/26/2015
Do Not Use After: 10/27/2016

UNIVERSITY OF Cincinnati

Information Sheet for Research
University of Cincinnati
Department: *CECH Education*
Principal Investigator: *Chris Atchison*

Title of Study: *Accessible Field Course Survey*
Introduction:
You are being asked to take part in a research study. Please read this paper carefully and ask questions about anything that you do not understand.

Who is doing this research study?
The person in charge of this research study is Dr. Christopher Atchison of the University of Cincinnati (UC) College of Education, Criminal Justice, & Human Services (CECH) and the McMicken College of Arts and Sciences Department of Geology

What is the purpose of this research study?
The purpose of this foundational research study is to understand the state of accessibility in field-based geoscience courses.

Who will be in this research study?
This study is composed of geoscience department representatives who may be students or faculty members above the age of 18.

What will you be asked to do in this research study, and how long will it take?
You will be asked to answer 9 questions in the attached survey. It will take about 15 minutes to complete.

Are there any risks to being in this research study?
There are no risks associated in participating in this research study.

Are there any benefits from being in this research study?
Through your participation in this research study your institution and others will help to improve the inclusion of geoscientists with diverse physical abilities and promote accessibility in geoscience field-courses.

What are the extrinsic benefits for being in this research study?
There are no financial benefits for participating in this study.

Do you have choices about taking part in this research study?
If you do not want to wish to take part in this research study you may simply disregard this invitation to participate.

Page 1 of 2

IRB #: 2015-6385

UNIVERSITY OF Cincinnati

Approved:
10/26/2015
Do Not Use After:
10/27/2016

How will your research information be kept confidential?
Information about your institution will be kept private by de-identifying the data. All survey responses will be cleared of any identifiable data and stored in a locked filing cabinet in a locked office. All survey responses will be kept for one year. After then, they will be destroyed.

Agents of the University of Cincinnati may inspect study records for audit or quality assurance purposes.

What are your legal rights in this research study?
Nothing in this consent form waives any legal rights you may have. This consent form also does not release the investigator, the institution, or its agents from liability for negligence.

What if you have questions about this research study?
If you have any questions or concerns about this research study, you may contact Dr. Christopher Atchison at christopher.atchison@uc.edu.

The UC Institutional Review Board reviews all research projects that involve human participants to be sure the rights and welfare of participants are protected.

If you have questions about your rights as a participant or complaints about the study, you may contact the UC IRB at (513) 558-5259. Or, you may call the UC Research Compliance Hotline at (800) 889-1547, or write to the IRB, 300 University Hall, ML 0567, 51 Goodman Drive, Cincinnati, OH 45221-0567, or email the IRB office at irb@ucmail.uc.edu.

Do you HAVE to take part in this research study?
You do not have to participate in this research study.
No one has to be in this research study. Refusing to take part will NOT cause any penalty or loss of benefits that you would otherwise have. You may start and then change your mind and stop at any time. You may skip any questions that you don't want to answer.

BY TURNING IN YOUR COMPLETED SURVEY YOU INDICATE YOUR CONSENT FOR YOUR ANSWERS TO BE USED IN THIS RESEARCH STUDY.

PLEASE KEEP THIS INFORMATION SHEET FOR YOUR REFERENCE.

Page 2 of 2

Appendix B: Institutional Review Board (IRB) informed consent forms for voluntary participation in the semi-structured interview

IRB #: 2015-6385

UNIVERSITY OF Cincinnati

Approved:
01/09/2017
Do Not Use After:
01/09/2018

Information Sheet for Research
University of Cincinnati
Department: ***Geology***
Principal Investigator: ***Ivan Carabajal***
Faculty Advisor: Dr. Christopher Atchison

Title of Study: *Accessible Field Course Survey*

Introduction:
You are being asked to take part in a research study. Please read this paper carefully and ask questions about anything that you do not understand.

Who is doing this research study?
The person in charge of this research study is Ivan Carabajal of the University of Cincinnati (UC) McMicken College of Arts and Sciences Department of Geology. He is being guided in this research by Dr. Christopher Atchison.

What is the purpose of this research study?
The purpose of this foundational research study is to understand the state of accessibility in field-based geoscience courses.

Who will be in this research study?
This study is composed of geoscience department representatives who may be faculty members above the age of 18 and have completed the Geoscience Field Accessibility Survey.

What will you be asked to do in this research study, and how long will it take?
You will be asked to participate in an interview that will be audiotaped. It will take between one-half-hour to one-hour. The interview will take place over the phone or over the internet. If you do not want to be audio taped, you cannot participate in the study.

