2018

Mediating Cultural Border Crossings Between American Indian Tribal College Students and Natural Resources Science Learning Using Culturally Congruent Education

Shandin Hashkeh Pete

MEDIATING CULTURAL BORDER CROSSINGS BETWEEN AMERICAN INDIAN

TRIBAL COLLEGE STUDENTS AND NATURAL RESOURCES SCIENCE

LEARNING USING CULTURALLY CONGRUENT EDUCATION

By

SHANDIN HASHKEH PETE

M.S., University of Montana, Missoula, MT, 2006
B.S., B.A., Salish Kootenai College, Pablo, MT, 2000

Dissertation

presented in partial fulfillment of the requirements
for the degree of

Doctor of Education
in Teaching and Learning

The University of Montana
Missoula, MT

May 2018

Approved by:

Scott Whittenburg Ph.D., Dean of The Graduate School
Graduate School

Lisa Blank, Ph.D., Chair
Department of Teaching and Learning

Morgen Alwell, Ph.D., Committee Member
Department of Teaching and Learning

Fletcher Brown, Ph.D., Committee Member
Department of Teaching and Learning

Martin Horejsi, Ph.D., Committee Member
Department of Teaching and Learning

Darrell Stolle, Ph.D., Committee Member
Concordia College Department of Education

Pete, Shandin Hashkeh, Ed.D, May 2018 *Teaching and Learning*

Mediating Cultural Border Crossings Between American Indian Tribal College Students and Natural Resources Science Learning using Culturally Congruent Education

Chairperson: Lisa M. Blank

Committee Members: Morgen Alwell, Fletcher Brown, Martin Horejsi, Darrell Stolle,

This study is motivated by two research questions: (1) How does Culturally Congruent Instruction (CCI) influence American Indian (AI) students' attitudes and achievement in natural resources science at a tribally controlled college/university (TCU)? And (2) What is the nature of the relationship between CCI course modifications and changes (or lack of) in AI students' science attitudes and achievement at a TCU? Findings developed a Culturally Congruent Instructional Framework (CCIF) for use in TCUs and beyond.

Previous research suggest that AI students and tribal college science must find congruence for the student to cross cultural boundaries of the institution. TCUs can address the need for AI science experts to provide stewardship over natural resources within sovereign territory. Previous researchers developed a survey that operationalized CCI content, pedagogy and instruction environment for K-12 science education. The present study used the content and pedagogy items as the basis for modifications in natural resources courses.

This study utilized a mixed-method, quasi-experimental design to assess changes in student attitude and achievement. Four courses were selected for treatment. Faculty engaged in workshops and follow-up individual training to modify their courses. The treatment and control courses were subjected to pre/post surveys assessing changes in attitude toward science, motivational orientation and students' perception of CCI. Student and faculty focus groups were conducted to gain insight into course modifications and challenges. Formative and summative data were collected to determine student achievement. Quantitative data were gathered using a non-equivalent control group design and analyzed using between group comparisons with *t*-tests and ANOVA. Qualitative data were gathered using a multiple case study design and within and across case thematic analysis.

Findings indicate no changes in attitude towards science; increase in self-efficacy and task value for treatment group; and a greater agreement that the use of Native languages, tribal guest speakers and collaborative group work support border crossing. Treatment AI students experienced higher achievement scores than the control AI groups. The CCIF model encompasses three levels of support for student border crossing. Institutions, departmental, faculty/course and student level mediating factors are presented to mediate the least hazardous border crossings for AI students.

Acknowledgements

There are many to thank for this opportunity. First, an acknowledgment of the sacrifices that those have made to see this accomplishment to the end. My wife Salisha, children Sisi, Siliye, Susseli, Inshiye and Chmte deserve much praise for supporting me in this educational endeavor. Many thanks to all the Natural Resources faculty for their willingness to participate and offer endless support. A special recognition to Pat Hurley, Dr. Woessner and Dr. Regina Sievert for their unique contribution to guiding my educational journey. A special acknowledgement to the faculty in the College of Education and Human Sciences, especially Dr. Blank, Dr. Alwell, Dr. Brown, Dr. Horejsi and Dr. Stolle for the knowledge they have passed down to me.

Many thanks also to the students at SKC that have seen the greatest struggles and greatest successes and continue to forge ahead to see their dreams achieved. I would like to also recognize the dreams and goals set forth by those ancestors that struggled through great cultural, spiritual and economic unrest - they proved a great driving motivator. Also, I am thankful for the opportunity to take on the challenge to see our young native people rise up and adapt, providing our unique perspectives and our worldview to the world; it is a privilege and a unique honor.

TABLE OF CONTENTS

List of Tables

List of Figures

Chapter I: Introduction

Conceptual Framework

Guitierrez and Rogoff (2003) define culture as a dynamic repertoire of beliefs and practices developed through participation in a cultural community whose members span generations and share traditions and understandings that are based in the group's experiences. From this perspective, Western Science is a culture itself given it has its own set of norms, values, dispositions and behavioral expectations whose overarching objective is the accumulation of evidence for the production of scientific knowledge. One way to be successful in science is to adopt the cultural ways of Western Science, but for many students, particularly those of non-European descent, there is a pronounced cultural disconnect between Western Science and their home cultures. (Aikenhead, 2001; Krogh & Thomsen, 2005; Taconis & Kessels, 2009). Aikenhead (1996), in his widely-acclaimed work emphasized the "need to recognize the inherent border crossings between students' life-world subcultures and the subculture of science…we need to develop curriculum and instruction with these border crossings explicitly in mind, before the science curriculum can be accessible to most students" (p. 2).

In the educational setting, the difficulty of this border crossing is dependent on a number of factors, including the distance between the teacher's culture, the student's culture, the cultural border for Western Science, and the "cultural flexibility" of each. Cultural incongruities in education may encompass a suite of factors such as a lack of curriculum content relevant to ethnically diverse students' lives; incompatibility between the behavioral norms of schools and students' home cultures; differences between the language of instruction and students' home language; and a disconnect between the pedagogy typically used in classroom instruction and the traditional teaching methods familiar to ethnically diverse students (Gilbert, 2010; Lee & Buxton, 2010; Tyler et al., 2008; Lee, Luykx, Buxton, & Shaver, 2007; Boykin, Tyler, Watkins-Lewis, & Kizzie, 2006; Lee, 2005; Barndhardt & Kawagley, 2005; Hilberg & Tharp, 2002; Yazzie, 1999).

These difficult border crossings are not limited to ethnically diverse students. Female students (Bailey & Graves, 2016), students from low socio-economic levels (Oakes et al., 1990) and students with disabilities are also marginalized in science education due to a lack of instructional congruence (Lee & Fradd, 2002). Instructors can strive for "instructional congruence," a term coined by Lee and Fradd (1998) for culturally congruent instruction that is appropriate for specific disciplines (like science) through the merging of "discipline specific" and "diversity oriented" pedagogies, while students can work toward reconciling their worldviews and behaviors with Western Science to allow both to meet on middle ground. This study is based on the theoretical framework of border crossing and finding middle ground in science education to enable students of diverse cultural backgrounds to succeed in science.

Statement of The Problem

A fundamental need for American Indian science experts exists. Indigenous lands comprise four percent of the United States that collectively contain more wildlands than all the National Parks and nature conservancy holdings in North America (Nabhan, 1997). American Indian tribes also exert sovereignty over approximately 20% of the Nation's fresh water resources (Van Der Velder, 2009). These vast and unspoiled resources on Indian reservations provide a unique management challenge as our global and societal needs strain open space and untapped resources (UNEP, 2007). Roger Romulus Martella, Jr., the former US

Environmental Protection Agency's (EPA) General Counsel (1994) writes,

> …the nation's approximately three hundred Indian reservations serve as homes to mammoth oil refineries, strip mining and forestry operations, toxic waste dumps, hazardous waste recycling centers, and agricultural waste incinerators, among scores of other types of heavy industrial activities and factories. Both geologically and geographically, these operations have been particularly well suited to Indian reservations. Miners and refiners viewed tribal lands as attractive because many reservations contain vast natural resources - including large stores of petroleum and precious minerals, as well as residents desperate for money. Landfill and incinerator operators traditionally liked Indian country because of its frequent isolation and the sparse population of most reservations. (p. 1868)

In addition to pressures placed on the natural resources of Indian reservations by outside entities, Indigenous people face daunting economic and educational challenges as most communities have been subject to substantial oppression and adversity in their histories. As a result, indigenous people have been ill-prepared and under-trained in modern Western Science disciplines, thereby depending primarily on non-Native Western Science experts for technical and management needs of native lands (Berardi et al., 2002; Nelson-Barber & Trumbull Estrin, 1995). All the while, Indigenous societies and Native American tribes possess and utilize unique and specific knowledge relating to the environment and local ecosystems (Fishman, 1991) and are generally actively engaged in environmental and biodiversity conservation on Indigenous lands through traditional means (Weber, Butler, & Larson, 2000). These indigenous knowledge systems - developed in the Americas for many thousands of years, and according to most Indigenous oral histories, since the time immemorial are being under-utilized and marginalized by Western Scientific educational systems (Battiste, 2002; Barnhardt & Kawagley, 2005; James, 2001).

However large the need for scientific expertise on Indian lands, there is a disparity of Native students entering into and completing science related degree programs. Beginning at the secondary education level, Native students experience a multitude of problems limiting success and interest in science. Poverty rates in rural areas are one of the major determinants of the quality of education received in secondary education, where nearly 57.4% of the American Indian population resides (Babco, 2003). In the Pacific Northwest, Native students are graduating at an average rate less than 50%, compared to their non-Native counterparts who are graduating at an average rate of 71.4% in secondary education (Faircloth & Tippeconnic, 2010). In postsecondary education, Native student participation has improved, yet few students are choosing science, technology, engineering and mathematics (STEM) fields as a major or career. In the United States between 2004 and 2008, less than 14% of Native students enrolled and completed a degree in a STEM field, while up to 34% of White and Asian American students enrolled and completed a degree in a STEM field (Eagan, Hurtado, Figueroa & Hughes, 2010). These statistics highlight the limited pool of available Native students entering into the tribal workforce to manage tribal lands from both an administrative and technical perspective. Many national, global and native leaders see the world as a whole, in urgent need of Native perspectives or worldviews in natural resources management (Pease-Pretty on Top, 2003; UNESCO, 2009).

Tribal colleges and universities have taken steps to offer solutions to these issues. All of the tribal colleges and universities in the United States and Canada highlight cultural traditions in their mission statements. However, they continually struggle with implementation of their mission (Ambler, 1998) while facing the dilemma of conforming to standard Western educational models. Wheeler (2004) elaborates further in his examination of the tribal college movement, explaining that,

> …there is concern about the relative success of tribal colleges in incorporating specific tribal culture, language, and values into their curricular and pedagogical structures. These concerns fall into two, somewhat contradictory or competing, directions: (a) a sense that more needs to be done to create models of knowledge and epistemologies that reflect the vast history of specific tribes, and, (b) a worry that the success of tribal colleges in accommodating Western intellectual traditions and requirements may threaten their identity. (p. 9)

There exists a need for education reform that will aid to recruit, retain and graduate tribal students in STEM fields while fostering the vision, mission and foundations of the tribal college system. Most tribal colleges are geared to provide a unique model needed to develop interest in science and graduate technically and scientifically trained Native students while developing future tribal leaders (Cummingham & Redmond, 2001). For example, tribal colleges are expanding facilities, creating new degree programs, devising new teaching methods and have been the forerunners in the integration of Indigenous knowledge and Western Science (Boyer, 2008). In addition, tribal colleges have the capacity and access to knowledge holders that enable them to lead the way in the integration of Native ways of knowing and Western Scientific knowledge (Kimmerer, 2002). Specifically, tribal colleges can address a common challenge, the need to preserve knowledge that is presently held by the elders of the community about the land ,as well as passing this knowledge on to the next generation (McDonald, McDonald, & McAvoy, 2000).

At Salish Kootenai College (SKC), most courses routinely consider traditional knowledge in parallel with mainstream scientific knowledge; yet, there remains concern about the success of incorporating culture, language and values into the curriculum and pedagogical structures (Wheeler, 2004). Full development of curriculum and instructional strategies that are founded in the tribal culture, language, and value have yet to be developed and assessed for tribal college students at Salish Kootenai College.

It has been suggested that the academic success rate of American Indian students in mathematics and science programs will increase if more attention is paid to the unique perspectives of these students and that society-at-large stands to benefit from gaining a perspective on the ways in which values and practices based in mathematics, science, and technology affect human relations and the Earth (Nelson-Barber & Trumbull Estrin, 1995). Furthermore, according to Demmert and Towner (2003), Native language and cultural programs in schools show significant influence on American Indian student motivation; sense of identity and self; positive attitudes; and supporting improved academic performance. As well, the most successful geosciences programs take pains to account for culturally-specific learning styles, cultural issues with pedagogy, community preferences and priorities (Riggs & Alexander, 2007). For example, the Aurora Alive Advanced Curriculum program at the University of Alaska has been incorporating Native language terminology into science lessons and has found that it helps American Indian students to make connections between Traditional Native Knowledge and Western Science (Riggs & Alexander, 2007).

Justification of the Study

A number of scholars, including those cited previously, have hypothesized that reconciling the cultural incompatibilities between students' home cultures and schools through the use of more culturally congruent instruction (CCI) will improve the academic achievement of ethnically diverse students. Culturally congruent instruction is an instructional strategy that seeks to provide congruence between a student's home culture and the culture of the educational discipline. Culturally congruent instruction fosters student empowerment to believe in themselves and their abilities to succeed while developing knowledge, skills, and values essential to becoming social critics capable of participating in important decision-making processes (Au, 1993; Erickson, 1997; Gordon, 1993; Ladson-Billings, 1995). Culturally congruent instruction is appropriate for specific disciplines (like science) through the merging of "discipline specific" and "diversity oriented" pedagogies, where students can work toward reconciling their worldviews and behaviors with Western Science to allow both to meet on middle ground. Culturally congruent instruction facilitates and supports the achievement of students from all cultural backgrounds. Furthermore, CCI requires teachers to create a learning environment where all students feel welcomed, supported, and provided with the best opportunities to learn, regardless of cultural and linguistic backgrounds (Barnes, 2006).

For decades, tribal entities, educational scholars specializing in diversity and equity, the federal government, and national education organizations have advocated the use of CCI to improve educational outcomes for ethnic minority students, including American Indian students (e.g., National Council of Teachers of Mathematics, 2004; National Indian Education Association, 2007; National Science Teachers Association, 2000). Meanwhile, empirical evidence supporting the efficacy of CCI for improving American Indian students' achievement, particularly in mathematics and science education, is limited. The number of relevant CCI studies involving American Indian students is small and many of the studies that have been reported did not employ rigorous research methodologies, such as the use of treatment and comparison groups or the random assignment of subjects, thereby weakening the scientific credibility of the evidence they provide. Demmert and Towner's (2003) literature review of 10,000 articles on culturally based education (CBE) for American Indian and Alaska Native students found few studies that used rigorous methodology and even fewer that provided evidence of the efficacy of CCI in improving student achievement.

A small, but growing, body of research is beginning to emerge in the literature that provides preliminary evidence of the importance of CCI in supporting diverse students' math and science achievement. Fourteen different quasi-experimental studies by Lipka and his team at the University of Fairbanks, for example, showed increased mathematics achievement (as indicated by gain scores derived from project pre-tests subtracted from post-test) in Yupik treatment students who were taught using a curriculum that incorporates traditional Yupik mathematical knowledge and teaching methods (Lipka, Parker & Yanez, 2005). Significant increases in achievement as measured by pre- and post-test control group design have also been correlated with the use of CCI in mathematics and science with American Indian students (see, for example, Cardell, Cross & Lutz, 1978; Gilbert, 2005; Hilberg, Tharp, & Degeest, 2000; Matthews & Smith, 1994). These studies provided preliminary evidence that shows that CCI supports increased academic science and math achievement in Indigenous students. This project hopes to contribute additional evidence of the efficacy of CCI in supporting American Indian students' science achievement.

Purpose of The Study

The Big Sky Science Partnership (BSSP) is a National Science Foundation funded Math-Science Partnership Teacher Institute administered by Salish Kootenai College (NSF Award # 0634587). The project partnered three Montana institutes of higher education (IHEs) with five tribal communities on three Montana American Indian reservations and K-12 schools and teachers on or near those reservations. As a part of the BSSP evaluation efforts, tribal, IHE and K-12 partners worked collaboratively to design and validate the culturally congruent instruction survey (CCIS). The CCIS is a 41-item instrument that operationalizes culturally congruent instruction in terms of content, pedagogy and instructional environment for K-12 science education for the five tribal cultures in the partnership. The survey was extensively tested, and empirical evidence indicated that it was reliable and had high predictive validity. The CCIS has been disseminated in professional settings and is in wide use, either intact or with context specific adaptations, as a tool for framing and assessing CCI, particularly in American Indian education contexts.

This research builds on the CCIS, utilizing items from the survey as variables for treatment course modifications that were tested for their efficacy, outside of the K-12 system, in supporting American Indian college students' science achievement. Further, the project used the CCIS as a foundation and utilized the findings from the present study to develop the Culturally Congruent Instruction Framework or CCIF, a model that will be useful in designing efficacious college level culturally congruent science courses.

There is a scarcity of research on the efficacy of culturally congruent instruction for science education at the tribal college level. Two similar models have been researched and implemented at the college level for American Indian students. Semken and Morgan (1997) used a Diné educational philosophy, based on Navajo knowledge and pedagogy, to develop an introductory physical geology course at Navajo Community College (now called Diné College). The model was implemented in one course (Geology 101) at Diné College, yet there were no empirical data reported to indicate its effectiveness. In a similar approach, Antonellis (2013) developed a course at Tohono O'odham Community College using O'odham culture, language, value system, and way of life. The non-American Indian researcher in this case developed the course through a collaborative effort from a student development team, local Indigenous educators and non-Indigenous educators. The course (Physics 121) was implemented and reported as qualitative case study for two American Indian students that completed the course. The research provided insight into student sense making, while suggesting further research to validate its effectiveness.

This model, developed in a tribal college context and across different science courses, will be particularly unique, offering valuable and empirical insight for transferability into other tribal colleges science curriculums. While perhaps not fully generalizable to all college contexts, it is thought that the model and more importantly, the process for developing the model will be adaptable for use in transforming and strengthening science education in other contexts as well, thus enabling improvements in student science achievement in college and increasing the numbers of students entering science related careers.

Research Questions

Based on the conceptual framework detailed above, this study hypothesizes that culturally congruent college science courses designed and taught in alignment with the CCIS will improve American Indian students' achievement in science, as measured by quantitative and qualitative methods. During the study, select STEM courses were modified in specific ways, using elements identified on the CCIS, in an effort to improve the cultural congruency of instruction. As these select courses were taught, student attitude and outcomes data were collected, analyzed, and examined. The research questions that this study addressed are:

1. (Quantitative) How does CCI influence American Indian students' attitudes and achievement in natural resources science at a tribally controlled college?
2. (Qualitative) What is the nature of the relationship between CCI course modifications and changes (or lack of) in American Indian students' science attitudes and achievement at a tribally controlled college?

Chapter II: Literature Review

Considering the demographic environment of tribal colleges and universities (TCU) in the 21st century, the necessary traits of effective modern TCU educators are an acknowledgment and understanding of the potential diversity among ethnic and cultural backgrounds of tribal and non-tribal rural students as well as a desire to acknowledge their own cultural experiences to modify or enhance the classroom environment. Studies on cultural diversity make the assumption that the academic achievement of students from culturally diverse backgrounds, and at any level of instruction, will improve if the academic institution and instructors make an attempt to ensure that the class curriculum is conducted in a manner that is congruent to the student's home culture (Gay, 2010). This type of instruction has evolved in the research literature as culturally responsive (Erickson, 1997), culturally congruent (Au & Kawakami, 1994), culturally compatible (Jordan, 1985), or culturally relevant (Ladson-Billings, 1995).

Culturally congruent instruction, therefore, is designed to give all students an equal chance at academic success (Irvine, 1990; Nieto & Bode, 2015; Weinstein, Curran & Tomlinson-Clarke, 2003). Through establishing and recognizing the cultures of a community of learners, students buy into and become active members of the learning process, thus contributing to their academic success. The culturally aware teacher also helps the students to consider that they can maintain high standards of excellence without compromising their cultural identity (Ladson-Billings, 1995; Weinstein, Curran & Tomlinson-Clarke, 2003).

This chapter provides an overview of the literature on CCI and its significance of use in the science curriculum of American Indian students in post-secondary education. Based on the review of literature, categorical themes for this study were created including: defining culturally congruent instruction and effective practices and the role as well as the impact that CCI plays in the level of engagement and motivation of students. This chapter concludes with a discussion of the theoretical framework: social constructivist theory, which were used to explore culturally responsive teaching as a meditational tool to aid students in achieving academically.

Culturally Congruent Instruction

Leaders in the field of multicultural education such as Banks and Banks (2009), Gay (2000), Howard (2003), Ladson-Billings (1995), and Nieto and Bode (2015) have advocated that the underachievement of minority groups comes as a result of the lack of culturally responsive teaching. Indeed, it has been argued that a key to learning is an understanding of culture (Banks & Banks, 2009). Howard Gardner (2011) posited that culturally congruent teaching provides instructional scaffolding that encourages students to learn by building on the experiences, knowledge, and skills they bring to the classroom.

Some researchers, particularly in elementary and secondary education (Bahr & Bahr, 1995; Haukoos & Satterfield, 1986; Jolly, 1996; Lam-Phoon, 1985; More, 1987; Murk, 1994; Nuby, 1995; Philips, 1972, 1983; Swisher & Deyhle, 1987; Tharp & Yamauchi, 1994; Vogt, Jordan, & Tharp, 1987) believed that learning and cognitive styles of American Indians are largely dictated by their culture, but it must be noted that one cannot generalize this belief to every single individual who is American Indian (MacIvor, 1999). Geneva Gay (2000) conjectured that instruction should use “cultural characteristics, experiences, and perspectives of ethnically diverse students as conduits for teaching them more effectively” (p. 106). To do this effectively, teachers at all levels of instruction need to be open to learning about the cultural characteristics of their own and other ethnic groups within their classrooms and transform that understanding into effective educational practice (HeavyRunner & DeCelles, 2002; Lee, Donlan & Brown, 2011; McAllister & Irvine, 2000; Pewewardy, 2003). The researchers posited that in order to meet the educational needs of students, educators must first be able to understand the social, cultural and political experiences of the student. In conventional postsecondary educational settings, these experiences are either absent or ignored (Barbatis, 2010; Doyle, Kleinfield, & Reyes, 2009; Froelich, 2006; Gonzalez, 2000; Huffman, 2001, 2003; Lee, Donlan, & Brown, 2011; Smiley & Sather, 2009). Researchers have repeatedly confirmed that teachers need to know more about the worldview of the students whom they instruct in order to better offer opportunities for learning success at all levels of instruction (Graybill, 1997; Pransky & Bailey, 2002).

One way to overcome the obstacle of underachievement for postsecondary students is through the use of CCI (Lee & Fradd, 1998). Instructors can strive for "instructional congruence", a term coined by Lee and Fradd in 1998 for CCI that is appropriate for specific disciplines (like science) through the merging of "discipline specific" and "diversity oriented" pedagogies, while students can work toward reconciling their worldviews and behaviors with Western Science to allow both to meet on middle ground. Culturally congruent instruction facilitates and supports the achievement of students from all cultural backgrounds and requires teachers to create a learning environment where all students feel welcomed, supported, and provided with the best opportunities to learn regardless of cultural and linguistic backgrounds (Barnes, 2006).

Aikenhead (1996) emphasized the "need to recognize the inherent border crossings between students' life-world subcultures and the subculture of science…we need to develop curriculum and instruction with these border crossings explicitly in mind, before the science curriculum can be accessible to most students" (p. 2). In the educational setting, how difficult this border crossing will be dependent on a number of factors including: the distance between the teacher's culture, the student's culture, and the cultural border for Western Science, and the "cultural flexibility" of each. Cultural incongruities in education may encompass a suite of factors such as a lack of curriculum content relevant to ethnically diverse students' lives; incompatibility between the behavioral norms of schools, and students' home cultures; differences between the language of instruction and students' home language; and a disconnect between the pedagogy typically used in classroom instruction and the traditional teaching methods familiar to ethnically diverse students (Barndhardt & Kawagley, 2005; Boykin, et al., 2006; Gilbert, 2010; Lee & Buxton, 2010; Lee, 2005; Lee, Luykx, Buxton & Shaver, 2007; Hilberg & Tharp, 2002; Tyler, et al., 2008; Yazzie, 1999). Ladson-Billings (1995), Gay (2000), and Nieto & Bode (2015) used a similar metaphor of a bridge to describe how teachers connect the students' school culture with their home cultures. They suggested that, when teachers increase their cultural awareness about themselves, they become conscious of their own cultural perspectives and they find ways to connect the students' home culture with the school culture. Culturally congruent teachers use teaching strategies to match the cultural needs of their students in the classrooms (Cummins, 1996; Gay, 2000; Nieto, 2002).

In 2006, Smith, Stumpff, and Cole, initiated the Native Cases Initiative Project, a collaborative study between Evergreen State College, Northwest Indian College, Salish Kootenai College, Grays Harbor College, and Washington Online. The project addressesd a void in the literature in STEM curriculum focusing on American Indians. The project also promoted scientific literacy through development and use of Native case studies with an emphasis on science for non-majors (Smith, Stumpff & Cole, 2012). The focus of the project was the creation of culturally relevant educational materials that serve as an important component in improving the participation and graduation rates of Native students. The project developed a collection of interdisciplinary cases. The collection included 85 interdisciplinary cases addressing significant issues such as salmon recovery, intergovernmental planning and management, climate change, sacred sites, indigenous science, health, energy, sustainability, education, and economic development.

Smith et al. (2012) used the cases to emphasize active learning and collaboration. Faculty were instructed through role playing, small group discussions, and jigsaw seminars to learn the cases and to design teaching and assessment plans. These faculty then worked with students using small group formats that mixed participants from two separate institutions. This served the ancillary purpose of creating peer relationships, mentors and inspiration across colleges to earn a bachelor's degree. After students discussed the case in small groups, they completed formal presentations of their group's conclusions.

In 2010-2011 the project surveyed more than 100 faculty who had received training in case implementation. Forty-three percent worked at four-year institutions, 18% at tribal colleges, and 10% at two-year colleges. Fifty-three percent were fulltime faculty, and 70% had taught for eight years or more. From these self-reported surveys, it was revealed that the cases were being used in interdisciplinary and disciplinary courses across educational levels and in general education to discipline specific courses. Additionally, faculty qualitatively observed that:

- Students learn to view issues from multiple perspectives--97% agree
- Students are more engaged--93% agree
- Students develop stronger critical-thinking skills--90% agree

- Students have a better grasp of the practical applications of core course concepts--89% agree
- Students strengthen communication skills--85% agree
- Students develop positive peer-to-peer relationships--78% agree
- Students gain confidence working in groups--61% agree

Further, Smith et al. (2012) surveyed student responses to cases. Students involved in cases over a long period of time were reported to have demonstrated substantial gains in learning new content and building a variety of skills in group work, public speaking, problem solving, and critical thinking. Student responses indicated that 95% thought that “the case studies were engaging,” 95% stating that “the cases addressed important issues in their community,” 89% stating that “the cases improved my critical-thinking skills,” 84% stating that “I am becoming more confident and successful in participating in groups,” and 78% stating that “I learned new things from other students in my group discussion.”

This research represents one of few projects that have implemented and measured American Indian student’s attitude toward a CCI component. The research was grounded in the literature that promotes culturally congruent instruction as having a positive impact on the academic achievement of American Indian students. Smith, Stumpff, and Cole’s study addressed the culturally congruent instructional practice; yet, it did not provide quantitative evidence that student’s achievement had increased. This study’s findings, participants and procedures are closely aligned to the instructional strategies promoted in this proposed study.

Culturally congruent instruction and similar terms have been described by a number of researchers as an effective means of meeting the academic and social needs of culturally diverse students (Gay, 2000; Ladson-Billings, 1995; Shade, Kelly &

Oberg, 1997). Culturally congruent instruction has the following characteristics that are void of the constraints of knowledge that are dictated by mainstream culture: It has an empowering nature that enables students to believe in themselves and their abilities to succeed; its transformative nature helps students to develop knowledge, skills, and values essential to becoming social critics capable of participating in important decision-making processes (Au, 1993; Erickson, 1997; Gordon, 1993; Ladson-Billings, 1995).

Similar to CCI in many respects, Gay (2000) defines culturally responsive pedagogy as "using the cultural knowledge, prior experiences, frames of reference, and performance styles of ethnically diverse students to make learning more relevant to and effective for them; it teaches to and through strengths of these students" (p. 28-29). It is culturally "validating, comprehensive, multidimensional, empowering, transformative and emancipatory" (Gay, 2000, p. 29). Hence, when teachers are equipped with the knowledge about the way students construct and process information, they will be more apt to identify and focus on students' strengths to further their academic success (Delpit, 1995). Additionally, teachers' knowledge of their students' learning and cognitive styles and communication skills enables them to seek out and incorporate materials and instructional strategies that correspond best to their students' needs. Gay (2000) describes culturally responsive teaching as having these characteristics:

- It acknowledges the legitimacy of the cultural heritages of different ethnic groups, both as legacies that affect students' dispositions, attitudes, and approaches to learning and as worthy content to be taught in the formal curriculum
- It builds bridges of meaningfulness between home and school experiences

as well as between academic abstractions and lived sociocultural realities

- It uses a wide variety of instructional strategies that are connected to different learning styles
- It teaches students to know and praise their own and other's cultural heritages
- It incorporates multicultural information, resources, and materials in all the subjects and skills routinely taught in schools. (p. 29)

Culturally responsive teachers realize the importance of academic achievement, but also the maintaining of one's cultural identity and heritage (Gay, 2000). Culturally responsive teachers care about their students. They provide choices and are unrelenting in their efforts to make sure their students understand. Linda Smith (1999), in her book *Decolonizing Methodologies – Research and Indigenous Peoples* observes that science teaching in schools has historically held a hostile attitude toward indigenous cultures and the manner in which indigenous people learn. A culturally responsive teaching approach can assist in mediating socially ingrained hostilities and provide a cultural bridge. This is a primary reason why culturally responsive teaching is needed and vital in multicultural diverse classrooms.

Culturally Responsive Practices

The Culturally Congruent Instruction Survey (CCIS) presents a set of culturally responsive practices the have been extensively tested producing reliable and high predictive validity (Sievert, LaFrance & Brod, 2011). In its original form, the 41-item survey operationalizes CCI in terms of curriculum content, instructional strategies and instructional environment for K-12 science education. The CCIS, though a survey designed to assess culturally relevant science instruction, are used as a guide for course modifications. The CCIS directly reflect culturally relevant science teaching practices as documented by scholars as being appropriate for American Indian students and have been reported in the literature in exploring the science practices of teachers of American Indian students in Montana (Sievert et al., 2011; Sievert, 2014). In this study, the CCIS curriculum content and instructional strategies category offer select practices for framing and assessing CCI in the tribal college science education context.

Section 1 and 2 from the CCIS are presented as target activities for implementation.

Section 1: Curriculum Content

1. A traditional story from a Montana Indian tribe
2. Contemporary issues relevant to Montana Indian tribes
3. Historical content about Montana Indian tribes
4. A fieldtrip to a site significant to Montana Indian tribes
5. Traditional science knowledge from Montana Indian tribes
6. Science content tied to a place-based context relevant to a Montana Indian tribe

Section 2: Instructional Strategies

8. Students work in *collaborative groups*
9. Instructor uses *extended wait time* in conversations with students
10. Instructor encourages students to assume responsibility for their learning - e.g., students made choices about how they studied a topic, how they were assessed, etc.
11. Local *tribal elders or other tribal community members* are used as guest teachers
12. Use teaching strategies that support Limited English Proficient or Second Language learners (e. g., *used graphics, models, other visuals*; move from concrete to abstract; make frequent contextualized use of vocabulary)
13. Use alternative forms of assessment like *authentic assessment*, or *performance-*

based assessment (instead of multiple choice, fill in the blank, e.g.)

14. Provide specific *formative feedback* to each student
15. Use *metaphors, analogies, or symbols* to represent science content
16. Use local *Native language* in instructional interactions with students
17. Provide ample opportunity for *students to engage in private practice* before publicly demonstrating their proficiency
18. Use science activities in which students design solutions to *problems relevant to their community*
19. Utilize *Supported mentoring* of students by adults other than the classroom teacher or paraprofessionals
20. Use *art-based teaching methods* (e.g., storytelling, music, drawing, painting, poetry, drama, etc.)
21. Use *observational learning strategies* (e.g., adult or peer modeling, demonstrations, apprenticeships)
22. Instructor is *flexible with time* (e.g., changed scheduling of instruction to meet individual students' needs)

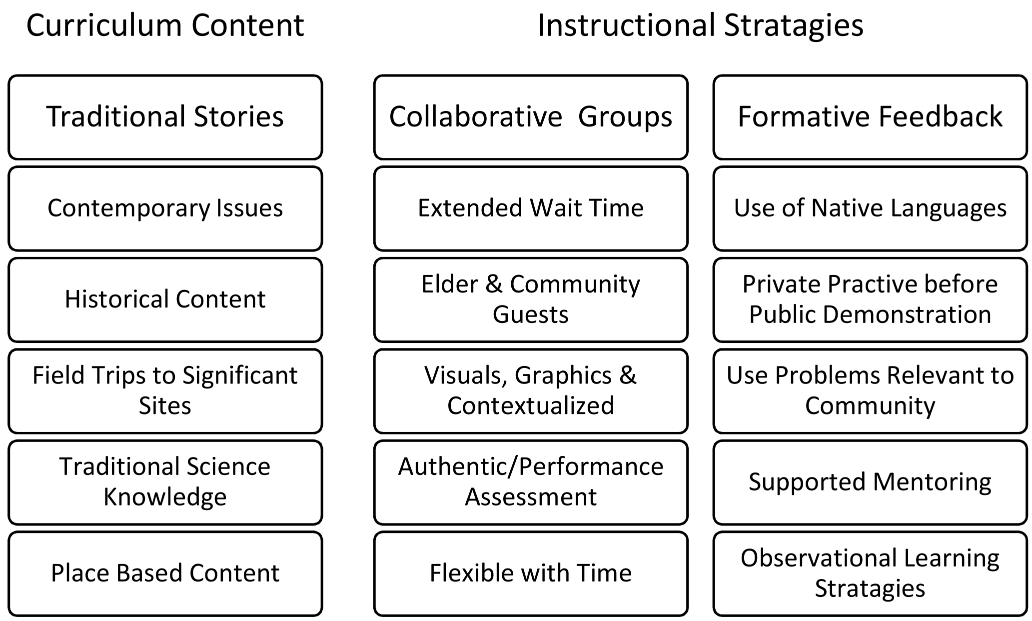

Figure 1. Summary of CCIS used for course modification (adapted from Sievert, 2014)

Theoretical Framework

Science has traditionally been taught with the expectation that students will comprehend and understand when teachers present content in a scientifically appropriate manner (Lee & Fradd, 1998). In the framework in Figure 1, the emphasis has been on the left side of the science graphic with little consideration to students' cultural understandings.

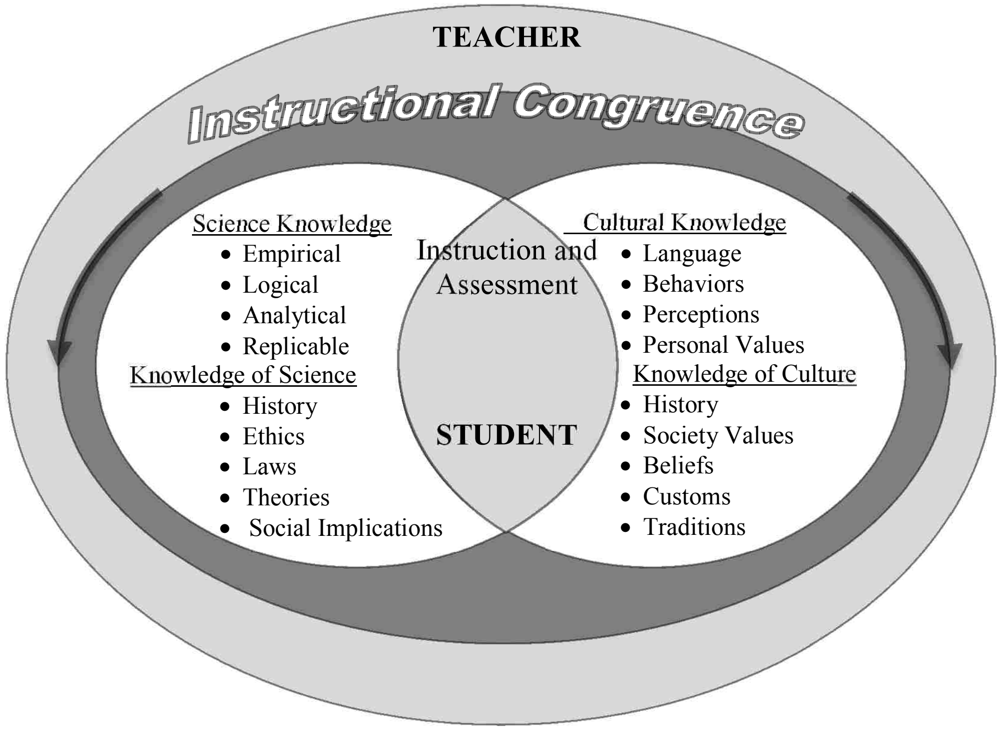

Figure 2. Conceptual framework for instructional congruence in science (adapted from Lee & Fradd, 1998)

This practice may account, in part, for the underrepresentation and alienation of diverse students in science. Research on cultural congruence indicates that when teachers and students share languages and cultures, they tend to develop congruent ways of communicating and sharing understandings (Au & Kawakimi, 1994; Trueba & Wright, 1992; Villegas, 1991). Although cultural congruence may be a critical initial step in promoting students' attention and engagement, the students may not learn science unless teachers also understand the nature of science and know how to guide the students in developing an understanding of science (Fradd & Lee, 1995).

The *nature of science* (NOS) is growing into an area of interest in the science education community primarily because an accurate understanding of NOS is crucial for science and science literacy (AAAS 1989; Matthews, 1994; McComas & Olson, 1998; NRC, 1996). In general, society's understanding of NOS is thought of as one of the most important components of scientific literacy because this knowledge is what citizens use when assessing public issues involving science and technology (Shamos, 1995). All teachers, especially at the primary school level, where students are introduced to scientific approaches, need to have a better understanding of the nature of science (AAAS, 1989). This is important because teachers bear the responsibility to introduce all young people to science. These early understandings play an important role in enticing students to pursue science as an educational endeavor (Clough, 2006). The participation of students in science is important in today's modern world as knowledge of scientists and how science works enhances understanding of the NOS as a human endeavor thus increasing interest in science and science classes; improving student learning of science content; and promoting better social decision-making (Matthews, 1994; McComas, Clough & Almazroa, 1998).

In the framework (Figure 1), cultural congruence typically stresses the right side of the science-culture graphic, where teachers and students interact based on shared languages and cultures without a particular focus on the nature of subject areas (Saunders, Goldenberg, & Hamann, 1992; Tharp & Gallimore, 19911; Tuyay, Jennings, & Dixon, 1995). To establish instructional congruence in science and cultural instruction, teachers need to know (a) who the students are, (b) how the students acquire and know culture, (c) what the nature of science is and what kinds of language and cultural experiences the students bring to the learning process, and (d) how to guide and enable the students to understand science. Through the combined understanding of culture and science, teachers can create a dynamic process that mutually supports both areas of learning (Fradd & Lee, 1997).

Guitiérrez and Rogoff (2003) defined culture as a dynamic repertoire of beliefs and practices developed through participation in a cultural community whose members span generations and share traditions and understandings that are based in the group's experiences. From this perspective, Western Science could be considered a culture itself, since it has its own set of norms, values, dispositions and behavioral expectations with the overarching objective of the accumulation of evidence for the production of scientific knowledge. To be successful in science, one is generally expected to understand and comply with the rules of the culture of Western Science, but for many students, particularly those of non-European descent, there is a pronounced cultural disconnect between Western Science and their home cultures (Aikenhead, 2001; Krogh & Thomsen, 2005; Taconis & Kessels, 2009). Aikenhead (1996), in his widely acclaimed work, emphasized the "need to recognize the inherent border crossings between students' life-world subcultures and the subculture of science…we need to develop curriculum and instruction with these border crossings explicitly in mind, before the science curriculum can be accessible to most students" (p. 2).

Phelan, Davidson, and Cao (1991) described four types of border crossings, Type I: Congruent Worlds/Smooth Transition, Type II: Different Worlds/Boundary Crossings Managed, Type III: Different Worlds/Boundary Crossings Hazardous and Type IV: Boundary Impenetrable/Boundary Crossings Insurmountable (see Figure 3).

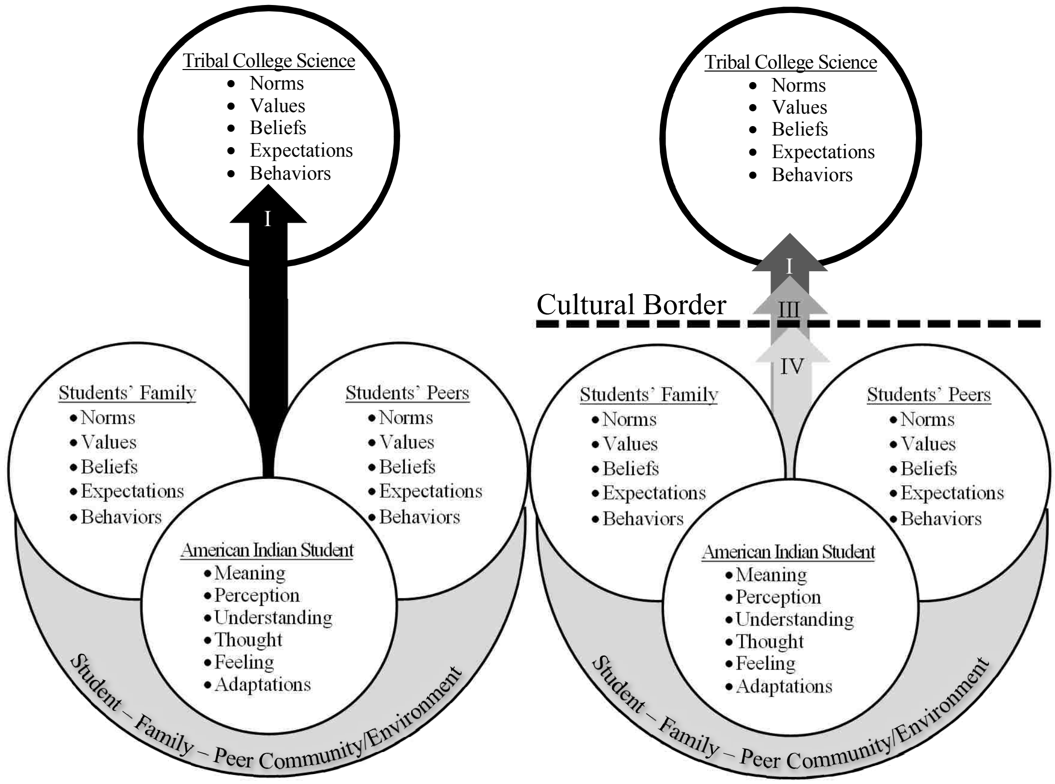

Figure 3. Conceptual model of American Indian student border crossings into tribal college science curriculum (adapted from Phelan et al., 1999)

Phelan et al. (1991) described a Type I crossing characteristic of students "values, beliefs, expectations and normative ways of behaving… for the most part, parallel across worlds." Students navigating this border crossing can do so unaided and with relatively little incongruence. Students experiencing a Type II crossing recognize that their family, peers and the educational institution are different and thus require added regulation of their own values and beliefs to align with the educational system. In the Type III crossing, like the Type II, students view the educational system as distinctly different. The difference between these two types are that the student may find transitioning between boundaries as hazardous, requiring special conditions in the "teacher's interaction style, the student's role, or the learning activity… similar to what takes place within the student's peer and/or family worlds"

(Phelan et al., 1991, p. 237).

Summary of the Literature Review

It is well documented that United States citizens who are members of ethnic minority groups are underrepresented in the STEM fields. According to the 2011 report, *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads*, ethnic minority students, who comprise 28.5 percent of the U.S. population, make up just 9.1 percent of STEM professionals (National Academy of Sciences, 2011). American Indians and Alaska Natives alone or in combination with another race constitute only 1.7% of the total U.S. population in 2010 or 5.2 million people (U.S. Census Bureau, 2013). However, American Indians and Alaska Natives only earned between 0.6 and 0.7 percent each of the S&E Bachelor's and Master's degrees awarded to U.S. citizens and permanent residents between 2001 and 2009 and, as of 2007, only 3.3 percent of American Indians and Alaska Natives who are at least 24 years of age held a degree in engineering or the natural sciences (National Science Foundation, 2009). While African American, Latino/a, and American Indian students aspire to attain STEM degrees at the same rate as White and Asian students, without considering gender differences, the on-time graduation rates of the former groups is much lower than that of the latter (National Academy of Sciences, 2011). These facts beg the question: What is happening before and during minority students' college careers that is impeding their graduation in S&E? Further, what can be done during their college careers to support underrepresented minorities in succeeding in S&E degree programs?

A number of factors have been hypothesized as influencing minority student success in STEM degrees, including the one addressed in this research study, the cultural congruency between students' home cultures and that of institutions of higher education, or IHEs. The American educational system is largely based on northern European values (Hollins, 2008; Singh, 2011), which can create a cultural divide for minority students as they encounter incongruencies, for example, between their own worldviews, epistemologies, values, and cultural norms with those of mainstream IHEs. The incongruencies may be even more pronounced in STEM programs, which tend to emphasize strict ways of thinking and behaviors characteristic of the Western Scientific paradigm that are often far removed from those of traditional American Indian cultures (Aikenhead & Michell, 2011; Cajete, 1999; Deloria & Wildcat, 2001). Cajete (1999) further explained, “Native science evolved in relationship to places and is therefore instilled with a ‘sense for place.’ Therefore, the first frame of reference for a Native science curriculum must be the ‘place of the community, its environment, its history and people.’ Native students must be made to feel that…science… is reflective of ‘their’ place” (p. 47). Additionally, Western Science tends to emphasize linear and objective thinking and the decontextualized examination of objects and phenomena to try and isolate them from variables that might influence their behavior or other outcomes. Many American Indian people, on the other hand, rather than decontextualizing events and objects and looking for straight-line chains of events, tend to emphasize a holistic or big picture perspective, in which everything is part of a larger whole. Intertwined events, cycles, and relationships within a system are considered integral to the character of the system, the individuals that comprise it and its manifestations.

Other examples of potential incongruities cited by scholars included:

- Western Science tends to prioritize accumulating knowledge for knowledge’s sake, while American Indian people tend to prioritize knowledge for its practical value to their community

- American Indian people may hold different ethical standards regarding the use of scientific knowledge than Western Science, which often seems to use knowledge simply because it can be used, without giving due consideration to whether it should be used
- Western Science tends to hold that everything is knowable and should be revealed, while American Indian people commonly accept that some things should remain unknown or known by a select few

In this research study, the researcher sought to study the nature and effects of some of the potential incongruities between students' home cultures and the cultures of IHEs on American Indian achievement in and attitude toward science, by transforming aspects of the college science curriculum to a more culturally congruent paradigm. Salish Kootenai College has a relatively large Environmental Science program that serves a substantial number of American Indian students. In collaboration between the SKC Natural Resource and Education faculty, selected parts of the science curriculum were revised to improve its "instructional congruency" (Lee & Fradd, 1998), and the impacts of these changes on student outcomes. Results were examined to determine how specific changes in curriculum correlated with changes in student achievement and attitudes toward science, and the nature of those changes. Findings were utilized to develop a model of instruction known as the Culturally Congruent Instructional Framework (or CCIF) that can be used more widely in tribal colleges and beyond, to improve American Indian achievement in STEM degree programs and, ideally, increase the representation of American Indian people in STEM professions.

Chapter III: Research Methodology

Research Design

This study utilized a mixed method, quasi-experimental design to assess changes in student attitude and achievement as a result of CCI treatment in selected Natural Resources courses at SKC. The research design determined the relationship among the variables contributing to the efficacy of CCI in the tribal college setting. Recommendation for a CCI framework that are effective at increasing students' achievement and attitude were developed from these data that may be transferable to other TCU's or other institutions serving minority populations. Quantitative data were gathered using a non-equivalent control group design (Gay, Mills & Airasian, 2012) where treatment and control groups were assigned from STEM courses offerings found in the SKC Natural Resources departments degree plan (Forestry, Hydrology and Wildlife/Fisheries). Qualitative data were gathered using a multiple case study design (Creswell, 2007). Among selected courses, particular treatment courses were highlighted using case studies to describe and intersect characteristics of CCI methods that contribute to positive and negative student attitude and achievement.

Treatment and control groups were selected from SKC's Natural Resource course offerings. Treatment courses were modified by the instructors using CCI methods to improve their cultural congruency (both content and pedagogy). Control groups were courses also found within SKC's Natural Resources Programs and taught by instructors that had not previously interacted or participated with the research project.

Student achievement data was collected for all students enrolled in each treatment and control course. The data was analyzed for differences in student achievement for treatment and control courses. Data types included quantitative data including individual grades on formative student course artifacts (quizzes, essays, labs, etc.) and summative student course artifacts (midterms, finals test, final presentations etc.).

In addition to achievement data, student attitude data was collected for all students enrolled in each treatment and control group. Survey instruments were used to evaluate changes in attitude and motivation. Surveys were given pre-treatment (during the first week of the course) and post-treatment (during the final week of the course) and then analyzed and compared to all student attitude data obtained for each course. Student attitude data were examined for correlations with specific aspects of course instruction.

Qualitative data were collected in treatment groups for case studies. These data included focus groups, instructor journals, and class observations. Focus groups were designed to probe student attitudes and reactions to instruction and content in the treatment courses. Instructor focus groups and journals were designed to characterize implementations of the CCI methods in the course and attitude and characterization of elements of the course due to the treatment. Additional detailed documentation of instruction was generated in the form of course syllabi and outlines; classroom observations of instruction was assessed utilizing the Reformed Teaching Observation Protocol (Sawada et al., 2002).

Population and Sample

The population targeted in this research was postsecondary tribal college students enrolled in Natural Resources Degree programs and cross-disciplinary programs in STEM. Included, were students enrolled in both associate and bachelor programs. The sample drew students from SKC's nine Associate of Science degree programs and 11 Bachelor of Science degree programs (Table 1). SKC served 855 students in the 2013-14 academic year. Of these students, 62% were enrolled tribal members. The remaining population included 22% non-Indian, 13% descendant of tribal groups, and 1% of Hispanic, Canadian First-Nations, Black and Asian. SKC American Indian students represented 65 different tribal groups from across the United Stated and Canada. Gender representation was 60% female and 40% male.

The sample included in this research included those students enrolled in the courses selected for modification and control group participants. Participants were notified of confidentiality of all data collected. Participants were also monetarily compensated ($30) for their time completing the survey and related focus groups sessions.