Are there any risks to being in this research study?
Some questions may make you uncomfortable. You can refuse to answer any questions that you don't want to answer. All interviews will be recorded. If you do not want to be audio taped, you should choose not to participate.

Are there any benefits from being in this research study?
Through your participation in this research study, your geoscience department and others may help to promote the inclusion of geoscientists with diverse physical abilities and promote accessibility in geoscience field-courses.

What will you get because of being in this research study?
You will not be paid to take part in this study.

Do you have choices about taking part in this research study?

Page 1 of 2

IRB #: 2015-6385

UNIVERSITY OF Cincinnati

Approved: 01/09/2017
Do Not Use After: 01/09/2018

If you do not want to wish to take part in this research study you may simply disregard this invitation to participate. All interviews will be recorded. If you do not want to be recorded, you should choose not to participate.

How will your research information be kept confidential?
Information about you will be kept private by providing participants with pseudonyms during the transcription process of audiotaped data. Audio files will be destroyed after verbatim transcription. Names of institutions will also be de-identified during the transcription process. Data will then be loaded onto a password-protected external hard drive and contained in a locked cabinet inside the PI's office at the University of Cincinnati. Interview transcriptions will be kept for one year. After that it will be destroyed/erased from all memory. Agents of the University of Cincinnati may inspect study records for audit or quality assurance purposes.

What are your legal rights in this research study?
Nothing in this consent form waives any legal rights you may have. This consent form also does not release the investigator, the institution, or its agents from liability for negligence.

What if you have questions about this research study?
If you have any questions or concerns about this research study, you should contact Ivan Carabajal at carabaig@mail.uc.edu. Or, you may contact Dr. Chris Atchison at christopher.atchison@uc.edu.

The UC Institutional Review Board reviews all research projects that involve human participants to be sure the rights and welfare of participants are protected. If you have questions about your rights as a participant, complaints and/or suggestions about the study, you may contact the UC IRB at (513) 558-5259. Or, you may call the UC Research Compliance Hotline at (800) 889-1547, or write to the IRB, 300 University Hall, ML 0567, 51 Goodman Drive, Cincinnati, OH 45221-0567, or email the IRB office at irb@ucmail.uc.edu.

Do you HAVE to take part in this research study?
No one has to be in this research study. Refusing to take part will NOT cause any penalty or loss of benefits that you would otherwise have. You may skip any questions that you don't want to answer.

You may start and then change your mind and stop at any time. To stop being in the study, you should tell Ivan Carabajal at carabaig@mail.uc.edu or Dr. Chris Atchison at christopher.atchison@uc.edu.

BY TAKING PART IN THIS INTERVIEW, YOU INDICATE YOUR CONSENT FOR YOUR ANSWERS TO BE USED IN THIS RESEARCH STUDY.

PLEASE KEEP THIS INFORMATION SHEET FOR YOUR REFERENCE.

Appendix C: Paper-Copy of the Geoscience Field Accessibility Survey

McMicken College of Arts and Science, Department of Geology

Help us understand the status of accessibility in field-based geoscience instruction by completing this survey. No identifiable information will be published.

1. Demographic Information

   University/Institution Name:________________________________ Years with Department:______

   Degrees Offered (check those that apply): ☐ B.A. ☐B.S. ☐ M.A. ☐M.S. ☐ Ph.D.

   What is YOUR position in the Department?

   ☐ Undergraduate Student ☐ Graduate Student (MA/MS) ☐ Graduate Student (PhD)

   ☐ Assistant/Associate Professor ☐ Professor ☐ Faculty Emeritus

   ☐ Research Associate ☐ Postdoctoral Other:____________________

2. From the options below, please select which field-based geology courses are offered by your Department
   .

   ☐ Economic Geology
   ☐ Geomorphology
   ☐ Geophysics
   ☐ Glaciology
   ☐ Historic Geology
   ☐ Introduction to Geology
   ☐ Limnology
   ☐ Natural Hazards
   ☐ Oceanography
   ☐ Paleontology
   ☐ Petrology
   ☐ Sedimentology
   ☐ Speleology
   ☐ Stratigraphy
   ☐ Structure/Tectonics
   ☐ Volcanology
   ☐ Other: ____________________

   Briefly describe these field courses below. Include the amount of trips per course, the duration of these field trips, and if the field courses are field-only or a part of a classroom or laboratory course.