Course Selection

SKC Natural Resources Science faculty members played a central role in initiating and designing the course modifications. A team composed of SKC science faculty members, and science education researchers identified treatment and control courses and criteria. Faculty members made preliminary selections of STEM courses that met the criteria that could serve as treatment courses. Criteria for choosing courses for the research study included:

- courses are part of the Natural Resources Degree programs, represent multiple science disciplines, and at least 50% are representative of entry level courses,
- changes in treatment course content and instruction could be readily accomplished without imposing an "artificiality" on the course or omitting significant content and course objectives that existed prior to treatment
- there was ready access to baseline or "pre" student outcomes for the course that could then be compared to outcomes collected after the modified course had been taught

Table 1.
Salish Kootenai College Bachelor and Associate Degree Offerings in STEM Fields

Associate of Science Degree Programs	**Bachelor of Science Degree Programs**
Elementary Education	Computer Science
Environmental Science	Early Childhood Education
Forestry	Elementary Education
General Science	Forestry
Hydrology	Hydrology
Information Technology	Information Technology
Mathematical Science	Life Science
Nursing	Nursing
Wildlife and Fisheries	Secondary Mathematics Education
	Secondary Science Education
	Wildlife and Fisheries

Choices for modifications were made to enable a systematic study of specific elements of CCI, to optimize data collection, and to increase sample sizes for each treatment. The student to faculty ratio at SKC in 2013 was about 8:1 (SKC Fact Book, 2013). This small ratio is reflected in the small class sizes in most courses. Because of this, some courses were designed to employ the same CCI methods so that they could be combined as one treatment to allow for larger student sample sizes. As an incentive and recruitment strategy, instructors were compensated at a rate of $550 per credit hour for each course they chose to modify. The number of courses identified for treatment and control groups are summarized in Table 2.

Table 2.
Summary of Treatment and Control Courses from SKC Natural Resources Degree Plans

		SKC Natural Resources Degree Program – Course Year Designation			
Quarter	Treatment Course	Forestry	Hydrology	Wildlife & Fisheries	N_{avg}
Fall	GEOL 101/102 Physical Geology and Lab		2nd Year		10
Winter	SCID 114 Scientific Literature	1st Year	1st Year	1st Year	10
Winter	ENVS 203 Weather and Climate		3rd Year		8
Winter	BIOS 410 Conservation of Biodiversity	4th Year			7
				N_{total}	35
	Control Courses				
Fall	GEOG 201 GIS I	2nd Year	1st Year	3rd Year	10
Winter	CHEM 110/111 Fund. of Gen. Chemistry and Lab	2nd Year	1st Year	3rd Year	12
Winter	MATH 241 Statistics	1st Year	1st Year	3rd Year	15
				N_{total}	37

Course Modification

Selected SKC Natural Resource course modifications to improve cultural congruent instruction relied on faculty workshops and collaborative consultations. For the courses occurring in the Fall quarter, faculty from the selected courses met during the prior academic year summer break to initially discuss the research design and expectations for course modifications. A timeline for initial training and collaborative consultations was developed. Follow-up faculty face-to-face or electronic contact was initiated to gather pre-treatment course data from prior academic years. Efforts were made to conduct individual face-to-face faculty meetings four-weeks prior to the first week of instruction to identify CCI methods that could be applied without significantly changing the course content. Effort was made to provide follow-up meetings as needed, prior to the first week of instruction to address issues related to

CCI methods and arrange additional accommodations to ensure effective application of the methods. Once course instruction was initiated, efforts were made to provide two collaborative consultations to support the course instruction and address issues that arose in applying the CCI. An identical format was followed for identified Winter courses (Figure 4).

ACADEMIC YEAR 2015-2016 — Initial Faculty Workshop occurred on 10/16/14 and 3/18/15

	Sun	Mon	Tue	Wed	Thur	Fri	Sat	Treatment Course Activites	Control Course Activites
AUGUST							1		
	2	3	4	5	6	7	8		
	9	10	11	12	13	14	15		
	16	17	18	19	20	21	22		
	23	24	25	26	27	28	29		
SEPTEMBER	30	31	1	2	3	4	5		
	6	7	8	9	10	11	12		
	13	14	15	16	17	18	19	Training - GEOL	
	20	21	22	23	24	25	26	Training - GEOL	
FALL QTR	27	28	29	30	1	2	3	Pre-Survey - GEOL	Pre-Survey
OCTOBER	4	5	6	7	8	9	10		
	11	12	13	14	15	16	17	Training - ENVS & SCID	
	18	19	20	21	22	23	24		
	25	26	27	28	29	30	31	Consultation - GEOL	
NOVEMBER	1	2	3	4	5	6	7		
	8	9	10	11	12	13	14	Instructor Training - SCID	
	15	16	17	18	19	20	21		
	22	23	24	25	26	27	28		
DECEMBER	29	30	1	2	3	4	5	Instructor Training - SCID	
	6	7	8	9	10	11	12	Post-Survey & Focus Group - GEOL	Post-Survey & Focus Group
	13	14	15	16	17	18	19	Training - ENVS, BIOS & SCID	
	20	21	22	23	24	25	26	Training - ENVS	
JANUARY	27	28	29	30	31	1	2		
WINTER QTR	3	4	5	6	7	8	9	Pre-Survey - ENVS, BIOS & SCID	Pre-Survey
	10	11	12	13	14	15	16		
	17	18	19	20	21	22	23		
	24	25	26	27	28	29	30	Consultation - ENVS, BIOS & SCID	
FEBRUARY	31	1	2	3	4	5	6	Consultation - ENVS & SCID	
	7	8	9	10	11	12	13		
	14	15	16	17	18	19	20		
	21	22	23	24	25	26	27		
MARCH	28	29	1	2	3	4	5		
	6	7	8	9	10	11	12	Post-Survey & Focus Group -	
	13	14	15	16	17	18	19	ENVS, BIOS & SCID	Post-Survey & Focus Group
	20	21	22	23	24	25	26		
APRIL	27	28	29	30	31	1	2		
SPRING QTR	3	4	5	6	7	8	9		

Faculty Focus Group occurred on 3/17/17

Breaks/Student-Faculty Holidays (yellow)
First and Last Day of Instruction (red)

Figure 4. Schedule of research activities

Faculty workshop and training. An initial faculty workshop was conducted to orientate faculty on the research project and the CCI methods. All faculty from the Natural Resources department were provided a brief overview of the research, including the conceptual framework and justification. The workshop continued with consultation with faculty to assess the existing strategies in the courses they instructed. During this time, the workshop was used to gain an understanding of the nature of the courses intended for modification including the content and instructor pedagogical style. This information aided in targeting the CCI methods appropriate for the courses. Once these understandings were gained, the remaining portion of the workshop focused on selected CCI strategies that fit each course. Demonstrations and existing examples of CCI methods were provided from the researcher's experience and from work completed by the Big Sky Science Partnership's culturally congruent units (found at: http://cas.umt.edu/bssp/curriculumCultureResources/culturallyCongruentUnits.php)

Following the initial workshop, individualized training was conducted with instructors who volunteered to participate in the study (Table 2). The course schedule of each selected course was inspected to determine the logistics of using the CCI methods from Section 1 (Curriculum Content). Next, the instructor and the researcher discussed specific instructional strategies from Section 2 (Instructional Strategies) that could be realistically employed in the course. The nature of the individualized content and instruction varied with teacher experience, course content and CCI methods utilized.

Data Collection

All student data were anonymous and confidential, and stored in a secure database. The collection of curriculum artifacts that documented the nature of course instruction such as syllabi and course outlines was also securely stored. Quantitative data types included two validated survey instruments, one researcher developed survey, individual student summative grades (midterm and final tests), individual student formative grades (graded reports, essays, quizzes, activities) and student retention. Qualitative data types included information from the validated survey instruments, a researcher developed survey along with focus groups with students and faculty members, and observation of treatment course instruction.

Quantitative data. Student achievement artifacts from courses selected for CCI treatment were collected both pre- and post-treatment. Data types included quantitative scores for individual grades on affected student course artifacts (quizzes, midterms, final exams, essay assignments, presentations and laboratory worksheets).

Two validated instruments and one generated questionnaire were utilized to assess student attitude toward CCI in treatment courses. The Attitude Toward Science in School Assessment (ATSSA) and the Motivated Strategies for Learning Questionnaire (MSLQ) were used to develop a suitable survey (Appendix A).

The ATSSA, developed by Germann (1988) is a 14-item Likert type instrument used to evaluate the relationship between attitude and achievement in science (Germann, 1988). The 14 questions use a five-point Likert scale. Points are assigned for each response from one (strongly disagree) to five (strongly agree). Negative items are reverse coded providing a range from 14 to 70 for the total attitude score. A neutral choice (neither agree nor disagree) on every item results in a total attitude score on the survey of 42. Blalock et al. (2008) reported reliability estimates in the 0.90's with a factor analysis supporting a one-dimensional structure. The instrument was tested among 700 secondary students, for this study, some of the questions were reworded for clarity for postsecondary students. The Flesch Reading

Ease (Flesch, 1948) score after rewording was 77.8 representing text that potentially can be understood at a fifth to eighth grade level. The Flesch Kincaid Grade Level (Kincaid. Fishburne, Rogers, & Chissom, 1975) score was 4.5 reflecting a U.S. grade level of education of about fourth grade.

The MSLQ was initially developed in 1986 by the National Center for Research on Improving Postsecondary Teaching and Learning (McKeachie. Pintritch, Smith, & Lin, 1986). The complete 62-item questionnaire is a self-reported instrument designed to assess postsecondary students' motivational orientations and use of different learning strategies in college courses. Divided into two sections, 31 items assess student goals and value belief (Value Component), belief about their skill to succeed in a course (Expectancy Component), and anxiety about tests in a course (Affective Component). An additional 31 items target student learning strategies. Overall, there are fifteen different scales that may be used together or as a single module (Pintrich et al., 1991). To assess additional factors that may shape student attitude toward course treatments, this study utilized the value component and expectancy component modules consisting of 15 questions (Appendix A).

Furthermore, to understand students' perception of CCI methods and evaluate instructors' efficacy in implementing content and pedagogical modification an additional 22 Likert-type questions were developed. Question development considered course content, instruction and students' perception of the course as related to their future success in science. Nine questions were developed to target pedagogical implementation while nine questions targeted course content (Appendix A).

In addition to these data, demographic information was gathered from SKC's Office of Institutional Effectiveness. Demographic data of interest included participant age, gender, year in school, major, ethnicity, tribal affiliation, and hours completed per academic year. In compliance with the University of Montana (UM) and SKC's policy, since human subject were involved in this research, an application was submitted and approved through UM and SKC's Institutional Review Board (Appendix B).

Qualitative data. Focus groups, classroom observation and course artifacts were utilized in concert with elements of the quantitative data to develop descriptive characterization of student and teacher perceptions of the CCIS methods.

Focus groups were used to provide detailed descriptions of the course from the perspective of the students and the teachers. Student focus groups used open-ended interview question designed to narrow in on the CCIS methods used in the course. An emphasis on confidentiality was stressed to maintain candidness of responses. The primary focus of intended responses was directed toward the content and pedagogical changes and the students' perception of these in the course (Appendix C).

Instructor focus groups relied on open-ended interview questions. The primary focus of the intended response was directed toward understanding the instructors' perspective and challenged in implementing CCIS methods (Appendix C).

In addition to the focus groups, three observations of instruction for each treatment course (beginning, middle and end of the course) were performed. These observations used the Reformed Teaching Observation Protocol (RTOP) (Sawada, Piburn, Falconer, Turley, Benford, & Bloom, 2000) (Appendix D). The Reformed Teaching Observation Protocol originated from work by the Arizona Collaborative for Excellence in the Preparation of Teachers (ACEPT). Within the collaborative, the Evaluation Facilitation Group (EFG) developed a qualitative observational instrument designed to characterize any classroom on a quantitative scale of reform (Piburn &

Sawada, 2000).

To capture reformed teaching in the classroom, the RTOP uses 25 items divided into three subsets: Lesson Design and Implementation (5), Content (10), and Classroom Culture (10). The first subset "Lesson Design and Implementation" captures reformed teaching. The ACEPT model describes reformed teaching as having these elements: (a) recognition of students' prior knowledge and preconceptions; (b) engage students as members of a learning community; (c) values a variety of solutions to problems; and (d) course direction is taken from ideas generated by students. The subsets "Content" and "Classroom Culture" are further divided into two smaller groups of five. The subset "Content" is divided into the assessment of the quality of the content and the process of inquiry in the course. The final subset, "Classroom Culture," is divided into the instructor/students' communicative interactions in the classroom and instructor/students relationship (Piburn & Sawada 2000).

Data Analysis

Generally, each data type was aggregated and analyzed as a group. Data collected from the survey instruments were analyzed using the R 3.4.2 Statistical Computing Platform and Microsoft Excel 16.11.1. Descriptive statistics included measures of central tendency and frequency distributions for demographic data. Inferential statistics included between group comparisons with *t*-tests and ANOVAS. To test for the overall efficacy of CCIS, a series of *t*-tests were used to determine if there was a difference in mean scores for each student outcome data type pre- and post-treatment.

A multiple case study design (Creswell, 2007) was employed to gain more insight into students and faculty perceptions of CCI. Case studies were compiled for treatment and control courses. Case descriptions were constructed from focus groups, instructor focus group, surveys and instructor journals. For each case, focus group audio recordings were transcribed and subsequently coded for thematic analysis using NVivo 10 (QSR International, 2012). Then within-case analysis for each treatment and control course was followed by a thematic analysis across all cases. This cross-case analysis (Creswell, 1998; Yin, 2003) used the themes established in the within-case analysis to evaluate similar and dissimilar emergent themes across all cases. These categories for themes that cut across treatment and control cases and those that stood alone in the treatment course context helped to triangulate broader concepts found in the quantitative data.

Perspective of the Researcher

The researcher attended Salish Kootenai College as an undergraduate. At SKC he received a Bachelor of Science in Environmental Science and a Bachelor of Arts in Native American Human Services. Further, he received a Master of Science in Geology at the University of Montana.

Since 2006, the researcher has worked in some capacity at SKC. In 2006 to 2012 he worked as an adjunct faculty member in the Natural Resources programs. During this time, he co-developed the current associates and Bachelor's Hydrology degree program. From 2012 to present, the researcher has worked full-time providing instruction in primarily second and third year hydrology courses.

To support the mission of SKC, faculty are encouraged to address the 4C's (Communication, Cultural Competency, Citizenship, Critical Thinking) in their courses. Also, they "should be woven into the curriculum at all levels" (SKC 2013-14 Faculty Handbook, p. 17). To integrate culture competency into the curriculum, the faculty of SKC advised:

> As a tribal college, SKC emphasizes building cultural understanding of Native American histories, cultures, and languages. Additionally, the curriculum should focus on helping students identify how their own culture affects their values and assumptions. The learning environment includes activities that help students gain a deeper understanding, appreciation, and sensitivity toward the many cultures represented at SKC. (p. 17)

The researcher was raised on the Flathead Indian Reservation of the Confederated Salish and Kootenai Tribes and immersed in the culture of his Salish tribal group in Arlee, Montana. The researcher's mother is Salish from Arlee, Montana and his father is Navajo from BeshBihToh Valley, AZ. Due to blood quantum criteria for enrollment enacted by most tribal governments, the researcher is enrolled as a member of the Navajo Nation, lacking the blood quantum requirements for enrollment in the Confederated Salish and Kootenai Tribes. However, being raised on the Flathead Indian Reservation and primarily by his mother, the researcher identifies more closely with the Salish cultural worldview. This has developed in the researcher cultural knowledge that has aided in meeting the SKC mandate. Furthermore, the research has worked on other research projects related to developing cultural foundation in other courses.

The current research is part of a larger four-year National Science Foundation (NSF) funded project (NSF Award # 1249423). The genesis of the research question arrived from the researcher’s work with the Big Sky Science Partnership as a co-instructor for two years. In this capacity, the researcher contributed cultural content, science content and instruction for Flathead Indian Reservation public elementary and secondary school teachers as a part of a teacher training institute housed at SKC. During this time, the researcher became familiar with Dr. Regina Sievert’s work on a

Culturally Congruent Instruction Survey as a product of the partnership (Sievert, 2014). During the researcher's work with Dr. Sievert, the research questions were developed to test components of the CCI at the tribal college. The researcher took the lead on the research design for the final year of the NSF study that set much of the current research apart from the larger funded project. Primary responsibilities of the researcher were to collaborate with Dr. Sievert to assist in development and use of survey instruments, focus group protocol, instructor workshop training and all qualitative and quantitative data analysis. Dr. Sievert provided managerial and budgetary oversight over the project. Additionally, Dr. Sievert provided her expertise and oversite in classroom observations protocol and administration of surveys and focus groups.

Chapter IV: Results

The purpose of this mixed method, quasi-experimental design study was to assess changes in student attitude and achievement as a result of CCI treatment in selected Natural Resources courses at SKC. The research design intended to determine the relationship among the variables contributing to efficacy of CCI in the tribal college setting. Quantitative data were gathered using a non-equivalent control group design (Gay, 2012) where treatment and control groups were assigned from STEM courses offerings found in SKC Natural Resources departments degree plan (Forestry, Hydrology and Wildlife/Fisheries). Qualitative data were gathered using a multiple case study design (Creswell, 2007). Treatment courses were highlighted using case study design to describe and intersect characteristics of CCI methods that contributed to positive and negative student attitude and achievement.

Descriptive Statistics

There were 801 students enrolled at SKC during the Fall quarter of the 2015-16 Academic Year. Of these students, 57.8% were enrolled members of a federally recognized tribe and 15.23% were descendants of a federally recognized tribe. The treatment course sample size represented 4.2% of the total student population and 4.8% of the American Indian student population. In addition, the treatment group represented 40.0% of all students enrolled in the Natural Resources degree programs (Forestry, Hydrology and Wildlife/Fisheries). Additionally, the treatment courses comprised 97.1% STEM majors including 58.8% freshman and 23.5 % sophomores.

The control course sample size represented 6.6% of the student population and 22.7% of the students enrolled in programs that required the selected control courses as part of their degree plans. American Indian students in the control courses represented 7.3% of all American Indian students at SKC. The control course sample was comprised of 71.9% STEM majors, where 61.1% were freshman and 25.9% were sophomores. Table 3 summarizes the course participant demographics of this research.

Table 3.
Participant Demographics

Ethnicity	2015-16 Academic Year Treatment Course, *n=34*	2015-16 Academic Year Control Course *n=57*
American Indian	22	34
Non-American Indian	12	23
Gender		
Female	15	30
Male	19	24
Class		
Freshman	20	33
Sophomore	8	14
Junior	2	6
Senior	4	0
Age		
18-29	16	27
30-60	18	26
Ethnicity by Gender		
American Indian Female	9	18
American Indian Male	15	16
Non-American Indian Female	6	11
Non-American Indian Male	4	8
Control Course		
CHEM 110/111		15
MATH 241		20
GEOG 201		22
Treatment Course		
BIOS 410	8	
ENVS 203	5	
GEOL 101/102	8	
SCID 114	13	

Descriptions of Courses and Modification

Courses selected for treatment through modifications to improve CCI were drawn from SKC's Natural Resources programs. Selection of treatment courses was guided by consultation with Natural Resources faculty. Course selection was limited to those within the Natural Resources degree programs with consideration to represent multiple science disciplines, while maintaining at least 50% at the entry level. Other considerations were that the changes in treatment course content and instruction could be readily accomplished without imposing an “artificiality” on the course or omitting significant content and course objectives that existed prior to treatment. The final consideration was that access to student outcomes for the course could be easily collected after the modified course had been taught.

Control course selection, where no modifications were made, were also selected from SKC’s Natural Resources Programs and taught by instructors that had not previously interacted or participated with the research project. Similarly, courses selected were to represent multiple science disciplines while maintaining at least 50% at the entry level.

Treatment courses. Treatment courses were modified by the course instructors using CCIS methods to improve their cultural congruency (both content and pedagogy). A team composed of SKC science faculty members and science education researchers identified the following treatment courses from SKC’s Natural Resources degree programs.

Physical geology and laboratory. Physical Geology (GEOL 101/102) was an introduction to topics such as plate tectonics, mountain building, rock and mineral identification, earthquakes and volcanoes, glaciers, hydrology, weathering and erosion, geological dating techniques, and mineral and fossil fuel resources. The relationship between geology and tribal cultures is also explored. The Physical Geology Laboratory (GEOL 102) included practical exercises designed to complement the lecture. Field trips introduced students to local geological features such as glacial erosion and deposition, extinct volcanoes, billion-year-old sedimentary rocks, geologic structures, landslides, stream features, and mineral deposits. GEOL 101 is four-credit course that met two days per week for one hour and 50 minutes per class meeting. GEOL 102 is a one credit laboratory course that met one day per week for one hour and 50 minutes.

Prior to modification, the Physical Geology course content delivery mode was characterized by weekly lectures supplemented with textbook readings and short in-class discussions. Summative student assessment included a midterm and final examination. Formative assessment was provided for through participation in textbook readings and discussion. The Physical Geology Laboratory course content delivery mode was characterized by a series of weekly in-class laboratory activities and one field trip or case study exploration depending on weather. Summative assessment included a final examination, while formative assessment was provided thought completion of weekly laboratory activities.

After consultation with the instructor, the course was modified to include elements of CCI. The lecture and laboratory course schedules were altered to allow for the inclusion of additional field trips to locations on the Flathead Indian Reservation (CCIS Section 1.4). Care was taken to better align lecture and laboratory activities. Primarily lectures focused on a geological concept for the first week of class followed by a field trip to a location that exemplified this concept and had significant connection to a traditional story, contemporary issues or historical contexts related to the Salish and/or Kootenai Tribes (CCIS Section 1.6). The laboratory section complimented the field trip by aligning its activities to further explore the location visited and the geological concept it exemplified. An example included moving a lecture focusing on glacier and glacier processes from the end of the course to the second third of the class, so a second field trip could be included in the class schedule that examined the themes of glaciers, structure, and earthquakes. To further bolster CCIS, the field trip was planned to be led by a tribal professional (CCIS Section 2.11). Following completion of this change, a new laboratory midterm was added that allowed for additional assessment of the fundamental concepts of geologic time, minerals, rocks, and plate tectonics.

Additional modifications were made to increase formative assessment of student learning and to provide additional feedback to the students. As a part of this effort, students were asked to send in weekly email reflections to the instructor concerning their challenges, conceptual connections they related to, overall thoughts on instruction, and cultural content directly or indirectly explored. The instructor then responded to these reflections to address issues and misconceptions (CCIS Section 2.14). Also, a laboratory day was designed to give the students practice time and review for the final comprehensive laboratory examination (CCIS Section 2.17) that required them to construct a geologic map and cross section using rocks set up in the laboratory that approximated a hypothetical situation that a geologist might encounter in the real world (CCIS Section 2.13).

In addition to the opportunity for students to engage in practice before demonstrating their proficiency, summative assessments were also modified. Selected questions on the midterm and final examinations were modified to contextualize the course content to enhance assessment of student learning. The characteristic feature of the exams prior to modification were largely questions and short answer format. To contextualize these assessments, some questions were changed to include sketching or graphing exercises to demonstrate student understanding (CCIS Section 2.12). Lectures, labsoratory activites, and field trips also added materials that enhanced the concept of place for each concept taught (CCIS Section 1.6).

Scientific literature. Scientific literature (SCID 114) is a survey of resource-related journals and the scientific writing style that is used to report the results of scientific research. In the course, students learn to access, read and critically interpret the literature of science. In addition, students develop essential skills for writing in scientific style. SCID is a three-credit course that met two days per week for one hour and 20 minutes per class meeting.

Prior to modification, the Scientific Literature course content delivery mode was characterized by weekly lectures supplemented with short research article readings. There were no summative student assessments for this course. Formative assessment types included quizzes and writing assignments throughout the quarter.

After consultation with the instructor, the course was modified to include elements of CCI. The assessment was modified to include a poster session complementing the addition of a synthesis paper (CCIS Section 2.12 and 2.13). This modification provided for an authentic assessment, or performance-based assessment of the students' learned skills in the course.

The course schedule was modified to include collaborative student group discovery activities (CCIS Section 2.8) employed to foster student understanding of different scientific writings followed by lectures that confirmed the students' discoveries. Previously, the lectures occurred prior to the collaborative student group work. Observational learning strategies (e.g., adult or peer modeling, demonstrations, apprenticeships) were also included to provide guidance in choosing a topic for the final synthesis paper. The instructor provided a model of papers she authored with annotations describing how resources were located to complete the writing (CCIS Section 2.21). Another component of this addition to the course was scheduling student peer reviews of the papers to demonstrate the writing and review process (CCIS Section 2.21). Additional modifications included an invitation of a tribal elder or member of one of the Culture Committees to talk about how scientific knowledge was shared in traditional settings (CCIS Section 1.5 and 2.11). The instructor also replaced existing scientific readings with ones that were clearly relevant to local or regional needs and those that included Native American perspectives or sources (CCIS Section 1.2).

Weather and climate. Weather and Climate (ENVS 203) provides a comprehensive survey of topics related to the study of weather and climate, with primary focus on the earth's energy balance, the role of moisture in the atmosphere, cloud development, formation of frontal systems, severe storms, climatic change and the impact of climatic variations on society. In this course, students learn the use of on-line information and resources about weather and climate. ENVS 203 is three-credit course that met two days per week for one hour and 20 minutes per class meeting.

Prior to modification, the Weather and Climate course content delivery mode was characterized by weekly lectures, supplemented with short research articles and textbook readings. Summative student assessment included a comprehensive final examination. Formative assessment for this course consisted of weekly discussions of reading material and short in-class activities.

After consultation with the instructor, the course was modified to include elements of CCI. Many lectures were replaced with opportunities that provided formative feedback and observational learning strategies, while using issues that were relevant to the local community. Examples of local climate change response served as a platform for student-led discussions (CCIS Section 1.6, 2.8 and 2.18) and concept mapping exercises (CCIS Section 2.12). Topics such as albedo and carbon cycling were then used to springboard to larger formative activities that promoted the use of the information gained in the discussions. The Stabilization Wedge game (Pacala & Socolow, 2004) was utilized to bring these ideas together, while allowing the students to devise solutions to climate change in the local community (CCIS Section 2.18).

Students were also tasked with peer teaching a section of the textbook in consultation with the instructor (CCIS Section 2.10 and 2.13). Another element that invited tribal community and professionals into the classroom, while highlighting problems relevant to the community, was the convening of a tribal climate change panel session (CCIS Section 1.5, 2.11 and 2.18). In this session, students heard first-hand accounts of the Tribe's natural resource and policy professional response to climate change. Students engaged in this forum by devising questions prior to the forum.

Conservation of biodiversity. Conservation of Biodiversity (BIOS 410) introduces the concepts and methods of preserving biological diversity in the Northern Rocky Mountains. The course emphasis is placed on rare and endangered species, methods of preserving ecosystems, and conservation issues on American Indian Reservations. BIOS 410 is three-credit course that met two days per week for one hour and 20 minutes per class meeting.

Prior to modification, the Conservation of Biodiversity course content delivery mode was characterized by weekly lectures supplemented with short research article and textbook readings. Summative student assessment included two written assignments, a final poster presentation, midterm and a comprehensive final examination. Formative assessment for this course consisted of weekly discussions of reading material.

After consultation with the instructor, the course was modified to include elements of CCI. To increase formative feedback several in-class activities were developed in conjunction with specific reading activities linked to an online question and answer forum. Discussions and activities were used to help bring relevancy of global topics to local and cultural conservation issues allowing for deeper connection to issues of local concern (CCIS Section 1.2, 1.6 and 2.18). A field trip was planned (CCIS Section 1.4) and a a guest speaker was scheduled to visit the class to provide additional historical content and significance to local places on the reservation (CCIS Section 1.3 and 2.11). Short videos on biocultural diversity and diversity issues relevant to Native American tribes (CCIS Section 2.18) were also included. To further an understanding of the student perception of the course and to provide flexibility in course content and delivery, a class observation journal was maintained that could inform how lectures could be updated to include more local and culturally relevant materials and student insights (CCIS Section 2.22). In response to weekly student progress being monitored, the course content, activities and examinations were adapted throughout the course, based on the needs and interests of the students (CCIS Section 2.10).

Summative assessment types were modified to compliment these changes. Two examinations were prepared using short answer and essay questions to assess students' understanding of the topics and critical thinking skills (CCIS Section 2.14). In addition, students were required to complete an essay and create an informational bulletin or poster on a conservation topic of their choice (CCIS Section 2.12, 2.13 and 2.18).

Control courses. Control groups were comprised of courses found within SKC's Natural Resources Programs and taught by instructors that did not interact or participate with the research project. A team composed of SKC science faculty members and science education researchers identified the following control courses from SKC's Natural Resources degree programs. Care was taken to ensure that the control courses represented multiple science disciplines and at least 50% are representative of entry level courses.

Fundamentals of general chemistry and laboratory. The lecture course (CHEM 110) instructs students in the basic concepts of general chemistry, with special emphasis on its fundamental principles and laws. Biological applications, although not a primary focus, are integrated throughout. The complementary laboratory section (CHEM 111) provides an inquiry-based, small scale approach to introductory laboratory experiences corresponding to concepts discussed in the lectures. CHEM 110 is four-credit course that met two days per week for one hour and 50 minutes per class meeting. CHEM 111 is a one-credit laboratory course that met one day per week for one hour and 50 minutes.

The Fundamentals of General Chemistry course content delivery mode was characterized by weekly lectures supplemented with textbook readings. Summative student assessment included a comprehensive final examination. Formative assessment was provided by weekly homework assignments and quizzes. The Fundamentals of General Chemistry Laboratory course content delivery mode was characterized by a series of weekly in-class lab activities. There were no summative assessment opportunities, yet formative assessment was provided through completion of weekly lab and pre-lab activities.

Statistics. Statistics (MATH 241) consists of an introductory survey of probability models, sampling, and statistical inference. The course uses examples drawn from biological and social sciences. MATH 241 is a five-credit course that met two days per week for two hours and 20 minutes per class meeting.

The Statistics course content delivery mode was characterized by weekly lectures supplemented with textbook readings. The course also utilizes base groups that are comprised of four to five students that are responsible for recording their attendance, collecting and distributing group's assignments, completing quizzes, and working together on group classroom activities.

Summative student assessment included a midterm and final examination. Formative assessment for this course consisted of 10 practice problem sets, 20 class activities, and 10 readiness assessment process quizzes.

GIS I. This course (GEOG 201) is an introduction to the science of spatial information and the use of Geographic Information System (GIS) software. The course includes a brief background session in geography and GIS, as well as an introduction to the ArcGIS software package. Topics also include spatial awareness, cartography, spatial data structure, Global Positioning System (GPS) for GIS, spatial analysis, spatial data sources, and legal issues associated with GIS. GEOG 201 is a three-credit course that met two days per week for two hours and 20 minutes per class meeting.

The GIS I course content delivery mode is characterized by weekly lectures on one day of instruction followed with guided textbook tutorials in the ArcGIS environment on the next day of instructions. The course also performs one field exercise to collect GPS data.

Summative student assessment included a final project and exam. Formative assessment for this course consisted of quizzes, short in-class assignments and lab reports.

Survey Data Analysis

Two validated instruments and one generated questionnaire were utilized to assess (Q1) *How CCI influences American Indian students' attitudes and achievement in Natural Resources science at a tribally controlled college?* The Attitude Toward

Science in School Assessment (ATSSA), the Motivated Strategies for Learning Questionnaire (MSLQ) and a 22 question Likert-type questionnaire were administered during the first week of course instruction, and again during the last week of instruction for treatment and control courses.

The following section summarizes statistical analysis results for the instruments and questionnaire for the pre- and post-treatment and control groups. The summary reports two-way analysis of variance on composite post course scores for ATSSA, MSLQ and the 22 question Likert-type questionnaire. This is followed by a two-way analysis of variance on individual scales in post course scores for MSLQ and the 22 question Likert-type questionnaire. Finally, a series of *t*-tests were conducted to determine if there was a difference in mean scores for individuals question in the ATSSA, MSLQ and the CCI (22 question Likert-type questionnaire) for pre/post treatment while comparing with the control group.

ATSSA. The ATSSA, developed by Germann (1988) is a 14-item Likert type instrument used to evaluate the relationship between attitude and achievement in science (Germann, 1988). Blalock, Lichtenstein, Owen, Pruski, Marshall, and Toepperwein (2008) reported reliability estimates in the 0.90's with a factor analysis supporting a one-dimensional structure. The instrument was tested among 700 secondary students, for this study, some of the questions were reworded for clarity and use with postsecondary students (Appendix A).

Post ATSSA composite scores were subjected to a two-way analysis of variance having two levels of instruction (Control, Treatment) and two levels of students' ethnicity (AI-American Indian, NAI-Non-American Indian) (Figure 5). The main effect instruction was statistically significant at the .05 significance level. The main effect of instruction yielded an F-ratio of $F(1, 52) = 22.497$, $p < .000$, $\eta_p^2 = 0.30$, indicating that the mean ATSSA Composite score was significantly greater in the Treatment group (M = 61.31, SD = 7.24) than for the Control Group (M = 49.15, SD = 11.10). The main effect of student ethnicity effect was non-significant, F(1, 52) = 0.694, p > .05. The interaction effect was also non-significant, F(1, 52) = 0.017, p > .05.

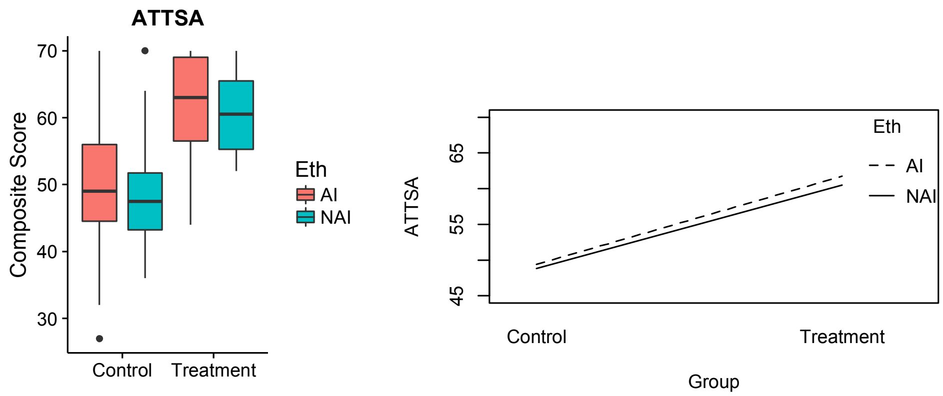

Figure 5. Box and interception plot showing mean Post ATSSA scores for control and treatment groups distinguishing between American Indian and non-American Indian students

Pre/Post Treatment course ATSSA composite scores were also subjected to a two-way analysis of variance having two levels of Time (PreTest, PostTest) and two levels of students' ethnicity (AI-American Indian, N-AI-Non-American Indian). The main effect of time and student ethnicity were non-significant, F(1, 59) = 0.012, p > .05 and F(1, 59) = 0.014, p > .05 respectively. The interaction effect was also non-significant, F(1, 59) = 0.426, p > .05.

Pre/Post Treatment and Control course ATSSA composite scores for individual questions were subjected to independent-samples *t*-test. Table 4 shows *t*-test results comparing the equality of mean ATSSA scores for pre- and post-surveys for all students in treatment courses and control courses. In the treatment courses, there was a significant difference in the means from pre/post responses for question #28 (p=0.03).

Table 4.
t-test Results Comparing Pre- and PostATSSA Survey Responses for All Students in Treatment and Control Groups. Also, t-test Results Comparing Pre- and Post-ATSSA Survey Responses for All Students in Treatment and Control Groups by Survey Question

Treatment Group (n=34)						Control Group (n=57)						
Pre-Survey		Post-Survey				Pre-Survey		Post-Survey				
M	SD	M	SD	Δ Mean	p-value	M	SD	M	SD	Δ Mean	p-value	
61.53	8.24	61.31	7.24	-0.22	0.46	50.04	11.86	49.15	11.10	-0.89	0.37	
M	SD	M	SD	Δ Mean	p-value	M	SD	M	SD	Δ Mean	p-value	Q #
4.56	0.61	4.66	0.48	0.10	0.25	3.96	1.09	4.00	1.00	0.04	0.44	24
4.47	0.90	4.59	0.57	0.12	0.27	3.39	1.35	2.65	1.35	-0.73	***0.01***	25
4.38	0.60	4.39	0.74	0.01	0.48	3.89	0.98	4.07	0.92	0.18	0.21	26
4.29	0.84	4.55	0.57	0.26	0.08	3.61	1.09	3.81	1.04	0.21	0.21	27
4.09	1.14	3.46	1.45	-0.62	***0.03***	2.98	1.36	3.15	1.32	0.17	0.30	28
4.53	0.56	4.59	0.63	0.06	0.35	3.86	0.96	3.93	1.07	0.07	0.38	29
4.15	0.89	4.07	1.16	-0.08	0.38	3.26	1.34	2.65	1.23	-0.61	***0.03***	30
4.62	0.55	4.52	0.63	-0.10	0.25	3.95	0.93	4.04	0.98	0.09	0.34	31
4.50	0.71	4.48	0.63	-0.02	0.46	3.84	1.00	3.85	1.06	0.01	0.48	32
4.35	0.69	4.55	0.51	0.20	0.10	3.27	1.38	3.00	1.44	-0.27	0.21	33
4.59	0.61	4.48	0.57	-0.11	0.24	3.68	1.12	3.85	1.03	0.17	0.26	34
4.38	0.78	4.31	0.71	-0.07	0.35	3.56	1.15	3.74	1.06	0.18	0.25	35
4.32	0.73	4.38	0.62	0.06	0.37	3.75	1.11	3.85	0.99	0.10	0.35	36
4.29	0.84	4.55	0.57	0.26	0.08	3.46	1.32	2.85	1.43	-0.61	***0.03***	37

Note: M=Mean. SD=Standard Deviation. ATSSA question responses range from 1 to 5 where 1= Strongly disagree, 2 = Disagree, 3 = Neutral/No Opinion, 4 = Agree and 5 = Strongly Agree
**Significance at p<0.05 are bold and italicized*

The mean score for questions #28, “If I knew that I would never take another science course again, I would feel sad,” decreased in the treatment group. In the control group, there was a significant difference in the means from pre- and post-responses for three questions, #’s 25, 30 and 37 (p=0.01, 0.03 & 0.03 respectively). The mean scores for questions #25, “I do not like science and it bothers me to have to study it,” #30, “Science makes me feel uncomfortable, irritable, restless, and impatient” and #37, “Science is boring” decreased. Since these question responses were inversed for scoring computation, the decrease reflects an increase toward agreement with the statements.

Table 5 shows *t*-test results comparing the equality of mean ATSSA scores for pre-surveys responses between treatment and control groups and mean ATSSA scores for post-surveys responses between treatment and control groups for all students. There was a significant difference in the means comparing pre-survey responses between treatment and control groups for all questions (p=0.00). The difference in the mean are all positive, indicating that the treatment groups all tended to agree significantly more with all questions than the control group prior to the initiation of the course. When comparing the post-survey responses between treatment and control groups, there were significant differences in the means comparing post-survey responses between treatment and control groups for all questions beside #'s 26 and #28 (p=0.08, 0.021 respectively). The mean scores for questions #26, "During science class, I am usually interested" and #28, "If I knew that I would never take another science course again, I would feel sad" were not significantly different. The difference in the mean for all remaining questions were positive, indicating that the treatment group continued to agree more significantly with the questions than the control group at course completion.

Table 5.

t-test Results Comparing Student ATSSA Survey Responses in Pre-Treatment Pre-Control and Post-Treatment Post-Control Groups

Treatment Group (n=34)		Control Group (n=57)				Treatment Group (n=34)		Control Group (n=57)				
Pre-Survey		Pre-Survey				Post-Survey		Post-Survey				
M	SD	M	SD	Δ Mean	p-value	M	SD	M	SD	Δ Mean	p-value	Q #
4.56	0.61	3.96	1.09	0.59	***0.00***	4.66	0.48	4.00	1.00	0.66	***0.00***	24
4.47	0.90	3.39	1.35	1.08	***0.00***	4.59	0.57	2.65	1.35	1.93	***0.00***	25
4.38	0.60	3.89	0.98	0.49	***0.00***	4.39	0.74	4.07	0.92	0.32	0.08	26
4.29	0.84	3.61	1.09	0.69	***0.00***	4.55	0.57	3.81	1.04	0.74	***0.00***	27
4.09	1.14	2.98	1.36	1.11	***0.00***	3.46	1.45	3.15	1.32	0.31	0.21	28
4.53	0.56	3.86	0.96	0.67	***0.00***	4.59	0.63	3.93	1.07	0.66	***0.00***	29
4.15	0.89	3.26	1.34	0.88	***0.00***	4.07	1.16	2.65	1.23	1.42	***0.00***	30
4.62	0.55	3.95	0.93	0.67	***0.00***	4.52	0.63	4.04	0.98	0.48	***0.02***	31
4.50	0.71	3.84	1.00	0.66	***0.00***	4.48	0.63	3.85	1.06	0.63	***0.01***	32
4.35	0.69	3.27	1.38	1.09	***0.00***	4.55	0.51	3.00	1.44	1.55	***0.00***	33
4.59	0.61	3.68	1.12	0.90	***0.00***	4.48	0.57	3.85	1.03	0.63	***0.00***	34
4.38	0.78	3.56	1.15	0.82	***0.00***	4.31	0.71	3.74	1.06	0.57	***0.01***	35
4.32	0.73	3.75	1.11	0.57	***0.00***	4.38	0.62	3.85	0.99	0.53	***0.01***	36
4.29	0.84	3.46	1.32	0.83	***0.00***	4.55	0.57	2.85	1.43	1.70	***0.00***	37

Note: M=Mean. SD=Standard Deviation. ATSSA question responses range from 1 to 5 where 1= Strongly disagree, 2 = Disagree, 3 = Neutral/No Opinion, 4 = Agree and 5 = Strongly Agree
**Significance at $p<0.05$ are bold and italicized*

Table 6 shows *t*-test results comparing the equality of mean American Indian (AI) and Non-American Indian (N-AI) students ATSSA pre-survey and post-survey responses in treatment groups. There was no significant difference in the means comparing pre-survey and post-survey responses between American Indian (AI) and Non-American Indian (N-AI) students for all questions. The difference in the mean between AI and N-AI students' pre-survey responses are mostly positive, indicating that N-AI scored slightly higher across most questions. The difference in the mean between AI and N-AI students' post-survey responses were negative for question #'s 24, 25, 27, 28, 29, 30 and 33 indicating that AI scored slightly higher than their N-AI students after course completion.

Table 6.
t-test Results Comparing American Indian (AI) and Non-American Indian (N-AI) ATSSA Pre-Survey and Post-Survey Responses in Treatment Groups

AI Treatment (n=22)		N-AI Treatment (n=11)				AI Treatment (n=19)		N-AI Treatment (n=10)				
Pre-Survey		Pre-Survey				Post-Survey		Post-Survey				
M	SD	M	SD	Δ Mean	p-value	M	SD	M	SD	Δ Mean	p-value	Q #
4.45	0.67	4.73	0.47	0.27	0.12	4.68	0.47	4.56	0.53	-0.13	0.26	24
4.36	0.99	4.64	0.67	0.27	0.21	4.68	0.49	4.44	0.73	-0.24	0.15	25
4.41	0.65	4.45	0.52	0.05	0.42	4.39	0.83	4.44	0.53	0.06	0.43	26
4.23	0.85	4.45	0.82	0.23	0.24	4.58	0.60	4.44	0.53	-0.13	0.29	27
4.00	1.11	4.36	1.21	0.36	0.20	3.58	1.35	3.13	1.73	-0.45	0.24	28
4.50	0.59	4.64	0.50	0.14	0.26	4.63	0.68	4.56	0.53	-0.08	0.39	29
4.18	0.87	4.18	0.98	0.00	0.50	4.26	1.02	3.67	1.41	-0.60	0.11	30
4.59	0.59	4.73	0.47	0.14	0.25	4.47	0.69	4.56	0.53	0.08	0.38	31
4.50	0.79	4.64	0.50	0.14	0.29	4.47	0.69	4.56	0.53	0.08	0.38	32
4.32	0.63	4.45	0.82	0.14	0.30	4.58	0.51	4.56	0.53	-0.02	0.46	33
4.50	0.67	4.82	0.40	0.32	0.05	4.47	0.60	4.56	0.53	0.08	0.37	34
4.36	0.83	4.45	0.69	0.09	0.38	4.32	0.73	4.33	0.71	0.02	0.48	35
4.27	0.75	4.45	0.69	0.18	0.26	4.32	0.66	4.56	0.53	0.24	0.18	36
4.32	0.88	4.27	0.79	-0.05	0.44	4.53	0.61	4.67	0.50	0.14	0.28	37

Note: M=Mean. SD=Standard Deviation. ATSSA question responses range from 1 to 5 where 1= Strongly disagree, 2 = Disagree, 3 = Neutral/No Opinion, 4 = Agree and 5 = Strongly Agree
**Significance at p<0.05 are bold and italicized*

Table 7 shows *t*-test results comparing the equality of mean ATSSA scores for pre-survey and post-survey responses for AI students in treatment and control groups. There was no significant difference in the means comparing pre-survey and post-survey responses among American Indian (AI) students for all questions in the treatment group, suggesting that these students did not agree significantly more or less than any questions after completion of the treatment course. There was one question that indicated a significant difference in the means when comparing pre-survey and post-survey responses between American Indian (AI) students in the control group. In the control courses among American Indian (AI) students, there was a significant difference in the means from pre- and post- responses for question #25 (p=0.01). The difference in the mean for questions #25, “I do not like science and it bothers me to have to study it,” was negative in the control group. Since this question response was inversed for scoring computation, the decrease in mean scores reflects an increase toward agreement with the statement after completion of the control course.

Table 7.
t-test Results Comparing ATSSA Pre-Survey and Post-Survey Responses for American Indian (AI) Students in Treatment and Control Groups. Also, t-test Results Comparing Pre- and Post-ATSSA Survey Responses for American Indian (AI) in Treatment and Control Groups

AI Treatment Group						AI Control Group						
(n=22)		(n=19)				(n=34)		(n=15)				
Pre-Survey		Post-Survey				Pre-Survey		Post-Survey				
M	SD	M	SD	Δ Mean	p-value	M	SD	M	SD	Δ Mean	p-value	
61.00	8.66	61.74	7.65	0.74	0.737	48.27	12.55	51.13	13.42	2.87	0.237	
M	SD	M	SD	Δ Mean	p-value	M	SD	M	SD	Δ Mean	p-value	Q #
4.45	0.67	4.68	0.47	0.23	0.11	3.79	1.12	4.07	1.03	0.27	0.21	24
4.36	0.99	4.68	0.49	0.32	0.11	3.38	1.33	2.43	1.34	-0.95	***0.01***	25
4.41	0.65	4.39	0.83	-0.02	0.46	3.76	1.02	4.07	1.10	0.30	0.18	26
4.23	0.85	4.58	0.60	0.35	0.07	3.36	1.06	3.87	1.06	0.50	0.07	27
4.00	1.11	3.58	1.35	-0.42	0.14	2.76	1.41	3.14	1.41	0.39	0.20	28
4.50	0.59	4.63	0.68	0.13	0.26	3.71	1.03	4.07	1.10	0.36	0.14	29
4.18	0.87	4.26	1.02	0.08	0.39	3.09	1.33	2.64	1.45	-0.45	0.16	30
4.59	0.59	4.47	0.69	-0.12	0.28	3.91	0.97	4.07	1.16	0.15	0.31	31
4.50	0.79	4.47	0.69	-0.03	0.45	3.71	1.06	3.87	1.19	0.16	0.32	32
4.32	0.63	4.58	0.51	0.26	0.08	3.18	1.33	3.00	1.51	-0.18	0.34	33
4.50	0.67	4.47	0.60	-0.03	0.45	3.53	1.13	4.00	1.07	0.47	0.09	34
4.36	0.83	4.32	0.73	-0.05	0.43	3.44	1.19	3.87	1.06	0.43	0.12	35
4.27	0.75	4.32	0.66	0.04	0.43	3.62	1.16	4.00	0.93	0.38	0.13	36
4.32	0.88	4.53	0.61	0.21	0.20	3.39	1.32	2.87	1.55	-0.53	0.12	37

Note: M=Mean. SD=Standard Deviation. ATSSA question responses range from 1 to 5 where 1= Strongly disagree, 2 = Disagree, 3 = Neutral/No Opinion, 4 = Agree and 5 = Strongly Agree
**Significance at p<0.05 are bold and italicized*

MSLQ. The Motivated Strategies for Learning Questionnaire (MSLQ) was initially developed in 1986 by the National Center for Research on Improving Postsecondary Teaching and Learning (McKeachie et al., 1986). The complete 62-item questionnaire is a self-reported instrument designed to assess post-secondary students' motivational orientations and use of different learning strategies in college courses. The MSLQ is divided into three sections, 31 items assess student goals and value beliefs (Value Component), belief about their skill to succeed in a course (Expectancy Component) and anxiety about tests in a course (Affective Component). The MSLQ is comprised of fifteen different scales that may be used together or as a single module (Pintrich et al., 1991). To assess students' attitude toward course treatments, this study utilized the value component and expectancy component modules consisting of 15 questions (Appendix A).

The MSLQ Value component, “Goal Orientation” (#’s 38 - 41), assesses students’ perception of the purpose for engaging in the learning tasks in a course. Pintrich et al. (1991) described goal orientation as a student's general goals or orientation to the course as a whole. Intrinsic goal orientation concerns the degree to which students perceives themselves to be participating in a task for reasons such as challenge, curiosity, mastery. Having an intrinsic goal orientation towards an academic task indicates that the student's participation in the task is an “…end all to itself, rather than participation being a means to an end” (p. 9).

The MSLQ Value component, “Task Value” (#’s 42 - 46), offers an evaluation of students’ perception of course material in terms of interest, importance, and utility of a course based on how interesting, important, and useful the tasks are throughout the course. Pintrich et al. (1991) differentiated,

> Goal orientation refers to the reasons why the student is participating in the task ("Why am I doing this?"). High task value should lead to more involvement in one's learning. On the MSLQ, task value refers to students' perceptions of the course material in terms of interest, importance and utility. (p. 11)

The MSLQ Expectancy component, “Self-Efficacy for Learning and Performance” (#’s 47 - 52), provides an evaluation of students' expectancy, based on two scales. Pintrich et al. (1991) explained,

> The items comprising this scale assess two aspects of expectancy: expectancy for success and self-efficacy. Expectancy for success refers to performance

expectations and relates specifically to task performance. Self-efficacy is a self-appraisal of one's ability to master a task. Self-efficacy includes judgments about one's ability to accomplish a task as well as one's confidence in one's skills to perform that task. (p. 13)

Post MSLQ composite scores were subjected to a two-way analysis of variance having two levels of instruction (Control, Treatment) and two levels of students' ethnicity (AI-American Indian, N-AI-Non-American Indian) (Figure 6).