3. Do you feel that your department is able to adequately accommodate a student with a…

mobility disability in a field course?	☐ YES	☐ NO	☐ UNSURE
visual disability in a field course?	☐ YES	☐ NO	☐ UNSURE
hearing disability in a field course?	☐ YES	☐ NO	☐ UNSURE

If you marked YES to any above, please describe any field-based accommodations you may have provided students in the past.

4. Does your department offer any field-course alternative projects for students that are unable to access field sites due to temporary or permanent physical conditions? For example, a temporary condition could be a broken ankle while a permanent condition could be cerebral palsy.

☐ YES ☐ NO ☐ UNSURE

Briefly describe what field-course alternatives your department offers, if any.

5. How confident is your program in assessing the accessibility of a field-site for students with mobility or sensory (visual and hearing) disabilities? Select an option that best represents your answer.

☐1	☐2	☐3	☐4
Unsure	Not Confident	Confident	Very Confident

6. Does your department have any students, faculty, or staff with a…

mobility disability?	☐ YES	☐ NO	☐ UNSURE
visual disability?	☐ YES	☐ NO	☐ UNSURE
hearing disability?	☐ YES	☐ NO	☐ UNSURE

7. Does your department have support from your university or college to provide accommodations for students with physical or sensory disabilities in the field? Select an option that best represents your answer.

☐1	☐2	☐3	☐4
Unsure	No Support	Some Support	Good Support

If support is available, please describe the type of support and where it is coming from (i.e Office of Diversity/Accessibility or Disability Services).

8. If you do not have institutional support for developing field-based accommodations, are you aware of alternative resources to support students in your department?

☐ YES ☐ NO

If YES, please explain below.

9. Would your department like to receive information on how to accommodate students with disabilities?

  ☐ YES   ☐ NO

Please provide the contact information of the department chair and/or field course coordinator below.

Name:____

Title/Position:___________________________________

University/Institution:______________________________

E-mail:____

Office Phone Number:______________________________

Name:____

Title/Position:___________________________________

University/Institution:______________________________

E-mail:____

Office Phone Number:______________________________

Appendix D: Electronic-Copy of the Geoscience Field Accessibility Survey

REQUEST EDIT ACCESS

Geoscience Field Accessibility Survey

Help us understand the status of accessibility in field-based geoscience instruction by completing this survey. No identifiable information will be published. Feel free to add any comments or additional information in the 'Other' text-boxes.

University/Institution Name

Your answer

What is YOUR position in the Department?

- [ ] Undergraduate Student
- [ ] Graduate Student (M.A./M.S.)
- [ ] Graduate Student (Ph.D.)
- [ ] Assistant/Associate Professor
- [ ]

- [ ] Professor
- [ ] Faculty Emeritus
- [ ] Research Associate
- [ ] Postdoctoral
- [ ] Other:

Years with Department

Your answer

What degrees does your department offer? Check those that apply.

- [ ] B.A.
- [ ] B.S.
- [ ] M.A.
- [ ] M.S.
- [ ] Ph.D.
- [ ] Other:

From the options below, please select which field-based geology courses are offered by your Department

- ☐ Economic Geology
- ☐ Geomorphology
- ☐ Geophysics
- ☐ Glaciology
- ☐ Historical Geology
- ☐ Introduction to Geology
- ☐ Limnology
- ☐ Natural Hazards
- ☐ Oceanography
- ☐ Paleontology
- ☐ Petrology
- ☐ Sedimentology
- ☐ Speleology
- ☐ Stratigraphy
- ☐ Structure/Tectonics
- ☐ Volcanology
- ☐ Other:

Briefly describe the field courses below. Include the amount of trips per course, the duration of these field trips, and if the field courses are field-only or part of a classroom or laboratory course.

Your answer

Do you feel that your department is able to adequately accommodate a student with a mobility disability in a field trip/course?

- Yes
- No
- Unsure
- Other :

Do you feel that your department is able to adequately accommodate a student with a visual disability in a field trip/course?

- Yes
- No
-

Unsure

Other :

Do you feel that your department is able to adequately accommodate a student with a hearing disability in a field trip/course?

Yes

No

Unsure

Other :

If you marked YES to any of the three questions above, please describe and field-based accommodations you may have provided to students in the past.

Your answer

Does your department offer any field-course alternative projects for students that are unable to access field sites due to temporary or permanent physical conditions? For example, a temporary condition could be a broken ankle while a permanent condition could be cerebral palsy.

- Yes
- No
- Unsure
- Other :

Briefly describe what field-course alternatives your department offers, if any.

Your answer

How confident is your program in assessing the accessibility of a field-site for students with mobility or sensory (visual and hearing) disabilities? Select an option that best represents your answer.