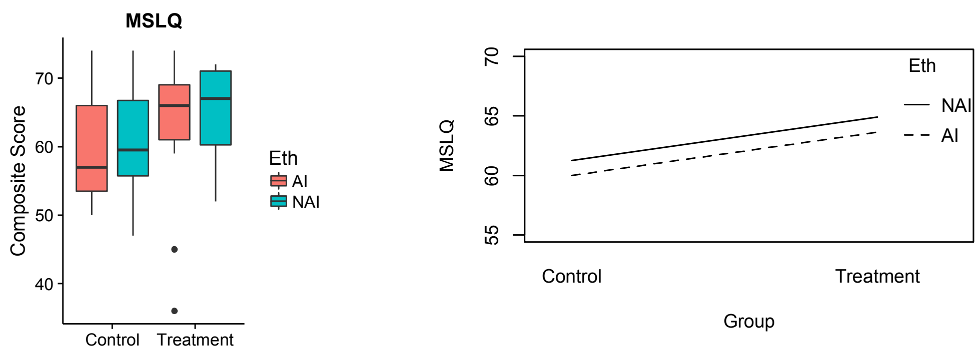

Figure 6. Box and interaction plot showing mean Post MSLQ scores for control and treatment groups distinguishing between American Indian and Non-American Indian students

The main effect of instruction and student ethnicity were non-significant where $F(1, 52) = 2.540$, $p > .05$ and $F(1, 52) = 0.143$, $p > .05$ respectively. The interaction effect was also non-significant, $F(1, 52) = 0.000$, $p > .05$.

Individual post-MSLQ scale composite scores were also subjected to a two-way analysis of variance having two levels of instruction (Control, Treatment) and two levels of students' ethnicity (AI-American Indian, NAI-Non-American Indian) (Figure 7).

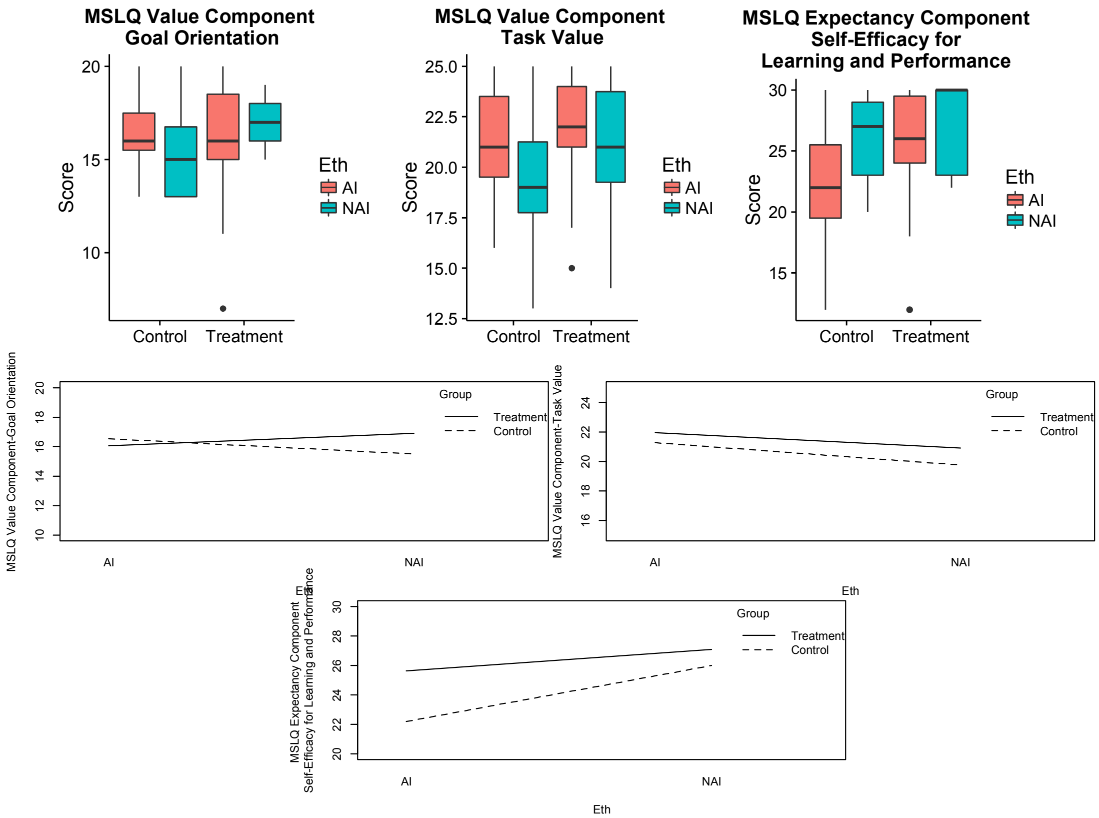

Figure 7. Box and interaction plot showing mean Post-MSLQ subscale scores for control and treatment groups distinguishing between American Indian and Non-American Indian students

The MSLQ Value Component-Goal Orientation scale did not exhibit a significant main effect for instruction or student ethnicity where $F(1, 52) = 0.138$, $p > .05$ and $F(1, 52) = 0.032$, $p > .05$ respectively. The interaction effect was also non-significant, $F(1, 52) = 1.714$, $p > .05$. The MSLQ Value Component-Task Value scale did not exhibit a significant main effect for instruction or student ethnicity where $F(1, 52) = 1.059$, $p > .05$ and $F(1, 52) = 2.577$, $p > .05$ respectively. The interaction effect was also non-significant, $F(1, 52) = 0.074$, $p > .05$. The MSLQ Expectancy Component-Self Efficacy for Learning and Performance scale did not exhibit a significant main effect for student ethnicity $F(1, 52) = 3.912$, $p > .05$. The main effect of instruction yielded an F ratio of $F(1, 52) = 4.507$, $p = .0385$, $\eta_p^2 = 0.08$, indicating that the mean MSLQ Expectancy Component-Self Efficacy for Learning and Performance scale was significantly greater in the Treatment Group (M = 26.12, SD = 4.36) than for the Control Group (M = 23.89, SD = 4.74). The interaction effect was non-significant, $F(1, 52) = 0.927$, $p > .05$.

Pre/PostTreatment course MSLQ composite scores were subjected to a two-way analysis of variance having two levels of Time (PreTest, PostTest) and two levels of students' ethnicity (AI-American Indian, N-AI-Non-American Indian). The main effect of time and student ethnicity were non-significant, $F(1, 59) = 0.020$, $p > .05$ and $F(1, 59) = 0.883$, $p > .05$ respectively. The interaction effect was also non-significant, $F(1, 59) = 0.102$, $p > .05$

Individual pre/post MSLQ scale composite scores were also subjected to a two-way analysis of variance having two levels of time (PreTest, PostTest) and two levels of students' ethnicity (AI-American Indian, N-AI-Non-American Indian). The MSLQ Value Component-Goal Orientation scale did not exhibit a significant main effect for time or student ethnicity where $F(1, 59) = 0.033$, $p > .05$ and $F(1, 59) = 3.157$, $p > .05$ respectively. The interaction effect was also non-significant, $F(1, 59) = 0.212$, $p > .05$. The MSLQ Value Component-Task Value scale did not exhibit a significant main effect for time or student ethnicity where $F(1, 59) = 0.069$, $p > .05$ and $F(1, 59) = 0.016$, $p > .05$ respectively. The interaction effect was also non-significant, $F(1, 59) = 0.212$, $p > .05$. The MSLQ Expectancy Component-Self Efficacy for Learning and Performance scale did not exhibit a significant main effect for time or student ethnicity where $F(1, 59) = 0.042$, $p > .05$ and $F(1, 59) = 0.790$, $p > .05$ respectively. The interaction effect was also non-significant, $F(1, 59) = 0.223$, $p > .05$.

Pre/Post Treatment and Control course MSLQ composite scores for individual questions were subjected to independent-sample *t*-test. Table 8 shows *t*-test results comparing the equality of mean MSLQ scores for pre- and post-surveys for all students in treatment courses and control courses. In the treatment courses, there was no significant difference in the means from pre- and post-responses for all questions. In the control group, there was a significant difference in the means from pre/post responses for question #41 (p=0.02). The mean scores for questions #41, "In a course like this, I prefer assignments that I can learn from even if they don't guarantee a good grade" increased from pre/post responses.

Table 8.
t-test Results Comparing Pre- and Post-MSLQ Survey Responses for All Students in Treatment and Control Groups

Treatment Group (n=34)						Control Group (n=57)						
Pre-Survey		Post-Survey				Pre-Survey		Post-Survey				
M	SD	M	SD	Δ Mean	p-value	M	SD	M	SD	Δ Mean	p-value	Q #
4.29	0.76	4.29	0.71	-0.01	0.48	3.95	0.85	3.96	0.76	0.02	0.47	38
4.38	0.65	4.38	0.73	0.00	0.49	4.05	0.79	4.07	0.68	0.02	0.45	39
4.12	0.69	3.90	0.88	-0.22	0.13	4.07	0.86	4.11	0.80	0.04	0.42	40
3.68	0.88	3.93	0.86	0.25	0.12	3.49	0.97	3.93	0.78	0.43	***0.02***	41
4.39	0.61	4.62	0.58	0.22	0.08	4.28	0.73	4.19	0.88	-0.10	0.30	42
4.47	0.61	4.48	0.64	0.01	0.47	4.37	0.72	4.44	0.58	0.08	0.32	43
4.18	0.72	4.28	0.66	0.10	0.28	3.96	0.78	3.89	0.80	-0.08	0.34	44
4.03	0.76	4.24	0.80	0.21	0.14	3.81	0.83	3.89	0.80	0.08	0.34	45
4.44	0.70	4.45	0.74	0.01	0.48	4.09	0.81	4.19	0.83	0.10	0.31	46
4.47	0.56	4.41	0.79	-0.06	0.37	4.19	0.79	4.07	0.87	-0.12	0.27	47
4.18	0.77	4.28	0.89	0.09	0.33	3.79	0.86	3.81	0.88	0.03	0.45	48
4.38	0.70	4.48	0.74	0.10	0.29	4.18	0.66	4.26	0.76	0.08	0.30	49
4.47	0.56	4.41	0.79	-0.06	0.37	4.18	0.80	4.00	0.83	-0.18	0.18	50
4.24	0.70	4.24	0.83	0.01	0.49	3.98	0.83	3.89	1.01	-0.09	0.33	51

Note: M=Mean. SD=Standard Deviation. MSLQ question responses range from 1 to 5 where 1= Strongly disagree, 2 = Disagree, 3 = Neutral/No Opinion, 4 = Agree and 5 = Strongly Agree (Questions comprising MSLQ Scales are delineated with dashed line)
**Significance at p<0.05 are bold and italicized*

Table 9 shows *t*-test results comparing the equality of mean MSLQ scores for pre-survey responses between treatment and control groups, and mean MSLQ scores for post-survey responses between treatment and control groups for all students. There was a significant difference in the means comparing pre-survey responses between treatment and control groups for question #'s 38, 39, 46, 47, 48 and 50 (p=0.03, 0.02, 0.04, 0.02, 0.03 respectively). The difference in the means were all positive, indicating that the treatment groups all tended to agree significantly more with all questions than the control group prior to the initiation of the course. When comparing the post-survey responses between treatment and control groups, there were significant differences in the mean for question #'s 42, 48 and 50 (p=0.02, 0.03, 0.03 respectively). The mean scores in the treatment group's post survey responses were greater than the control group's post-survey responses for questions #42, "I think I will be able to use what I learn in this course in other courses", #48, "I am certain that I can understand the most difficult material in this course" and #50, "I expect to do well in this class." This indicates that the treatment group agreed more significantly with the questions then the control group at course completion.

Table 9.
t-test Results Comparing Student MSLQ Survey Responses in Pre-Treatment Pre-Control and Post-Treatment Post-Control Groups

Treatment Group (n=34) Pre-Survey		Control Group (n=57) Pre-Survey				Treatment Group (n=34) Post-Survey		Control Group (n=57) Post-Survey				
M	SD	M	SD	Δ Mean	p-value	M	SD	M	SD	Δ Mean	p-value	Q #
4.29	0.76	3.95	0.85	0.35	***0.03***	4.29	0.71	3.96	0.76	0.32	0.05	38
4.38	0.65	4.05	0.79	0.33	***0.02***	4.38	0.73	4.07	0.68	0.31	0.06	39
4.12	0.69	4.07	0.86	0.05	0.39	3.90	0.88	4.11	0.80	-0.21	0.17	40
3.68	0.88	3.49	0.97	0.19	0.18	3.93	0.86	3.93	0.78	0.01	0.49	41
4.39	0.61	4.28	0.73	0.11	0.23	4.62	0.58	4.19	0.88	0.43	***0.02***	42
4.47	0.61	4.37	0.72	0.10	0.25	4.48	0.64	4.44	0.58	0.04	0.41	43
4.18	0.72	3.96	0.78	0.21	0.10	4.28	0.66	3.89	0.80	0.39	***0.03***	44
4.03	0.76	3.81	0.83	0.22	0.10	4.24	0.80	3.89	0.80	0.35	0.05	45
4.44	0.70	4.09	0.81	0.35	***0.02***	4.45	0.74	4.19	0.83	0.26	0.11	46
4.47	0.56	4.19	0.79	0.28	***0.04***	4.41	0.79	4.07	0.87	0.34	0.07	47
4.18	0.77	3.79	0.86	0.39	***0.02***	4.28	0.89	3.81	0.88	0.46	***0.03***	48
4.38	0.70	4.18	0.66	0.21	0.08	4.48	0.74	4.26	0.76	0.22	0.14	49
4.47	0.56	4.18	0.80	0.30	***0.03***	4.41	0.79	4.00	0.83	0.41	***0.03***	50
4.24	0.70	3.98	0.83	0.25	0.07	4.24	0.83	3.89	1.01	0.35	0.08	51
4.32	0.73	4.16	0.82	0.17	0.17	4.31	0.76	3.85	0.91	0.46	***0.02***	52

Note: M=Mean. SD=Standard Deviation. MSLQ question responses range from 1 to 5 where 1= Strongly disagree, 2 = Disagree, 3 = Neutral/No Opinion, 4 = Agree and 5 = Strongly Agree (Questions comprising MSLQ Scales are delineated with dashed line)
**Significance at p<0.05 are bold and italicized*

Table 10 shows *t*-test results comparing the equality of mean American Indian (AI) and Non-American Indian (N-AI) students' MSLQ pre- and post-survey responses in treatment groups. There was a significant difference in the means comparing pre-survey responses between American Indian (AI) and Non-American Indian (N-AI) students for question #'s 38, 41 and 52 (p=0.04, 0.04 and 0.05 respectively). The difference in the mean between AI and N-AI students pre-survey responses for these questions are negative indicating that N-AI students agreed more strongly for these questions prior to the course. There was a significant difference in the means comparing post-survey responses between American Indian (AI) and Non-American Indian (N-AI) students for question #39 (p=0.01). The difference in the mean between AI and N-AI students' post-survey responses for questions #39, "In a course like this, I prefer material that arouses my curiosity even if it is difficult to learn," are negative, indicating that N-AI students agreed more strongly for these questions after course completion.

Table 10.
t-test Results Comparing American Indian (AI) and Non-American Indian (N-AI) MSLQ Pre-Survey and Post-Survey Responses in Treatment Groups

AI Treatment (n=22) Pre-Survey		N-AI Treatment (n=11) Pre-Survey				AI Treatment (n=19) Post-Survey		N-AI Treatment (n=10) Post-Survey				
M	SD	M	SD	Δ Mean	p-value	M	SD	M	SD	Δ Mean	p-value	Q #
4.14	0.81	4.64	0.50	-0.50	***0.04***	4.17	0.76	4.56	0.53	-0.39	0.10	38
4.27	0.69	4.64	0.50	0.20	0.07	4.21	0.77	4.78	0.50	-0.57	***0.01***	39
4.00	0.60	4.36	0.81	-0.36	0.08	4.00	0.86	3.67	0.87	0.33	0.18	40
3.55	0.99	4.00	0.45	-0.45	***0.04***	3.89	0.91	4.00	0.71	-0.11	0.38	41
4.33	0.65	4.55	0.52	-0.21	0.18	4.65	0.61	4.56	0.53	0.09	0.35	42
4.36	0.65	4.73	0.47	-0.36	0.06	4.47	0.61	4.44	0.73	0.03	0.46	43
4.27	0.62	4.00	0.89	0.27	0.16	4.42	0.60	4.00	0.71	0.42	0.06	44
3.95	0.82	4.18	0.60	-0.23	0.22	4.37	0.67	4.00	1.00	0.37	0.13	45
4.41	0.71	4.64	0.67	-0.23	0.18	4.53	0.60	4.22	0.93	0.30	0.20	46
4.45	0.51	4.55	0.69	-0.09	0.34	4.32	0.86	4.67	0.53	-0.35	0.14	47
4.09	0.73	4.40	0.84	-0.31	0.15	4.26	0.89	4.44	0.87	-0.18	0.31	48
4.36	0.57	4.45	0.93	-0.09	0.39	4.42	0.82	4.67	0.53	-0.25	0.21	49
4.45	0.51	4.55	0.69	-0.09	0.34	4.32	0.86	4.67	0.53	-0.35	0.14	50
4.23	0.74	4.27	0.65	-0.05	0.43	4.16	0.81	4.44	0.87	-0.29	0.21	51
4.18	0.78	4.64	0.50	-0.45	***0.05***	4.16	0.81	4.67	0.53	-0.51	0.05	52

Note: M=Mean. SD=Standard Deviation. MLSQ question responses range from 1 to 5 where 1= Strongly disagree, 2 = Disagree, 3 = Neutral/No Opinion, 4 = Agree and 5 = Strongly Agree (Questions comprising MSLQ Scales are delineated with dashed line)
**Significance at p<0.05 are bold and italicized*

Table 11 shows *t*-test results comparing the equality of mean MSLQ scores for pre- and post-survey responses for AI students in treatment and control groups. In the treatment courses among American Indian (AI) students, there was a significant difference in the means from pre- and post-responses for question #45 (p=0.05). The difference in the mean for questions #45, "I like the subject matter of this course," was positive, suggesting that AI students agreed significantly more with this statement after completion of the treatment course. In the control courses among AI students, there was a significant difference in the means from pre- and post-responses for question #'s 40, 41, 43 and 46 (p=0.01 for all questions). The difference in the mean for these questions were all positive indicating that AI students agreed significantly more with these statements after completion of the control course.

Table 11.
t-test Results Comparing MSLQ Pre-Survey and Post-Survey Responses for American Indian (AI) Students in Treatment and Control Groups

AI Treatment Group						AI Control Group						
(n=22)		(n=19)				(n=34)		(n=15)				
Pre-Survey		Post-Survey				Pre-Survey		Post-Survey				
M	SD	M	SD	Δ Mean	p-value	M	SD	M	SD	Δ Mean	p-value	Q #
4.14	0.81	4.17	0.76	0.03	0.45	4.00	0.82	4.20	0.68	0.20	0.21	38
4.27	0.69	4.21	0.77	-0.06	0.40	4.12	0.77	4.27	0.59	0.15	0.25	39
4.00	0.60	4.00	0.86	0.00	0.50	4.00	0.98	4.53	0.64	0.53	***0.01***	40
3.55	0.99	3.89	0.91	0.35	0.13	3.65	1.01	4.20	0.56	0.55	***0.01***	41
4.33	0.65	4.65	0.61	0.31	0.07	4.06	0.78	4.40	0.74	0.34	0.08	42
4.36	0.65	4.47	0.61	0.11	0.29	4.24	0.78	4.67	0.49	0.43	***0.01***	43
4.27	0.62	4.42	0.60	0.15	0.22	3.79	0.81	4.07	0.80	0.27	0.14	44
3.95	0.82	4.37	0.67	0.41	***0.05***	3.68	0.88	3.93	0.88	0.26	0.18	45
4.41	0.71	4.53	0.60	0.12	0.28	4.09	0.87	4.60	0.51	0.51	***0.01***	46
4.45	0.51	4.32	0.86	-0.14	0.27	4.03	0.87	3.80	1.01	-0.23	0.21	47
4.09	0.73	4.26	0.89	0.17	0.25	3.71	0.91	3.80	1.01	0.09	0.37	48
4.36	0.57	4.42	0.82	0.06	0.40	4.12	0.77	4.20	0.86	0.08	0.37	49
4.45	0.51	4.32	0.86	-0.14	0.27	4.15	0.93	3.80	0.94	-0.35	0.12	50
4.23	0.74	4.16	0.81	-0.07	0.39	4.00	0.89	3.67	1.18	-0.33	0.14	51
4.18	0.78	4.16	0.81	-0.02	0.46	4.00	0.92	3.67	0.98	-0.33	0.13	52

Note: M=Mean. SD=Standard Deviation. MSLQ question responses range from 1 to 5 where 1= Strongly disagree, 2 = Disagree, 3 = Neutral/No Opinion, 4 = Agree and 5 = Strongly Agree (Questions comprising MSLQ Scales are delineated with dashed line)
**Significance at p<0.05 are bold and italicized*

CCI. Twenty-two Likert-type questions were developed to understand students' perception of CCI strategies prior to course treatment and as an evaluation of instructors' efficacy in implementing content and pedagogical modification. Question development considered course content, instruction and students' perception of the course as related to their future success in science. Nine questions (#'s 1 - 3, 12 - 14, and 20 - 22) were developed to target pedagogical implementation of the CCIS, nine questions (#'s 4 – 11 and 15) targeted CCIS course content and four questions (#'s 16 – 19) targeted students' perception of the course's CCIS as they related to their future success in science (Appendix A).

Post CCI scaled composite scores were subjected to a two-way analysis of variance having two levels of instruction (Control, Treatment) and two levels of students' ethnicity (AI-American Indian, N-AI-Non-American Indian) (Figure 8). The main effect of instruction and student ethnicity were non-significant where $F(1, 52) = 3.392$, $p > .05$ and $F(1, 52) = 0.020$, $p > .05$ respectively. The interaction effect was also non-significant, $F(1, 52) = 0.000$, $p > .05$.

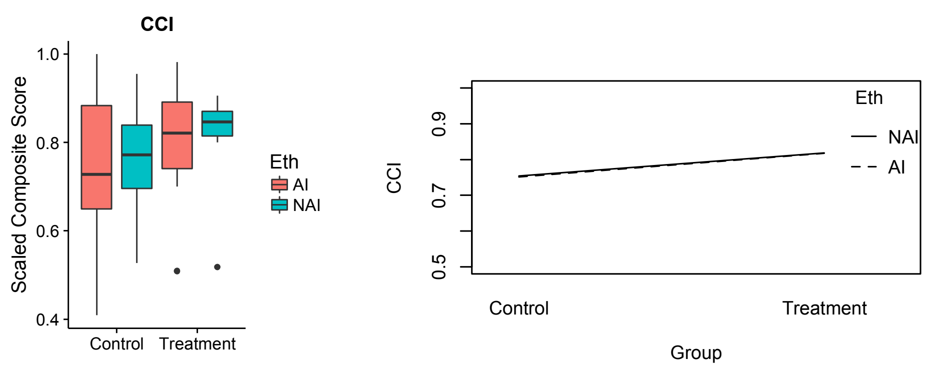

Figure 8. Box and interaction plot showing mean Post-CCI scores for control and treatment groups distinguishing between American Indian (AI) and Non-American Indian (N-AI) students

Pre- Post-Treatment course CCI composite scores were also subjected to a two-way analysis of variance having two levels of Time (PreTest, PostTest) and two levels of students' ethnicity (AI-American Indian, N-AI-Non-American Indian). The main effect of time and student ethnicity were non-significant, $F(1, 59) = 0.011$, $p > .05$ and $F(1, 59) = 0.107$, $p > .05$ respectively. The interaction effect was also non-significant, $F(1, 59) = 0.115$, $p > .05$.

Individual pre- and post-CCI scale composite scores were also subjected to a two-way analysis of variance having two levels of time (PreTest, PostTest) and two levels of students' ethnicity (AI-American Indian, N-AI-Non-American Indian) (Figure 9). The CCI Course Content scale did not exhibit a significant main effect for time or student ethnicity where $F(1, 59) = 2.051$, $p > .05$ and $F(1, 59) = 0.254$, $p > .05$ respectively. The interaction effect was also non-significant, $F(1, 59) = 0.128$, $p > .05$. The CCI Instruction scale did not exhibit a significant main effect for time or student ethnicity where $F(1, 59) = 1.476$, $p > .05$ and $F(1, 59) = 0.042$, $p > .05$ respectively. The interaction effect was also non-significant, $F(1, 59) = 0.102$, $p > .05$. The CCI Future Success in Science scale did not exhibit a significant main effect for time or student ethnicity where $F(1, 59) = 0.223$, $p > .05$ and $F(1, 59) = 0.054$, $p > .05$ respectively. The interaction effect was also non-significant, $F(1, 59) = 0.010$, $p > .05$. Pre- and Post-treatment and control course CCI composite scores for individual questions were subjected to independent-samples *t*-tests.

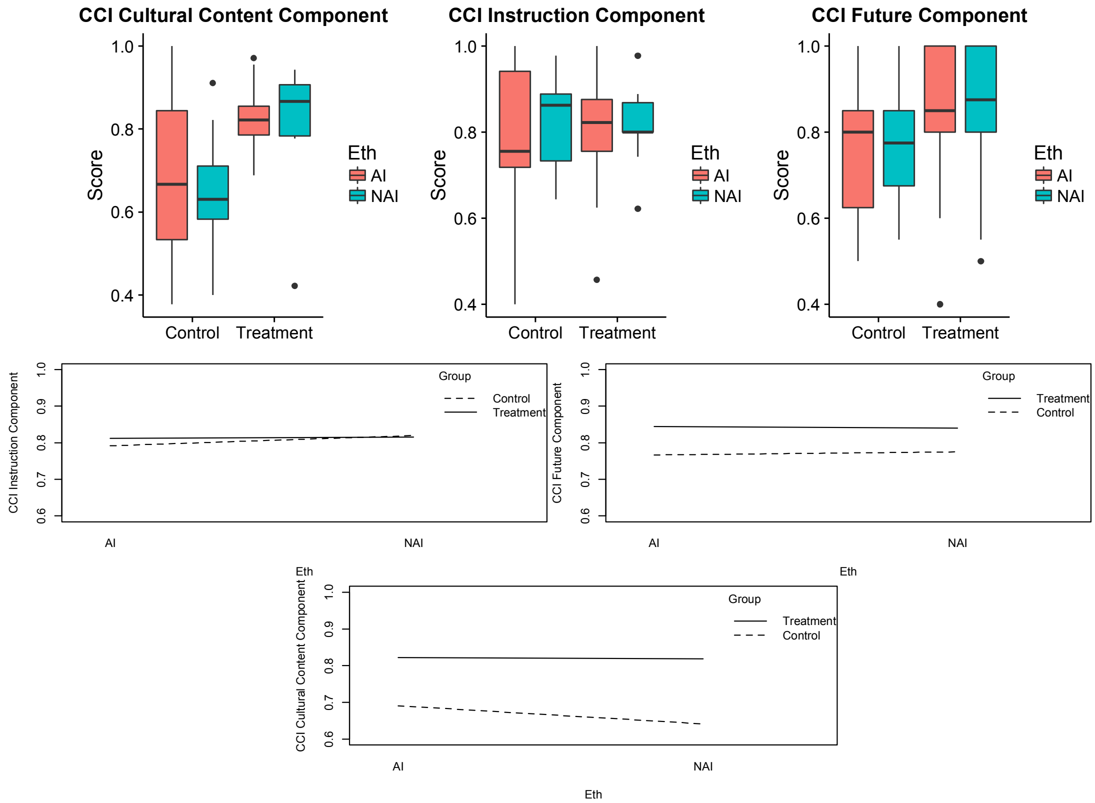

Figure 9. Box and interaction plot showing mean Post-CCI subscale scores for control and treatment groups distinguishing between American Indian (AI) and Non-American Indian (NAI) students

Table 12 shows *t*-test results comparing the equality of mean CCI scores for pre- and post- surveys for all students in treatment courses and control courses. In the treatment courses, there was significant differences in the means from pre- and post- responses for question #'s 22, 4, 9, 18 and 19 (p-value = 0.03, 0.01, 0.00, 0.01 and 0.03 respectively). The difference in the mean for question #'s 22 ("The use of Native languages in the course would help me to grasp concepts we study"), #4 ("Collaborating with other students on course activities/assignments improved my understanding of the concepts in this course"), #18 ("This course increased my interest in pursuing a science related degree"), and #19 ("This course increased my interest in pursuing a science profession") are positive, indicating that the treatment groups all tended to agree significantly more with these statements after course completion. The difference in the mean for question #9 (“Timely feedback from the instructor on my progress in the course improved my learning.”) is negative, indicating that the treatment group tended to agree significantly less with this statements after course completion.

In the control group, there was a significant difference in the means from pre- and post-responses for question #’s 2, 3, 8 and 11 (p-value = 0.01, 0.03, 0.03 and 0.02 respectively). The mean scores for these questions were all negative, indicating that the control group tended to agree significantly less with these statements after course completion.

Table 12.
t-test Results Comparing Pre- and Post-CCI Survey Responses for All Students in Treatment and Control Groups

Treatment Group (n=34)						Control Group (n=57)						
Pre-Survey		Post-Survey				Pre-Survey		Post-Survey				
M	SD	M	SD	Δ Mean	p-value	M	SD	M	SD	Δ Mean	p-value	Q #
4.15	0.78	4.17	0.85	0.03	0.45	3.65	0.89	3.27	1.15	-0.39	0.05	1
4.24	0.65	4.34	0.77	0.11	0.27	4.09	0.77	3.63	1.01	-0.46	***0.01***	2
4.21	0.77	4.43	0.79	0.22	0.13	4.05	0.91	3.62	1.13	-0.44	***0.03***	3
4.15	0.71	4.15	0.72	0.00	0.49	3.79	1.12	3.57	1.08	-0.23	0.21	12
4.19	0.82	4.48	0.58	0.29	0.06	3.85	1.11	3.70	1.06	-0.16	0.28	13
4.13	0.79	3.83	0.83	-0.30	0.09	3.72	1.17	4.71	1.34	1.00	0.15	14
4.06	0.81	3.92	0.88	-0.14	0.26	3.69	0.95	3.40	0.88	-0.29	0.12	20
3.21	0.98	3.50	0.71	0.29	0.13	2.98	1.19	3.05	1.20	0.07	0.41	21
2.94	0.81	3.41	0.80	0.47	***0.03***	2.92	1.14	2.90	1.14	-0.02	0.47	22
4.00	0.82	4.48	0.63	0.48	***0.01***	4.16	0.84	4.19	0.96	0.03	0.45	4
4.06	0.74	3.79	1.03	-0.27	0.12	3.89	0.98	3.81	0.88	-0.08	0.36	5
3.97	0.80	4.00	0.89	0.03	0.45	3.93	0.90	3.67	1.07	-0.26	0.12	6
4.09	0.83	4.28	0.88	0.19	0.19	4.07	0.86	4.15	0.77	0.08	0.35	7
4.06	0.83	3.81	0.87	-0.25	0.15	3.79	0.90	3.30	1.26	-0.49	***0.03***	8
4.44	0.70	3.66	1.20	-0.79	***0.00***	4.45	0.66	4.19	0.88	-0.26	0.07	9
4.62	0.49	4.46	0.58	-0.15	0.13	4.45	0.81	4.41	0.93	-0.04	0.42	10
4.50	0.71	4.28	0.75	-0.22	0.11	4.55	0.69	4.22	0.75	-0.33	***0.02***	11
4.24	0.55	4.03	0.73	-0.20	0.11	4.15	0.83	4.11	1.01	-0.03	0.44	15
4.33	0.74	4.24	0.83	-0.09	0.32	4.17	0.82	4.15	0.78	-0.01	0.47	16
4.21	0.77	4.25	0.75	0.04	0.41	4.24	0.82	4.08	0.84	-0.16	0.21	17
4.00	0.82	4.46	0.74	0.46	***0.01***	3.87	1.13	3.74	0.90	-0.13	0.31	18
4.00	0.70	4.37	0.79	0.37	***0.03***	3.85	1.01	3.56	1.05	-0.29	0.11	19

Note: M=Mean. SD=Standard Deviation. CCI question responses range from 1 to 5 where 1= Strongly disagree, 2 = Disagree, 3 = Neutral/No Opinion, 4 = Agree and 5 = Strongly Agree (Questions comprising CCIS Scales are delineated with dashed line)
**Significance at p<0.05 are bold and italicized*

Table 13 shows *t*-test results comparing the equality of mean CCI scores for pre-survey responses between treatment and control groups and mean CCI scores for post-surveys responses between treatment and control groups for all students. There was a significant difference in the means comparing pre-survey responses between treatment and control groups for question #'s 1, 14 and 20 (p=0.00, 0.04, 0.03 respectively). The difference in the mean are all positive indicating that, prior to the initiation of the course, the treatment groups all tended to agree significantly more with the statements (#1), "The inclusion of culturally relevant topics in this course helped me learn better," (#14) "Including oral histories and traditional stories helped me to grasp the science concepts in the course better" and (#20) "Working with tribal professionals in this course helped me to grasp the concepts we studied." When comparing the post-survey responses between treatment and control groups, there were significant differences in the mean for question #'s 1-3, 12, 13, 20, 9, 18 and 19 (p=0.00, 0.00, 0.00, 0.02, 0.00, 0.03, 0.03, 0.00, 0.00 respectively). The difference in the mean were positive, with exception to question #9 ("Timely feedback from the instructor on my progress in the course improved my learning"), indicating that, prior to the initiation of the course, the treatment groups all tended to agree significantly more with these statements.

Table 13.
t-test Results Comparing Students' CCI Survey Responses in Pre-Treatment Pre-Control and Post-Treatment Post-Control Groups

Treatment Group (n=34)		Control Group (n=57)				Treatment Group (n=34)		Control Group (n=57)				
Pre-Survey		Pre-Survey				Post-Survey		Post-Survey				
M	SD	M	SD	Δ Mean	p-value	M	SD	M	SD	Δ Mean	p-value	Q #
4.15	0.78	3.65	0.89	0.49	***0.00***	4.17	0.85	3.27	1.15	0.90	***0.00***	1
4.24	0.65	4.09	0.77	0.15	0.18	4.34	0.77	3.63	1.01	0.72	***0.00***	2
4.21	0.77	4.05	0.91	0.15	0.21	4.43	0.79	3.62	1.13	0.81	***0.00***	3
4.15	0.71	3.79	1.12	0.36	0.05	4.15	0.72	3.57	1.08	0.58	***0.02***	12
4.19	0.82	3.85	1.11	0.33	0.07	4.48	0.58	3.70	1.06	0.79	***0.00***	13
4.13	0.79	3.72	1.17	0.41	***0.04***	3.83	0.83	4.71	1.34	-0.89	0.28	14
4.06	0.81	3.69	0.95	0.37	***0.03***	3.92	0.88	3.40	0.88	0.52	***0.03***	20
3.21	0.98	2.98	1.19	0.22	0.18	3.50	0.71	3.05	1.20	0.45	0.08	21
2.94	0.81	2.92	1.14	0.02	0.47	3.41	0.80	2.90	1.14	0.51	0.06	22
4.00	0.82	4.16	0.84	-0.16	0.19	4.48	0.63	4.19	0.96	0.30	0.09	4
4.06	0.74	3.89	0.98	0.17	0.20	3.79	1.03	3.81	0.88	-0.03	0.46	5
3.97	0.80	3.93	0.90	0.04	0.41	4.00	0.89	3.67	1.07	0.33	0.11	6
4.09	0.83	4.07	0.86	0.02	0.46	4.28	0.88	4.15	0.77	0.13	0.28	7
4.06	0.83	3.79	0.90	0.27	0.08	3.81	0.87	3.30	1.26	0.51	0.07	8
4.44	0.70	4.45	0.66	-0.01	0.49	3.66	1.20	4.19	0.88	-0.53	***0.03***	9
4.62	0.49	4.45	0.81	0.17	0.13	4.46	0.58	4.41	0.93	0.06	0.39	10
4.50	0.71	4.55	0.69	-0.05	0.36	4.28	0.75	4.22	0.75	0.05	0.40	11
4.24	0.55	4.15	0.83	0.09	0.29	4.03	0.73	4.11	1.01	-0.08	0.37	15
4.33	0.74	4.17	0.82	0.17	0.17	4.24	0.83	4.15	0.78	0.09	0.35	16
4.21	0.77	4.24	0.82	-0.03	0.42	4.25	0.75	4.08	0.84	0.17	0.21	17
4.00	0.82	3.87	1.13	0.13	0.28	4.46	0.74	3.74	0.90	0.72	***0.00***	18
4.00	0.70	3.85	1.01	0.15	0.22	4.37	0.79	3.56	1.05	0.81	***0.00***	19

Note: M=Mean. SD=Standard Deviation. CCI question responses range from 1 to 5 where 1= Strongly disagree, 2 = Disagree, 3 = Neutral/No Opinion, 4 = Agree and 5 = Strongly Agree (Questions comprising CCIS Scales are delineated with dashed line)
**Significance at p<0.05 are bold and italicized*

Table 14 shows *t*-test results comparing the equality of mean American Indian (AI) and Non-American Indian (N-AI) students' CCI pre- and post-survey responses in treatment groups. There was no significant difference in the means comparing pre-survey responses between American Indian (AI) and Non-American Indian (N-AI) students for all questions. There was a significant difference in the means comparing post-survey responses between American Indian (AI) and Non-American Indian (N-AI) students for question #'s 14 (p=0.03) and #22 (p=0.03). The difference in the mean between AI and N-AI students' post-survey responses were negative, indicating that AI students agreed more strongly than N-AI students with the statements (#14), "Including oral histories and traditional stories helped me to grasp the science concepts in the course better" and (#22) "The use of Native languages in the course would help me to grasp concepts we study" after course completion.

Table 14.
t-test Results Comparing American Indian (AI) and Non-American Indian (N-AI) CCI Pre-Survey and Post-Survey Responses in Treatment Groups

AI Treatment (n=22) Pre-Survey		N-AI Treatment (n=11) Pre-Survey				AI Treatment (n=19) Post-Survey		N-AI Treatment (n=10) Post-Survey				
M	SD	M	SD	Δ Mean	p-value	M	SD	M	SD	Δ Mean	p-value	Q #
4.18	0.65	4.09	1.04	-0.09	0.38	4.16	0.79	4.33	1.00	0.18	0.31	1
4.18	0.65	4.36	0.67	0.18	0.23	4.42	0.68	4.22	0.97	-0.20	0.27	2
4.09	0.82	4.55	0.52	0.45	0.05	4.33	0.67	4.67	1.00	0.33	0.16	3
4.23	0.74	4.00	0.67	-0.23	0.21	4.29	0.57	3.89	0.93	-0.41	0.09	12
4.23	0.83	4.22	0.83	-0.01	0.49	4.41	0.50	4.67	0.71	0.25	0.15	13
4.19	0.77	4.10	0.88	-0.09	0.38	4.06	0.71	3.33	1.03	-0.73	***0.03***	14
4.18	0.81	3.91	0.83	-0.27	0.18	3.80	0.89	4.00	0.93	0.20	0.31	20
3.23	1.00	3.18	0.98	-0.05	0.45	3.50	0.52	3.40	1.14	-0.10	0.40	21
3.05	0.77	2.73	0.90	-0.32	0.15	3.64	0.65	2.80	0.84	-0.84	***0.03***	22
4.00	0.85	4.00	0.77	0.00	0.50	4.53	0.61	4.44	0.73	-0.08	0.38	4
4.09	0.73	4.00	0.77	-0.09	0.37	3.79	0.95	3.75	1.28	-0.04	0.47	5
3.86	0.81	4.18	0.75	0.32	0.15	3.94	0.91	4.14	0.90	0.20	0.32	6
4.23	0.87	4.00	0.77	-0.23	0.21	4.32	0.85	4.33	1.00	0.02	0.48	7
4.18	0.81	3.90	0.88	-0.28	0.19	3.71	0.80	4.00	1.10	0.29	0.26	8
4.45	0.78	4.55	0.52	0.09	0.36	3.84	1.07	3.11	1.36	-0.73	0.07	9
4.68	0.49	4.55	0.52	-0.14	0.23	4.50	0.51	4.44	0.73	-0.06	0.41	10
4.45	0.79	4.55	0.52	0.09	0.37	4.21	0.77	4.44	0.73	0.23	0.23	11
4.23	0.52	4.27	0.65	0.05	0.42	4.00	0.79	4.11	0.60	0.11	0.36	15
4.38	0.66	4.27	0.90	-0.11	0.35	4.26	0.89	4.33	0.71	0.07	0.42	16
4.32	0.70	4.00	0.89	-0.32	0.14	4.21	0.77	4.38	0.74	0.16	0.31	17
3.95	0.77	4.09	0.94	0.14	0.33	4.50	0.61	4.33	1.00	-0.17	0.30	18
4.00	0.60	4.00	0.89	0.00	0.50	4.41	0.62	4.22	1.09	-0.19	0.29	19

Note: M=Mean. SD=Standard Deviation. CCI question responses range from 1 to 5 where 1= Strongly disagree, 2 = Disagree, 3 = Neutral/No Opinion, 4 = Agree and 5 = Strongly Agree (Questions comprising CCIS Scales are delineated with dashed line)
**Significance at p<0.05 are bold and italicized*

Table 15 shows *t*-test results comparing the equality of mean CCI scores for pre- and post-survey responses for AI student in treatment and control groups. In the treatment courses among American Indian (AI) students, there was a significant difference in the means from pre- and post- responses for question #'s 22, 4, 7, 8, 18 and 19 (p=0.02, 0.02, 0.05, 0.02, 0.01, 0.02 respectively). The difference in the mean for question #'s 22, 4, 18 and 19 are positive suggesting that AI students agreed significantly more with the statements, "The use of Native languages in the course would help me to grasp concepts we study," "Collaborating with other students on course activities/assignments improved my understanding of the concepts in this course," "This course increased my interest in pursuing a science related degree," and "This course increased my interest in pursuing a science profession" after completion of the treatment course. The difference in the mean for question #'s 8 and 9 are negative, suggesting that AI students agreed significantly less with the statement "The inclusion of guests from the tribal community to help teach this course enhanced my learning" and "Timely feedback from the instructor on my progress in the course improved my learning". In the control courses among AI students, there were no significant difference in the means from pre- and post- responses.

Table 15.
t-test Results Comparing CCIS Pre-Survey and Post-Survey Responses for American Indian (AI) Students in Treatment and Control Groups

AI Treatment Group						AI Control Group						
(n=22)		(n=19)				(n=34)		(n=15)				
Pre-Survey		Post-Survey				Pre-Survey		Post-Survey				
M	SD	M	SD	Δ Mean	p-value	M	SD	M	SD	Δ Mean	p-value	Q #
4.18	0.65	4.16	0.79	-0.02	0.46	3.71	0.97	3.20	1.26	-0.51	0.07	1
4.18	0.65	4.42	0.68	0.24	0.13	4.15	0.74	3.67	1.23	-0.48	0.09	2
4.09	0.82	4.33	0.67	0.24	0.16	4.09	0.97	3.67	1.23	-0.42	0.10	3
4.23	0.74	4.29	0.57	0.07	0.38	4.00	1.15	3.69	1.25	-0.31	0.21	12
4.23	0.83	4.41	0.50	0.18	0.21	4.00	1.15	3.85	1.14	-0.15	0.34	13
4.19	0.77	4.06	0.71	-0.13	0.30	3.85	1.20	3.50	1.45	-0.35	0.21	14
4.18	0.81	3.80	0.89	-0.38	0.09	3.88	0.86	3.67	0.89	-0.21	0.24	20
3.23	1.00	3.50	0.52	0.27	0.20	3.15	1.23	3.23	1.24	0.08	0.42	21
3.05	0.77	3.64	0.65	0.59	***0.02***	3.06	1.20	3.23	1.24	0.17	0.33	22
4.00	0.85	4.53	0.61	0.53	***0.02***	4.06	0.95	3.93	1.16	-0.13	0.35	4
4.09	0.73	3.79	0.95	-0.30	0.14	3.91	1.06	3.87	0.83	-0.05	0.44	5
3.86	0.81	3.94	0.91	0.08	0.39	4.21	0.84	3.87	1.13	-0.34	0.12	6
4.23	0.87	4.32	0.85	0.09	0.36	4.06	0.98	4.00	0.85	-0.06	0.42	7
4.18	0.81	3.71	0.80	-0.47	***0.05***	4.03	0.87	3.38	1.33	-0.64	0.06	8
4.45	0.78	3.84	1.07	-0.61	***0.02***	4.41	0.74	4.07	0.96	-0.35	0.09	9
4.68	0.49	4.50	0.51	-0.18	0.13	4.44	0.96	4.40	1.06	-0.04	0.45	10
4.45	0.79	4.21	0.77	-0.24	0.17	4.59	0.70	4.33	0.72	-0.25	0.13	11
4.23	0.52	4.00	0.79	-0.23	0.15	4.12	0.89	3.93	1.16	-0.19	0.27	15
4.38	0.66	4.26	0.89	-0.12	0.32	4.21	0.86	4.29	0.83	0.07	0.39	16
4.32	0.70	4.21	0.77	-0.11	0.32	4.33	0.85	4.14	0.86	-0.19	0.24	17
3.95	0.77	4.50	0.61	0.55	***0.01***	3.91	1.10	3.80	0.94	-0.11	0.37	18
4.00	0.60	4.41	0.62	0.41	***0.02***	3.82	1.01	3.60	1.18	-0.22	0.26	19

Note: M=Mean. SD=Standard Deviation. CCI question responses range from 1 to 5 where 1= Strongly disagree, 2 = Disagree, 3 = Neutral/No Opinion, 4 = Agree and 5 = Strongly Agree (Questions comprising CCIS Scales are delineated with dashed line)
**Significance at p<0.05 are bold and italicized*

Summary

The following tables summarize the important findings discussed above. Table 16 shows post survey *t*-test results comparing equality of mean between control and treatment groups for the ATSSA, MSLQ, individual MSLQ scales, CCI and individual CCI scales. As previously discussed, the post-ATSSA composite scores subjected to a two-way analysis of variance indicated that the mean ATSSA composite score was significantly greater in the treatment group (M = 61.31, SD = 7.24) than for the control group (M = 49.15, SD = 11.10). This is also indicated in the independent-samples *t*-test for the ATSSA. The treatment group's mean post-MSLQ Expectancy Component-Self Efficacy for Learning and Performance scale also indicate a significantly greater score than the control group. This was also found earlier when the post-MSLQ Expectancy Component-Self Efficacy for Learning and Performance scale was subjected to a two-way analysis of variance (F(1, 52) = 4.507, p =.0385).

Table 16.
t-test Results Comparing All Survey Scales Between Control and Treatment Responses for All Students

	Control Group Post survey (n = 27)		Treatment Group Post Survey (n=29)		Difference in the		
	M	SD	M	SD	Mean	p-value	Cohens's d
ATSSA	49.15	11.1	61.31	7.24	-12.16	***0.000***	1.326
MSLQ							
Total	60.56	7.92	64.07	8.74	-3.51	0.061	0.422
Value Component							
Goal Orientation	16.07	2.37	16.34	2.81	-0.27	0.350	0.105
Task Value	20.59	3.18	21.59	3.10	-0.99	0.121	0.317
Expectancy Component							
Self-Efficacy for Learning and Performance	23.89	4.74	26.14	4.36	-2.25	***0.035***	0.494
CCI							
Total	78.04	19.12	83.03	16.44	-5.00	0.149	0.281
Course Content	27.26	12.82	31.28	7.75	-4.02	0.083	0.391
Instruction	35.56	6.28	35.03	6.16	0.52	0.378	0.084
Future Success	15.22	3.61	16.72	3.82	-1.50	0.068	0.405

Table 17 shows *t*-test results comparing equality of mean between pre/post treatment groups for the ATSSA, MSLQ, individual MSLQ scales, CCI and individual CCI scales. The independent-samples *t*-test for composite CCI, CCI Course Content scale and CCI Instruction scale indicate a significant decrease in agreement from pre- to post-course. From previous results, the independent-samples *t*-test for the difference in the mean for question #'s 22 ("The use of Native languages in the course would help me to grasp concepts we study"), #4 ("Collaborating with other students on course activities/assignments improved my understanding of the concepts in this course"), #18 ("This course increased my interest in pursuing a science related degree") and #19 ("This course increased my interest in pursuing a science profession") are positive indicating that the treatment groups all tended to agree significantly more with these statements after course completion.

Table 17.
t-test Results Comparing All Survey Scales for Students Between Pre- and Post-Survey Responses for Treatment Courses

	Treatment Group Pre Survey (n = 34)		Treatment Group Post Survey (n=29)		Difference in the		
	M	SD	M	SD	Mean	p-value	Cohens's d
ATSSA	61.53	8.24	61.31	7.24	-0.22	0.456	0.028
MSLQ							
Total	63.79	7.34	64.07	8.74	0.28	0.446	0.034
Value Component							
Goal Orientation	16.47	2.30	16.35	2.81	-0.13	0.423	0.049
Task Value	21.38	2.98	21.59	3.10	0.20	0.396	0.067
Expectancy Component							
Self-Efficacy for Learning and Performance	25.94	3.51	26.14	4.37	0.20	0.422	0.050
CCI							
Total	88.91	9.76	83.03	16.44	-5.88	***0.049***	0.449
Course Content	34.65	5.16	31.28	7.75	-3.37	***0.026***	0.522
Instruction	37.85	3.70	35.03	6.16	-2.82	***0.018***	0.571
Future Success	16.41	2.78	16.72	3.82	0.31	0.358	0.095

Table 18 shows *t*-test results comparing equality of mean between pre/post American Indian treatment groups for the ATSSA, MSLQ, individual MSLQ scales, CCI and individual CCI scales. These results show a significant difference in the mean for the CCI Course Content scale. The American Indian students exhibited a decrease in agreeance with the question in the course content scale. However, from the previous discussion American Indian students agreed significantly more with the statements, “The use of Native languages in the course would help me to grasp concepts we study,” “Collaborating with other students on course activities/ assignments improved my understanding of the concepts in this course,” “This course increased my interest in pursuing a science related degree,” and “This course increased my interest in pursuing a science profession” after completion of the treatment course. However, the difference in the mean for question #’s 8 and 9 were negative, suggesting that American Indian students agreed significantly less with the statement “The inclusion of guests from the tribal community to help teach this course enhanced my learning” and “Timely feedback from the instructor on my progress in the course improved my learning”.

Table 18.
t-test Results Comparing All Survey Scales for AI Students Between Pre- and Post-Survey Responses for Treatment Courses

	AI Treatment Group Pre Survey (n = 22)		AI Treatment Group Post Survey (n=19)		Difference in the		
	M	SD	M	SD	Mean	p-value	Cohens's d
ATSSA	61.00	8.66	61.74	7.65	0.74	0.388	0.090
MSLQ							
Total	62.86	7.56	63.63	9.64	0.77	0.388	0.089
Value Component							
Goal Orientation	15.95	2.42	16.05	3.31	0.10	0.457	0.034
Task Value	21.14	3.23	21.95	2.97	0.81	0.205	0.262
Expectancy Component							
Self-Efficacy for Learning and Performance	25.77	3.52	25.63	4.67	-0.14	0.456	0.034
CCI							
Total	90.00	9.08	83.32	18.17	6.68	0.079	0.491
Course Content	35.36	4.22	31.21	8.75	-4.15	***0.035***	0.641
Instruction	38.18	3.67	35.42	6.54	-2.76	0.057	0.540
Future Success	16.45	2.70	16.68	3.97	0.23	0.416	0.069

Achievement Data

Individual student summative (midterm and final tests) and formative grades (graded reports, essays, quizzes, activities) were collected for treatment and control courses. Formative scores were averaged over the 10-week treatment and control courses for comparison. Summative assessment types, including midterm and final examination scores, were also averaged. Final grades were used in cases where neither a midterm nor final examination was a part of the course.