- Unsure
- Not Confident
- Confident
- Very Confident
- Other :

Does your department have any students, faculty, or staff with a mobility disability?

- Yes
- No
- Unsure
- Other :

Does your department have any students, faculty, or staff with a visual disability?

- Yes
- No
- Unsure
- Other :

Does your department have any students, faculty, or staff with a hearing disability?

- Yes
- No
- Unsure

- Other :

Does your department have support from your university or college to provide accommodations for students with physical or sensory disabilities in the field? Select an option that best represents your answer.

- Unsure
- No Support
- Some Support
- Good Support
- Other :

If support is available, please describe the type of support and where it is coming from (i.e. Office of Diversity/Accessibility or Disability Services).

Your answer

If you do not have institutional support for developing field-based accommodations, are you aware of alternative resources to support students in your department?

- Yes
- No
- Other :

If YES, please explain below.

Your answer

Would your department like to receive information on how to accommodate students with disabilities?

- Yes
- No

Please enter department contact email below:

Your answer

SUBMIT

100%: You made it.

Never submit passwords through Google Forms.

Appendix E: Semi-Structured Internet Protocol

GUIDING QUESTIONS

- What are the experiences of geoscience field instructors (GFIs) who have provided accessible field opportunities for students with disabilities?
  - Do any patterns or commonalities exist among these lived experiences?
- What are the challenges that GFIs face when implementing accessible field options?
  - How common are these challenges?
- What is the status of geoscience field accessibility?

ASK ABOUT

ACCESSIBLE FIELD PRACTICES – WHATS BEEN DONE

- Have you ever had a SWD participate in a field course? Tell me about the student.
- Tell me about that process... was the course already accessible or did you have to alter aspects of the field course?
- What was the nature of the field trip? (Look and see, mapping, using field instruments, etc.)?
  - Was it an introductory class? Advanced level?
- What were some of the hurdles that you ran into while making the course accessible? What about those hurdles when you finally got into the field?
- How do you think the student responded to this design?
  - Did you have any communication regarding how to implement a more accessible design?

ALTERNATIVE COURSEWORK

- Do you offer field alternative courses such as virtual field trips or lab assignments that serve as substitutes for field classes? Describe these alternative courses
- Was the academic rigor of the alternative coursework comparable to field courses?
- Were alternative field trips effective in teaching concepts that are usually learned in a field environment?
- Did non-SWDs ask to take alternative coursework instead of participating in a field trip?

TYPES OF TRAINING/ RESOURCES

- Do you feel that your department fosters an inclusive environment?
  - If so what are they doing? Any training?
  - Are you receiving any support outside of your department? Outside of your institution?

Appendix F: Email for Geoscience Field Accessibility Survey Recruitment

Dear [NAME],

Greetings. My name is Ivan Carabajal and I am a geoscience education graduate research assistant at the University of Cincinnati. My primary focus is to promote inclusion and access in undergraduate geoscience field-courses to students with physical and sensory disabilities.

My advisor, Dr. Chris Atchison, and I have created a survey intended to assess the state of accessibility of field courses in geoscience programs across the US. We understand the importance of field-based experience in the geoscience curriculum and believe that all students should have access to these studies regardless of any physical disabilities they may have.

The anticipated outcome of our research is to create a set of guidelines that will assist geoscience faculty in assessing the accessibility of their current and future field-based learning experiences. We would be very appreciative if you participated in the online survey linked below, which will take approximately 10 minutes of your time. If you feel that another member of your department would be better suited to complete this survey, please forward them this email.

If you have any questions, please contact Dr. Chris Atchison at christopher.atchison@uc.edu.

Sincerely,
Ivan Carabajal

Consent statement: http://www.theiagd.org/assets/Geoscience-IRB-Accessibility-Consent-Statement.pdf

Survey: https://goo.gl/HNzj0n

Appendix G: Email for Semi-Structured Interview Recruitment

Dear [E-mail Recipient],

You are being contacted in regards to your department's participation in a Geoscience Field Accessibility Survey conducted by researchers at the University of Cincinnati. We appreciate your department's input and would like to further discuss the survey responses concerning accessible geoscience field-based curriculum in the form of an interview. The purpose of this interview is to gain a deeper understanding on how your department provides modifications and accommodations to field-based curriculum for students with mobility, visual, and hearing disabilities.

If you wish to participate, please review the Interview Information Sheet and contact myself or my advisor Dr. Christopher Atchison at christopher.atchison@uc.edu. We look forward to working with you and appreciate your department's survey participation.

Thank you.