Formative assessment scores were subjected to a two-way analysis of variance having two levels of instruction (Control, Treatment) and two levels of students' ethnicity (AI-American Indian, N-AI-Non-American Indian) (Figure 10). The main effect of instruction was statistically significant at the .05 significance level. The main effect of instruction yielded an F ratio of $F(1, 65) = 15.277$, $p < .000$, $\eta_p^2 = 0.19$, indicating that the mean formative assessment scores were significantly greater in the treatment group ($M = 0.8537$, $SD = 0.1353$) than for the control group ($M = 0.7323$, $SD = 0.1351$). The main effect of student ethnicity was also statistically significant at the .05 significance level. The main effect of student ethnicity yielded an F-ratio of $F(1, 65) = 4.622$, $p = 0.035$, $\eta_p^2 = 0.10$, indicating that the mean formative assessment scores were significantly greater for Non-American Indians ($M = 0.8317$, $SD = 0.1194$) than for American Indians ($M = 0.7634$, $SD = 0.1573$). The interaction effect was non-significant, $F(1, 52) = 0.017$, $p > .05$.

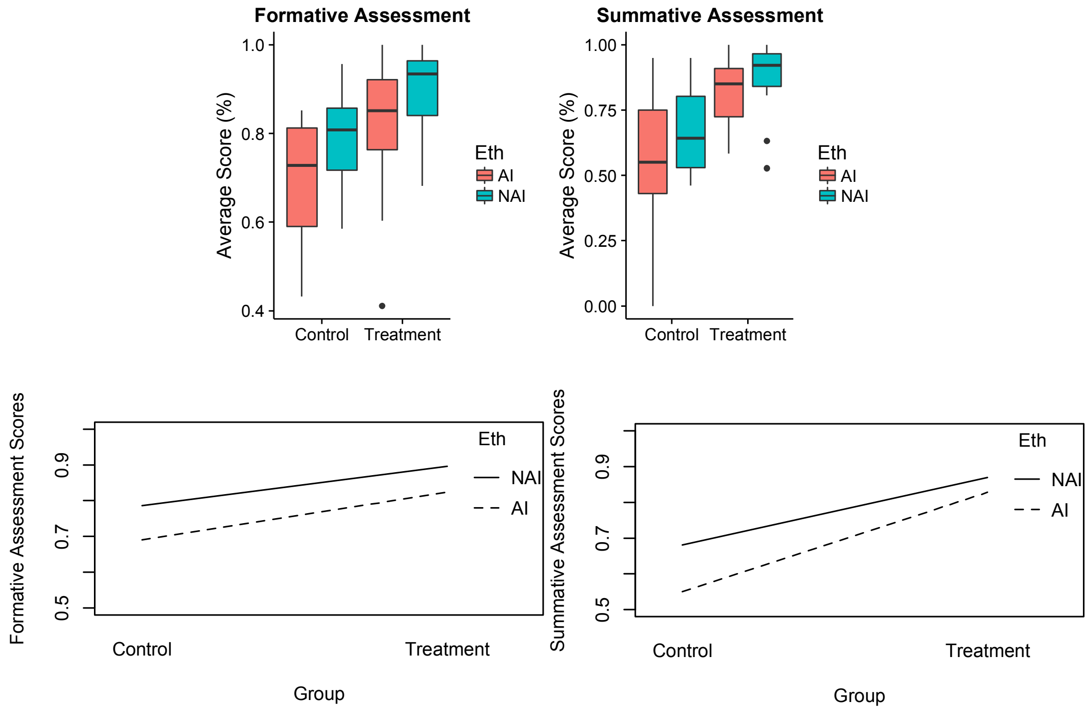

Figure 10. Box and interaction plot showing formative and summative course scores for control and treatment groups distinguishing between American Indian (AI) and Non-American Indian (NAI) students

Summative assessment scores were subjected to a two-way analysis of variance having two levels of instruction (Control, Treatment) and two levels of students' ethnicity (AI-American Indian, N-AI-Non-American Indian) (Figure 10). The main effect of instruction was statistically significant at the .05 significance level. The main effect of instruction yielded an F ratio of $F(1, 81) = 30.193$, $p < .000$, $\eta_p^2 = 0.27$, indicating that the mean summative assessment scores were significantly greater in the treatment group ($M = 0.8463$, $SD = 0.1314$) than for the control group ($M = 0.6038$, $SD = 0.2406$). The main effect of student ethnicity was non-significant, F ratio of $F(1, 81) = 3.039$, $p = 0.0851$. The interaction effect was non-significant, $F(1, 81) = 0.956$, $p > .05$.

Achievement data was also subjected to *t*-tests to compare the equality of the mean for summative and formative scores across treatment and control courses for American Indian and non-American Indian students.

Table 19 show that there were no significant differences between American Indian and non-Native American students in both treatment and control courses. The same analysis for American Indian and non-Native American students in the control courses revealed a significant difference where non-American Indian students scored better on formative assessment types (M=0.773, SD=0.125) and summative assessment types (M=0.688, SD=0.175) than their American Indian peers (M=0.690, SD=0.140; M=0.550, SD=0.274 respectively) (Table 20).

Table 19.
t-test Results Comparing Formative and Summative Score for Treatment Courses

AY 2015-16 TREATMENT COURSES							
Formative Assessment Score		n	Mean	SD	Difference in Mean	p-value	Effect Size, Cohen's d
	AI	21	0.834	0.123			
	N-AI	10	0.895	0.142	-0.060	0.120 **equal variance*	0.456
Summative Assessment Score		N	Mean	SD	Difference in Mean	p-value	Effect Size, Cohen's d
	AI	21	0.824	0.150			
	N-AI	10	0.907	0.101	-0.082	0.064 **equal variance*	0.656

Table 20.
t-test Results Comparing Formative and Summative Score for Control Courses

AY 2015-16 CONTROL COURSES							
Formative Assessment Score		n	Mean	SD	Difference in Mean	p-value	Effect Size, Cohen's d
	AI	18	0.690	0.140			
	N-AI	13	0.773	0.125	0.083	***0.049*** **equal variance*	0.628
Summative Assessment Score		n	Mean	SD	Difference in Mean	p-value	Effect Size, Cohen's d
	AI	29	0.550	0.274			
	N-AI	18	0.688	0.175	0.138	***0.021*** **unequal variance*	0.614

Achievement data for American Indians students in treatment and control courses were subjected to *t*-tests to compare the equality of the mean for summative and formative scores across the courses. Table 21 shows that American Indian students in the treatment course achieved significantly higher scores for summative and formative assessment types then their American Indian counterparts in the control group. Achievement data for non-American Indian students in treatment and control courses were also subjected to *t*-tests to compare the equality of the mean for summative and formative scores across the courses. Table 21 shows that non-American Indian students in the treatment course achieved significantly higher scores for summative and formative assessment types then their non-American Indian counterparts in the control group.

Table 21.
t-test Results Comparing American Indian (AI) Students' Formative and Summative Achieve Data in Treattment and Control Courses and t-test Results Comparing American Indian (AI) and Non-American Indian (N-AI) Students' Formative and Summative Achieve Data in Treatment and Control Courses

AY 2015-16 TREATMENT v. CONTROL COURSES						
Formative Assessment Score	n	Mean	SD	Difference in Mean	p-value	Effect Size, Cohen's d
AI Treatment Group	21	0.834	0.123			
AI Control Group	18	0.690	0.140	0.144	***0.001*** **equal variance*	1.096
Summative Assessment Score	N	Mean	SD	Difference in Mean	p-value	Effect Size, Cohen's d
AI Treatment Group	21	0.824	0.150			
AI Control Group	29	0.550	0.274	0.274	***0.000*** **unequal variance*	1.294
Formative Assessment Score	n	Mean	SD	Difference in Mean	p-value	Effect Size, Cohen's d
N-AI Treatment	10	0.895	0.142			
N-AI Control	13	0.773	0.125	0.121	***0.021*** **equal variance*	0.906
Summative Assessment Score	n	Mean	SD	Difference in Mean	p-value	Effect Size, Cohen's d
N-AI Treatment	10	0.907	0.101			
N-AI Control	18	0.688	0.175	0.219	***0.000*** **equal variance*	1.586

Case Studies

Qualitative data was gathered in treatment and control courses using focus groups and classroom observations of instruction utilizing the Reformed Teaching Observation Protocol (Sawada et al., 2002). The data was analyzed using a multiple case study design (Creswell, 2007). Besides classroom observations and student and faculty focus groups, other data included instructor journals and course syllabi and outlines. Focus groups were designed to probe student attitudes and reactions to instruction and content in the treatment and control courses. Instructor focus groups and journals were designed to characterize implementations of the CCI methods in the course, attitude and characterization of elements of the course due to the treatment. During the study, selected STEM courses were modified in specific ways, using elements identified on the CCIS in an effort to improve the cultural congruency of instruction. Control and treatment courses were highlighted using case studies to describe and intersect characteristics of CCI methods that contributed to positive and negative student attitude and achievement.

These data were collected to (Q2) *determine the nature of the relationship between CCI course modifications and changes (or lack of) in American Indian students' science attitudes and achievement at a tribally controlled college?*

Case Context

Salish Kootenai College, founded in 1973, is a tribally controlled college located in Western Montana on the Flathead Indian Reservation. SKC, a four-year land grant institution and chartered member of the American Indian Higher Education Consortium, was officially chartered in 1977 by the Confederated Salish and Kootenai Tribes. SKC was the first tribally controlled college to achieve regional accreditation by the Northwest Commission on Colleges and Universities. The mission of SKC is "to provide quality postsecondary educational opportunities for Native Americans locally and from throughout the United States. The College will promote community and individual development and perpetuate the cultures of the Confederated Tribes of the Flathead Nation." In response to the mission, most SKC Natural Resources courses are charged with the task to consider traditional knowledge in parallel with mainstream scientific knowledge.

During the 2015-2016 academic year there were 66 full-time faculty where 21.2% (14) were American Indians. Full-time STEM faculty comprised 19.1% (29) of all faculty with 3.0% (2) American Indian. Full-time Natural Resources faculty comprised 10.6% of all faculty with 1.5% (1) American Indian. In this study there were no American Indian faculty teaching treatment or control courses.

All treatment and control courses occurred during the Fall and Winter Quarters at the Piel Qlawqn building on SKC's campus. The Piel Qlawqn building was built in 2003 housing the Forestry, Hydrology, Wildlife, Mathematics, Life Science and Secondary Science Education departments. Courses were conducted in traditional classroom space (square room with white board and forward facing aisled tables) or traditional laboratory space (square room with whiteboard and forward facing aisled laboratory workstations). The courses occurred two days per week for one hour and 20 minutes over a 10-week quarter.

Case Descriptions

Faculty participating in this study consisted of four male and two female faculty. The control courses (Table 22 and Table 23) were instructed by three males while the treatment courses were instructed by one male and two female faculty. Ages ranged from 34 to 67 years. The faculty had a range of teaching experience at SKC, some faculty had as little as two years and as many as 34 years of experience. Two faculty had earned a PhD with the additional four faculty holding Master's of Science.

Table 22.
Control Course Instructor Demographic

Control Course	Age	Gender	Highest Degree Attained	Teaching Experience at SKC (Years)	Other Relevant Experience (Years)
CHEM 110/111	35	male	PhD	3	4
MATH 241	44	male	MS	18	4
GEOG 201	34	male	MS	8	3

Table 23.
Treatment Course Instructor Demographic

Treatment Course	Age	Gender	Highest Degree Attained	Teaching Experience at SKC (Years)	Other Relevant Experience (Years)	Average RTOP Score
BIOS 410	42	female	MS	2	17	70
ENVS 203	46	male	PhD	6	1	44
GEOL 101/102	46	male	PhD	6	1	38
SCID 114	67	female	MS	34	7	74

Control Course – CHEM 110/111. The 35-year-old male instructor for the control course CHEM 110/111 completed a PhD in Chemistry in 2010. The instructor has three years of teaching experience, all at SKC beginning in 2012. Prior to coming to SKC, the instructor held four years of professional/research experience, completing a post-doctoral research and working as a chemist with the United States Department of Agriculture. The students in the course consisted of all STEM majors including General Science, Hydrology, Life Science, Secondary Science Education and Wildlife. There were 13 freshmen, one sophomore and one junior. The average student age was 30.1 ranging from 19 to 53 years. There were ten females and five males. Of the 15 students, eight were American Indian.

Control Course – MATH 241. The 44-year-old male instructor for the control course MATH 241 completed a Master's of Science in Mathematics in 1997. The instructor has 18 years teaching experience at SKC beginning in 1997. Previously, the instructor gained four academic years of teaching experience as a graduate teaching assistant. All of the instructor's professional/research experience has been at SKC where he has shaped the Mathematics Department courses as the department head for the past five years. The students in the course consisted of 15 STEM majors including Forestry, General Science, Hydrology, Life Science, Psychology, Secondary Science Education and Wildlife. There were an additional five Non-STEM majors including Business Management and Social Work. There were 15 freshmen, one sophomore and four juniors. The average student age was 26.4 ranging from 19 to 45 years. There were ten females and ten males. Of the 20 students, 10 were American Indian.

Control Course – GEOG 201. The 34-year-old male instructor for control course GEOG 201 completed a Master's of Science in Forest Science in 2007. The instructor has eight years teaching experience at SKC beginning in 2007. Previously, the instructor gained three academic years of teaching experience as a graduate teaching assistant. All of the instructor's professional/research experience has been at SKC where he has completed many federally funded research projects over the last four years. The students in the course consisted of 14 STEM majors including Forestry, Hydrology, Psychology and Wildlife. There were an additional eight Non-STEM majors including Non-Declared and Tribal Historic Preservation. There were nine freshmen, 12 sophomores and one junior. The average student age was 35.5 ranging from 19 to 55 years. There were eleven females and eleven males. Of the 22 students, 16 were American Indian.

Treatment Course – BIOS 410. The 42-year-old female instructor for treatment course BIOS 410 completed a Master's of Science in Biology in 1999. The instructor has two years teaching experience at SKC, beginning in 2013. Previously, the instructor gained two academic years of teaching experience as a graduate teaching assistant. Prior to coming to SKC, the instructor held 17 years of professional/research experience as a Biologist. She worked for the CSKT Tribes as a Biologist for 11 years and an additional four years for the United States Geological Survey. Earlier she completed two years of work with the National Park Service. The students in the course consisted of eight STEM majors including Environmental Science, Forestry, Hydrology, Secondary Science Education and Wildlife. There were two freshmen, two sophomores, two juniors and two seniors. The average student age was 32.9 ranging from 24 to 55 years. There were six females and two males. Of the eight students, seven were American Indian.

During the course, three observations were made using the Reformed Teaching Observation Protocol (Sawada et al., 2000). After the observed instruction, the instructor and course were scored at a 67, 71 and 71, averaging 70 overall. The scores for the days of instruction all fell in the category. “Active student participation in the critique as well as the carrying out of experiment.” The average RTOP score for this instructor and course of 70 falls near the middle of the category of, “Active student participation in the critique as well as the carrying out of experiment” (Sawada, 2003).

Treatment Course – ENVS 203 & GEOL 101/102. The 46-year-old male instructor for the treatment courses ENVS 203 and GEOL 101/102 completed a PhD in Geoscience in 2013. The instructor has six years teaching experience at SKC, beginning in 2009. Previously, the instructor gained one academic year of teaching experience as a graduate teaching assistant. The instructor has also completed many federally funded research projects over the last five years. Besides his academic pursuits, the instructor holds eight years of experience in the service industry. The students in ENVS 203 consisted of 5 STEM majors including Hydrology and

Secondary Science Education. There were two freshmen and three sophomores. The average student age was 30.4 ranging from 25 to 33 years. There were one female and four males. Of the five students, three were American Indians.

During the course ENV 203, four observations were made using the Reformed Teaching Observation Protocol (Sawada et al., 2000). The instructor and course scored a 25, 39, 52 and 61, averaging 44 overall. These score of 25 is characterized as “Straight lecture” while a score of 39 is characterized as “Lecture with some demonstration and minor student participation.” The day of instruction scoring 52 is categorized as “Significant student engagement with some minds-on as well as hands-on involvement” while the top score of 61 is on the lower end of the category “Active student participation in the critique as well as the carrying out of experiment.” The average RTOP score for this instructor and course of 44, falls in the upper end of the category “Lecture with some demonstration and minor student participation”.

The students in GEOL 101/102 consisted of seven STEM majors including Hydrology and Secondary Science Education. There was one non-STEM major from the Art Department. There were six freshmen and two sophomores. The average student age was 26.9 ranging from 20 to 33 years. There were four females and four males. Of the eight students, three were American Indian.

During the course GEOL 101/102, four observations were made using the Reformed Teaching Observation Protocol (Sawada, et. al., 2000). The instructor and course scored an 18, 27, 51 and 57, averaging 38 overall. The scores 18 and 27 are characterized as “Straight lecture” while a score of 51 and 57 are characterized as “Significant student engagement with some minds-on as well as hands-on involvement” The average RTOP score for this instructor and course of 38, falls in the middle of the category “Lecture with some demonstration and minor student participation".

Treatment Course – SCID 114. The 67-year-old female co-instructor for SCID 114 completed a Master's of Science in Biology in 1972. The instructor has 34 years teaching experience at SKC, beginning in 1981. Previously, the instructor was a curriculum designer for seven years, four years at SKC and three at another community college. The instructor also served as department head for SKC's first General Science program, First Environmental Science program and Director of all Natural Resources degrees at SKC. The students in the course consisted of 13 STEM majors including Forestry, Hydrology and Wildlife. There were eleven freshmen and two sophomores. The average student age was 34.7 ranging from 19 to 55 years. There were four females and nine males. Of the 13 students, 10 were American Indian.

During the course, four observations were made using the Reformed Teaching Observation Protocol (Sawada et al., 2000). The instructor and course score a 56, 75, 80 and 84, averaging 74 overall. The score of 56 is characterized as "Significant student engagement with some minds-on as well as hands-on involvement" while a score of 75 is characterized as the upper end of "Active student participation in the critique as well as the carrying out of experiment." The days of instruction scoring 80 and 84 fall in the top category of "Active student involvement in open-ended inquiry, resulting in alternative hypotheses, several explanations, and critical reflection." The average RTOP score for this instructor and course of 74, falls in the upper end of the category "Active student participation in the critique as well as the carrying out of experiment."

Cross-Case Theme Analysis

The emerging themes from data collected in treatment and control course focus groups were grouped in the following categories: Course Activities/Instruction, Course Content, Cultural Content, Course Environment and Overall Impressions. Themes falling in these categories were examined across all treatment and control course focus groups to determine similarities and differences within the experiences of the students enrolled in the courses. Frequently occurring and similar themes emerging from the focus groups were highlighted along with unique themes occurring in control and treatment groups.

Similarities

Theme: Course activities/instruction – hands-on real world applications and examples. Most of the course content in this study required either a laboratory or direct performance-based instruction. The control course, GEOG 201, relied on structured modules that students were guided through by their instructor. Each student had their own computer workspace arranged in rows where the instructor could freely walk around and narrated while privately assisting. In addition, during the fourth week of class the students engaged in an outdoor data gathering exercise. In the focus group, one student remarked that "…doing this particular activity, that was, that was helpful…", while another student followed up stating "Hands on, walking around, actually appreciating…. see what it does. It was pretty cool." These "Real world application[s]", as one student expressed were also reflected in another control course, CHEM 110/111.

In the control course, CHEM 110/111, the laboratory provided an opportunity to directly observe chemistry phenomenon though hands-on experimentations. The lab and lecture combinations are isolated to classroom space, yet the activities provided many students with a feeling that was “just like getting out into the field” as one student expressed. Another student explained that the class engaged in a lab where they learned “…about the [Flathead] lake and how they research and what they do…”.

These hands-on activities helped students to relate to the content while “…concreting the concepts. That way, we had something to relate it to, just beside the “homework problems” as stated by another student in the control course MATH 241. In this course, the instructor also engaged the class in data gathering activity to exemplify statistics concepts. One student described the activity, “When we did the surveys…We use…SKC students… we’d have to find, view the statistics so like, whatever test we were learning or equation… it made like our stats real so we had to find our own stats, instead of having numbers given to you.” In another activity, the instructor used the idea of blood-quantum as a foundation to teach a statistics concept. One students remembered, “I think a couple of other times, we used examples of blood quantum or Native American students here within the school, compared to non-Native American students.”

In the treatment course, GEOL 101/102, the instructor engaged the students in many hands-on activities in the lab section. The class generally sat together at a long table with the instructor seated at one of the ends. The laboratory activities centered around interactive demonstrations and laboratory worksheets with accompanying material (geological maps and rock samples) that illustrated concepts. In addition, the laboratory section also embarked on two field trips to locations of geological importance in the Flathead Indian Reservation. One student remarked that, “There was no way, you could just really sit there, and not participate.” Following up, the student also exclaimed, “Yeah. It was always as a group, and then hands on.” The laboratory activities complimented the lectures that were primarily graphic rich slide presentations. A student noted that, "Sometimes, just, like, really didn't make any sense to me, till we did the lab, and it just clicked…" Similar experiences were also shared in other treatment courses. The instructor of the course, in his course journal, noted that:

> The students did not fully understand this until they completed the lab following the field trip. This is historically a problem when students complete the class final and are asked to identify rocks which may be similar but weather differently. They generally miss identify [*sic*] several of the rocks due to not fully understanding how the same rocks can look differently. The overall connection to place and there [*sic*] ability to see the rocks in place prior to completing the lab also seemed to expedite there [*sic*] ability to answer the lab questions as the class finished the 4-hour lab in 3 hours which had never been done before.

The same instructor also taught the treatment course ENVS203. A similar sentiment was conveyed by the students concerning the hands-on and real-world context of the course. During one activity the class utilized an infrared camera to examine energy loss in electrical conductance. A handful of students recalled this activity where one remarked, "I could see the power lines through the walls, how they're emitting energy and how that's always hot, they're consuming energy…" Related to this, another student mentioned in a blog assignment that, "Gaining knowledge that associates costs with the various energy industries along with understanding the technology that is developing is probably one of my favorite aspects of this course." This course overall broadened the perspectives of the students to energy conservation. One student noted, "I mean, professionally and just, like, society culturally I guess… It goes on so many other levels than just professional." Further, another student exclaimed, "I am already doing stuff at home, like unplugging all of my appliances, recycling plastic…[things] I've never done before." These examples of students understanding in real-world terms by the instructor of these two courses were also evident in the remaining two treatment courses.

The treatment course BIOS 410 was a traditional weekly lecture-based course. After modifications of the course, the instructor increased in-class activities with a focus in local context. In this course there were a larger number of juniors and seniors than the other treatment course. The instructor of the course noted that this composition of students eased effort to include parts the CCIS into the course. One student recalled an example of this effort saying that "[the instructor] would pull up on the board things like…U.S. fish and wildlife service point of view… The IUCN Red List and what they are doing about endangered species and what the purpose is of that, and things like that." Another student elaborated stating that "there was some discussion current to them, which I appreciated. Current-ness, like, globally related conservation." One assignment in the course called for students to craft a presentation about a tribal specific conservation project. This assignment was found to be noteworthy by two students whom remarked, "…the presentations were really interesting. Um, because we learned about just conservation efforts and your endangered animals, and kind of, what's going on with it, and so it was great to learn about all these different things that are happening across the country." The other student said, "…[the presentation] went in-depth and thought is very informative. And they were all related to tribes." In addition to the real-world context, the presentations allowed the students hands-on presentation experience.

The content of the treatment course SCID 114 focused on writing and presenting scientific research. The course did not lend to a hands-on approach similar to those with laboratory sections. However, the course relied on activities that encouraged students' engagement where the students worked in pairs or groups of three to read, discuss and analyze the writing material covered. As an example of this approach, the students were asked what percentage of time they spent passively listening to lecture, one students said "…maybe 20%". This was followed by another student stating, "That's about right, see 'cause she had us hands on a lot.". The students further engaged in a series of review processes and presentations of their writing. A part of this process was a peer review component. One student recognized the importance of this activity noting that "We're all starting, not everybody's going to get edits right at the beginning. But for you to learn how to be good… this is what scientists do, a bunch of them get together and bounce ideas back off each other. If you can't do that, well you can't compete in the job market." This understanding of real world applications demonstrates the effort of the instructor. The instructor noted in her journal that, "…the course is currently a hands-on environment, clearly there is room for improvement in student understanding and confidence as indicated above. The subject is relatively foreign to the usual cultural approaches, but there is room for improvement also."

Theme: Overall impressions – course is valuable to my future. Many students in the control and treatment group acknowledged that the course was valuable to their future professional and educational goals. The control course, GEOG 201, when asked the question, "How valuable do you think this course is to your future profession?" The class-wide response was, "Very valuable.". Next, the following dialog occurred:

Student 1: Very valuable… [The course] adds extra stress though because it's like, oh I really need to know a lot of procedures.

Student 2: I talked to [a former student]... she told me this morning how important GIS is in all the natural resources jobs. She graduated here.

Student 3: I think everywhere you go in the world, GIS is really important. In your job or whatever you're doing out there, even at, even at that home. With your, uh, your own land and your own, you know, your farming, your cows, everything. It's really widely important to know GIS.

Student 4: That's what I like about it. I think that those kinds of possibilities, of what we can use these ... skills for is gonna be pretty good for careers.

When asked the same question in CHEM 110/111 and MATH 241 students in the focus groups unanimously agreed. One student in CHEM 110/111 elaborated that "…it relates to my career once I graduate from here… it kind of opened my eyes a little bit to a different way of looking at the science field." The same sentiment was reflected by a student in MATH 241. The student explained, "Like when I started, I was… as a business major, I'm going to use the results from statistics, not necessarily have to know how to do it. But then, at the end of it, I'm like, 'Okay, I could see where I'm going to need to do, need to apply it', and then it makes it easier to understand data that is coming in."

The students in the treatment courses also thought that the courses were valuable to their future goals. In GEOL 101/102 two students noted that the material covered aligned with their declared majors. One student remarked, "Pretty valuable! I mean, with hydrology it's pretty important." The other student followed up saying, "And, yeah, for ground water, especially." In SCID 114 the students' remarks on the future value were also frequent. One student stated, "I think this course is extremely valuable, especially considering that it's a 100-level course…it's more to show you the tricks to help increase your speed." Another student remarked that the free citation software used in the course "…is not only beneficial to this one particular subject, but we can use it later on. I mean I was so amazed with that program." One other student followed up regarding the citation software exclaiming "I find it very beneficial. …the technical side I think was very good, and I think this course has the potential to be extremely useful."

In the treatment course ENVS 203, the students also found the content material aligning with their current and future goals. When asked the question "How valuable do you think this course is to your future profession?" all students exclaimed, "Yes". One student specifically mentioned, "Definitely the hydrology stuff." In BIOS 410 the students also unanimously agreed. One student further explained "Yeah. Just, like, it's hard to articulate. I felt like I gained a lot of knowledge. Like I could speak fairly articulately in an arena where they were discussing these new concepts."

Differences

Treatment only theme: Course activities – guest speakers and field trips. One of the CCIS promoted in the workshops with treatment course faculty was to utilize local tribal elders, community members or tribal professionals as guest speakers in the course schedule. In the treatment course GEOL 101/102, the instructor modified the course to include a local professional to lead a field trip to a location of local significance. The field trip brought the students to a location near a silver mine located on the North end of the Flathead Indian Reservation to examine the local geology and highlight some effects of mining on the environment. In his journal, the instructor remarked that "the overall connection to place and [the students] ability to see the rocks in place prior to completing the lab also seemed to expedite their ability to answer the lab questions…" Additionally, the instructor remarked "I believe the addition of this field trip was a success in terms of student learning." In the students' focus group, the students recalled the field trip. One student remarked "I like the field trip, but I think it would have been better, instead of, like, the first day, if we would have done it later." The student continued to explain that a later field trip would have provided them with more background information allowing them to be more familiar with the presentation. Another student corroborated by saying "Instead of, like, a whole bunch of gibberish." Finally, the students also explained that a second field trip was scheduled, but cancelled due to lack of time.

In the treatment course ENVS 203, the instructor modified the course to include a panel of professionals from the Confederated Salish and Kootenai Tribes that had worked on the tribal Climate Change Adaptation Plan. The panel convened near the end of the course as a means to integrate many of the climate concepts the students had worked on. In the faculty focus groups, the instructors noted that this and other invitations to community Elder and tribal professionals had to be arranged through a liaison and this provided a degree of difficulty. Further, the instructors noted that invited guests showed up only 1/3 of the time in which they were invited. The instructors mentioned the preferred and more successful method of integrating this CCIS was to bring the students to the location of the elders or tribal professional. The students in the course found the panel beneficial. One student remembered, "I really liked the guest speakers that we had come in. The discussion that we had with them was good." Another student said "…I guess I hadn't realized how much was happening in the valley, about that kind of stuff… you know, actual professionals working on those kinds of issues. It was good to see."

In the treatment course BIOS 410, the instructor had intended to invite a guest speaker and a tribal Elder to the course. There were complications with the logistics and scheduling for these guests resulting in cancellations. However, the students provided commentary in the focus groups calling for field trips and guests to augment their learning. One student responded when asked about field trips "…if we had more time… If the class was longer than an hour and 20 minutes. Because we talked about Pablo Reservoir, which is right here, which I think we could easily get to." Another student followed up saying, "Like in a day. Yeah, just to kind of see… Because we learned about all these things of culture locally, but I think a field trip or two would be beneficial." Other students suggested a hike to a local habitat reserve or to tribal protected areas. Yet one student acknowledged that the "time frame is a limit, but that would've been awesome."

The treatment course SCID 114 included an invitation to a tribal Elder or member of one of the CSKT Culture Committees to talk about indigenous scientific knowledge. Due to the complication mentioned earlier this CCIS did not occur. As a surrogate for this, the instructor showed a video in class of a current researcher who uses indigenous scientific knowledge as a basis for her research. The students in the focus group remarked concerning this saying "…they did a video, like a speaker…" and "…it was basically like a, like doing a presentation." The instructor also mentioned the use of the video in the faculty focus group. The instructor recalled how the students struggled with understanding the purpose of the video and the style of research that the video promoted. Also, to augment this CCIS, the instructor took the class the campus library to highlight the research resources available on campus. The students remarked unfavorably saying, "I mean, it could have been helpful, but [it was] the least helpful.” Additionally, another student remarked, “It could have been [helpful] for other people, but personally for me it wasn’t helpful.”

Treatment only theme: Course content – time intensive and course material overload. In the treatment course GEOL 101/102 a number of students expressed a feeling that the course progressed too quickly and relied heavily on students’ ability to follow fast-paced lectures. When asked the question in the focus group about the impression of the class one students said “He always had, like a ton of slides. So, it’s like, you didn’t even have time to take notes.” The student continued to explain that the instructor stated the slides would be made available to the students so that in-class note taking was not necessary. The student mentioned “But, I don’t know if it was always the best.” Another student corroborated saying “Yeah… He would just like sit back, and just… He was like, ‘click, click, click, click.’” Following this, another student elaborated, “And sometimes, there was like so many. There'd be like 200 slides for one week. So, you'd go back and try to find the slide you were looking for and it would just be like, taking forever. Because there's so many.” Other students expressed their frustration with this part of the class exclaiming “It’s just frustrating” and “It’s hard not to get frustrated.” This discussion lead to a deeper issue where the students expressed that the instructor is “…not very understanding. I think, when you try and tell him something, he feels like you're giving him an excuse.” The students further explained “…I was trying to say something to him, and he's like, ‘Well, why do I care?’ And I was like, ‘I'm just letting you know, I'm going to be late.’ And he's like, ‘Well not my problem.’” A student concluded “I mean, otherwise, class-wise, like, it was good. Just, if, if you have a problem or something, and you try to talk to him, he doesn't seem too understanding.”

In the treatment course ENVS 203, that is instructed by the same instructor as GEOL 101/102, the students expressed less concern with the instructor and more with the course content. One student summarized saying, “I liked it, there's a lot of content to cover.” Another student agreed stating, “I thought the same thing, there was a lot of content.” When exploring further, the student clarified saying, “Yeah, a lot of work too, just with the, the blogs and the reading, the peer teaching kind of build up to, like, it was, it was, it's a tough course but it's a really good course, so, like, I learned a lot man. More about weather and climate in one class than I have my entire life, so.” Similar to this student’s general evaluation that, “it’s a really good course,” other students provided consensus that it was helpful. One student explained, “I think it's pretty well structured. Because I kind of thought about that, how we had to cover four chapters in basically two class periods with the teaching exercises and then, if we actually had to read and do it on our own it probably would have been a lot longer and a lot more work.” Another student agreed saying, “Yeah, I kind of actually really, I kind of liked how the class was structured, I don't really, besides all the blogging ideas kind of petered out at the end, that would probably be the only thing I'd really be able to say.”

In the treatment course BIOS 410, some students expressed a similar concern while others felt the opposite. One student summarized, “It felt like it was time-intensive.” Another student explained, “I think the only other thing I might add is it was… I thought it was a little bit intensive, as far as how much time it took up outside of class... I think it's hard for some teachers to consider that we have full loads, or in some cases, people have children and stuff.” Other students took issue with the amount of time some portions of the class took. One students mentioned “…you know, like, not everybody participates, and that's okay, because not everybody feels comfortable participating, but, I think if they just gave more knowledge, they were better structured sessions." Another student followed saying, "…a set time with it instead of open, because sometimes it would go on for like, a half an hour or longer." Finally, a student concluded saying, "…it either drug on, or it was not an effective use of time, or ... Not an effective use of time." When following up with the rest of the class some students disagreed. One student mentioned, "I don't [agree], just because it's a 400-level class…I am surprised that it is a level 400 class…I'm just surprised that like SKC has 400-level classes. Like, I thought that was neat. Because this has been my first one…"

In the treatment course SCID 114, the students expressed similar issues with time and rigidity in the course structure. While the theme was present in this course it was less pronounced than the previous courses. One student mentioned specifically, "It's like deadlines for us were firm and that there was also two definitive deadlines… and feedback probably would have been better." One other student agreed while following up saying, "Just towards the end, the pace of submitting the papers increased substantially, like one instance between the first [paper] and the second [paper] it was like three weeks." Many agreed that the pace of the assignments caused concern. One students summarized, "It was like much faster paced and a lot of people were still trying to figure it out…" Despite some misgivings, some students related the overall benefit of the course. One student remarked "So, by the time the end of the course I can actually see my improvements compared to when I first did my first draft going to the end and me being able to organize the structure and you know, stuff like that, like um, some technical things to my paper. So, personally I felt like it helped benefit me in the scientific portion of my degree." Another student noted "I really liked too… with everybody's presentation, like how much we all kind of learned… as a whole and the class… I kind of learned a lot from the presentation and all the different topics and things."

Treatment only theme: Cultural content – covered well / valuable / learned a lot: One of the final themes that was unique to the treatment courses as a whole was the positive responses to the cultural content added to some of the courses. The treatment courses GEOL 101/102 and ENVS 203 were the exception. The students found the courses lacked a cultural connection. One student in GEOL 101/102 exclaimed "…I don't think there's much culture involved or anything. It definitely wasn't any stories or anything, or any kind" Another student in the course corroborated exclaiming, "Like, at all." Further, another student explained "It was pretty scientific based." After this comment a student recalled, "…that first day, when we were, kind of, talking about those stories and stuff." Another student from the course remembered "Yeah, The field trip. Yeah. Besides that, there wasn't anything cultural." In ENVS 203 the students did note the connection of some cultural content through the panel of professionals from the Confederated Salish and Kootenai Tribes that had worked on the Tribal Climate Change Adaptation Plan that was discussed previously.

In the course BIOS 410, the students reflected on the cultural content used in the course. One student commented about the instructor saying, "It's not like she's out of touch and stuck to the material and the text…" while another student interjected, "yeah, it's very culturally relevant." Following this, the same student explained that, "I guess too she brought up more [culturally] traditional stuff for this class than I've had in any of my other classes." When probed further, the students were asked if the content was tribally specific or representative of general Native American in context. All of the focus group participants agreed that both were brought into the course. One student then pointed out that, "…I mean, even I thought, uh, I know I've thought it before, but also just having to, you know, know the difference between, you know, tribal ecological knowledge compared to western science…" Other students followed up expressing that "Personally, it made me feel better as a tribal member to know that we're doing something."

In the course SCID 114, the students reflected on a few but memorable cultural content components used in the course. One student recalled generally stating that, "Having a way for indigenous students to be able to include those vital morals to our lives into our papers, is to me, beautiful and I'd love to see that change in scientific literature for the betterment of planning. But uh, that was definitely my favorite part of the course." When exploring further the student remembered a specific assignment that contributed to this feeling, the student said, "Yeah we, it was a whole activity where we made an outline that included our, our sciency stuff and then our feelings too." This spurred another student to remark that, "kind of incorporated like a cultural like feel to what we were talking about." The course participants then agreed that there were many examples used in the class that had local tribal context. One student remarked that, "The native stuff was more fun like watching the presentation, what the students did, not really from the instructors." The student elaborated saying, "Well basically a lot of the stuff that I'm talking about, you know, I basically referenced a lot of the tribes in the northwest and everything… but most of it was referencing other native tribes within the local area of within Idaho or Washington."

Faculty Focus Group Reflection

Some faculty expressed concern with implementing some of the CCIS. One faculty member expressed difficulty in arranging guest speakers and tribal elders. It was stated that on these occasions the invited guest/tribal elders only showed up about 1/3 of the time. However, it was also stated that reaching out to the local tribal and professional community is much easier than at other institutions and also supported by the SKC administration. When guests and elders did attend, the faculty noted that students were more engaged and actively listening. Another instructor noted that tribal elders were very liberal with time and consumed the entire class period. This instructor found this to be acceptable yet was not prepared to give up this much time in the course schedule. This challenge was discussed where familiarity with the tribal elders would help in planning future invitations. Further, there was discussion on the potential success of bringing the class to the tribal elder or professional to allow more control over time. Additional considerations discussed were timing these event later in the course. This would allow students to have additional time to absorb content material, so they may establish a broader knowledge base to formulate questions for the eventual visits.

The faculty also discussed issues related to the incorporation of cultural content in their respective courses. Most faculty conveyed that the use of some CCIS related to content was an easy fit into their course schedule and was well received by the students. One instructor noted that their use of the local language was well received by the students. Another instructor found that students that were receptive to cultural content additions were more likely to come to their office to ask questions and engage in class discussions. Additionally, the instructor found these additions very effective while pointing out that more effort will be place on incorporate more into other courses. Continuing, it was also found that consistent feedback from students verify that they greatly appreciate the cultural content added to the course. One instructor contradicted this observation indicating that the addition of tribal content was not effective based on their students' responses and conversations. This instructor reevaluated stating that the student enrollment in their course was too low to judge the effectiveness of the cultural content additions.

Other CCIS highlighted in the focus group illustrated some of the challenges and success of their implementation. One instructor noted that providing students with a choice increased engagement and positive feedback. Some courses encouraged students to choose topics that were relevant to their tribal communities. The instructors further discussed how students choose their topics about their tribes or cultural issues of importance and then present them to their peers. These student presentations were found to be an important part of successfully in engaging all the students in these course.

In all, most faculty found that the addition of CCIS improved part of their courses. In their opinion, improvements were seen in increased student engagement in the course through specific CCIS such as the use of Native languages in the class, using issues relevant to tribal communities, allowing students to share their knowledge from their communities and the use of field trips and guest speakers from the community. Faculty also found challenges in implementing CCIS. Specifically, small class sizes, short 10-week quarter system and lack of understanding of assessment types.

Chapter V: Conclusions and Recommendations

Conclusions

This study hypothesized that culturally congruent college science courses designed and taught in alignment with the CCIS will improve American Indian student attitude and achievement in science. During the study, select STEM courses were modified in specific ways, using elements identified on the CCIS, in an effort to improve the cultural congruency of instruction. As these select courses were taught, student attitude and outcomes data were collected, analyzed, and examined. The research questions that this study addressed were:

1. (Quantitative) How does CCIS influence American Indian students' attitudes and achievement in natural resources science at a tribally controlled college?
2. (Qualitative) What is the nature of the relationship between CCI course modifications and changes (or lack of) in American Indian students' science attitudes and achievement at a tribally controlled college?

One of the primary challenges faced in this research was supporting faculty modifications of their courses. All the participating faculty members developed a plan for course modification using CCIS after one-on-one consultation and follow up meetings. The faculty members were then tasked with implementing the changes. Faculty received some support through the implementation stages, yet largely faculty were given the freedom to implement the CCIS to maintain the flow of their existing course. The frequency and variety of CCIS used were governed by variables such as time, number of years teaching the course and flexibility in the overall program curriculum to adapt changes. Additional challenges were found due to a declining student enrollment count SKC has been experiencing over the last five years. This trend resulted in uncharacteristically low enrollment in some of the treatment courses. These and other conclusions, recommendations and implications for future research will be discussed.

First, the perspective of the researcher must be emphasized and elaborated as it will serve as a lens to interpret the results. Knowing that the researcher translates meaning through a Salish worldview, this epistemology will be briefly described to serve as a guide for the following conclusion of this study.

The researcher's mother is a Salish Indian, and the lifeway's, knowledge system and view of the world from a Salish perspective have shaped him. Defining the philosophy of the Salish people as a whole may be beyond the scope of this research, however the researcher can provide a cursory understanding of the knowledge base of the Salish people and how this philosophical system is similar to those that are mentioned in Ozmond and Carver (1981).

The general tenets of the Salish philosophy are found in many parts of Salish lifeway's, culture and language. First, exploring the Salish philosophy from the foundations of Plato's idealism, one can begin to understand the similarities while situating the main points in the perspective of a theory of knowledge. Plato's theory of knowledge is founded on the idea that reality operates as a standard according to which belief and perceptions can be measured; where ideas or forms are the source of all true knowledge (Ozmon & Craver, 1980, p. 4). Plato mistrusted sensory data from the material world, citing its ever-changing nature as a source of mere opinion rather than true knowledge (p. 4). Similarly, Salish philosophy perceives knowledge originating from sensory data, yet the ways of knowing and the areas of knowing that are populated by this sensory data are not generally mistrusted. Also, the idea of spirit and spirituality are thought of as among the group of sensory data. This may include but not be limited to dreaming, intuitions, visioning.

In the Salish philosophy, the physical response either in body or in matter exists outside the metaphysical processes of emotions, mental capacity and spirituality. This is evidenced in the language. Salish people, when asking what one is thinking says "*Stem̓ aspuʔus*? [What's in your heart?]". The heart becomes the center of a form of thought, the emotional process that guides understanding, and also decision and logic. The mental process involves an awareness of the Salish concept of *mi* [acts and realities] and the quality of *pẋpáẋt* [wisdom or cleverness]. Mental and emotional components are interlinked, where thought and emotional responses are determinant on how facts and realities are linked to the physical realm. The physical realm acts upon the emotional and mental capacity though sensory input, thereby affecting the mental and emotional wellbeing of the Salish individual (Figure 11).

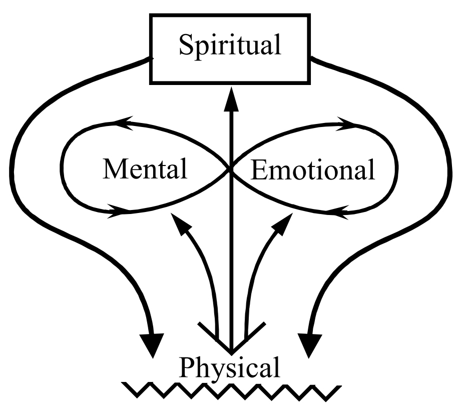

Figure 11. Working model of Salish philosophy

A spiritual force within and outside the body is largely accessed through this mental, physical, and emotional triad. The spiritual realm acts upon the physical world and affects to provide both good and potentially bad outcomes and products. Spirituality is the provider of the matter that comprises the physical world and thus the origination of the emotional and mental process. This is similar to Aristotle's ideas of form and matter, where a physical being always exist as that physical being, however the matter from which it is made can change and has, in essence, a soul that guides and directs its form (Ozmon & Carver, 1980, p. 42). Salish spirituality, in this vein, is then thought of as existing in all physical forms, from rocks and twigs to insects and bears. Further, spirituality in the Salish philosophy surrounds everything and guides all physical, emotional and mental matter. The truth, then, is thought of as the spirit and spirituality in a Salish worldview.

A revised model of Salish epistemology (Figure 12) included verification of understanding and knowledge through interaction with others. The progression from the working model shows an individual exchanging emotional thought (emotions represented by the heart and intuition represented by the spiral) and mental thoughts (logic represented by the square with four compartments and order/cataloging represented by four parallel lines) concerning the physical world (represented by the figures resting on the zigzag lines). The observed physical world through emotional and mental thought are confirmed or rejected by the individual's social structure (*sq̓eymułx*ʷ or tipi shapes above the individual). The spiritual power (circle with zigzag lines radiating from it at the top of the diagram) delivers the truth through spiritual guides manifested in the physical world. The individual seeks the truth through communication with the spiritual realm in hopes to shape the physical world into a form that is beneficial to members composing the social structure and themselves. This research utilized this concept to guide the interpret the results and draw conclusions from the research questions.

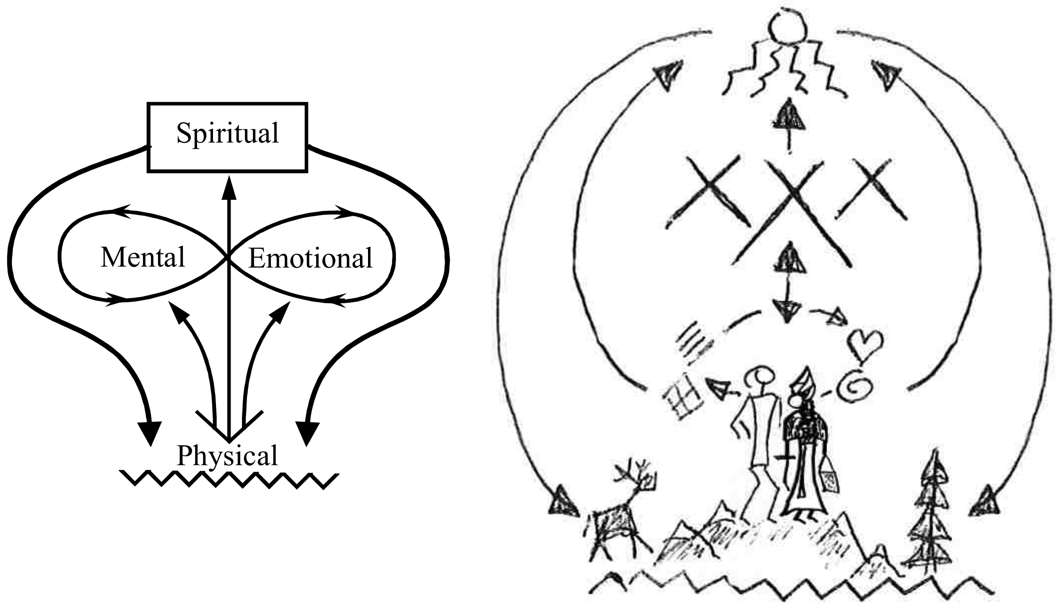

Figure 12. Progression towards a conceptual model of Salish epistemology

Research question one (Q1). To address how CCIS may have influenced American Indian students' attitudes and achievement in Natural Resources science at a tribally controlled college, a representative sample was needed. At the time of the study, there were 801 students enrolled at SKC and 463 were members of a Federally recognized tribe. The final treatment course sample size represented 4.2% (n=34) of the total student population and 4.8% (n=22) of the total American Indian student population. More specifically, the treatment group represented 40.0% of the all students enrolled in the Natural Resources degree programs (Forestry, Hydrology and Wildlife/Fisheries). Also, the treatment courses were comprised of 97.1% STEM majors including 58.8% freshman and 23.5 % sophomores. The student population sampled at SKC represented a cross-section of American Indians in the beginning stages of seeking a STEM related degree.

ATSSA. An examination of the quantitative results revealed some contrast and similarities in attitudes and achievement in Natural Resources science. The attitude toward science of the American Indian students in the treatment courses as measured by the ATSSA (Table 18) indicate that there was not a significant difference in the scores from pre-test to post-test conditions. However, the mean for pre- and post-groups was generally positive as indicated by a score greater than 42 (neutral).

This occurrence was not isolated to the American Indian students. There was also no significant difference in the attitude toward science of the non-American Indian students in the treatment courses from pre- to post-test conditions. From these results it can be assumed that attitudes from students of both ethnicities remained generally positive through the 10-week courses given exposure to varying levels of CCIS modification.

Many assumptions can be made from these results. One may be that not enough CCIS were used and those used were not implemented efficaciously to elicit significant attitude changes. Another assumption is that the attitudes of the students taking the courses were already fixed due to prior or coinciding events. Germann (1988), the developer of the ATSSA survey, recognized that there are many variables that interact with a students' attitude toward science. Germann explained that "the governing causes include worldview, belief systems, existing knowledge, lifestyles, life goals, needs, and drives" (p. 697). Further, Germann also recognized that the way in which a subject is taught is also a result of the instructor's own knowledge, worldview, belief systems, life goals, lifestyle, needs, skills and attitudes.

Aikenhead (1996) applied the metaphor of the border crossing to describe how a student may find congruence between these variables mentioned by Germann. Recall how Phelan et al. (1991) described four types of border crossings, Type I: Congruent Worlds/Smooth Transition, Type II: Different Worlds/Boundary Crossings Managed, Type III: Different Worlds/Boundary Crossings Hazardous and Type IV:

Boundary Impenetrable/Boundary Crossings Insurmountable. Since the attitudes toward science remained fixed, the students in this study may have experienced either a Type I, II or III border crossing.

Phelan et al. (1991) described a Type I crossing characteristic of students "values, beliefs, expectations and normative ways of behaving… for the most part, parallel across worlds." Students navigating this border crossing can do so unaided and with relatively little incongruence. Students experiencing a Type II crossing recognize that their family, peers and the educational institution are different and thus require added regulation of their own values and beliefs to align with the educational system. In the Type III crossing, like the Type II, students view the educational system as distinctly different. The difference between these two types are that the student may find transitioning between boundaries as hazardous, requiring special conditions in the "teacher's interaction style, the student's role, or the learning activity… similar to what takes place within the student's peer and/or family worlds" (Phelan et al., 1991).

The American Indian student in the treatment courses may have experienced one or a combination of these types of crossings to maintain the attitude toward science across the 10-week course. Figure 13 provides a model illustrating two scenarios from these results. In one case, the students' worldview and the tribal college are encompassed within the same larger social structure (Figure 12A). In other words, the culture of the college is congruent with the culture of the students. In the second scenario, there is a clear cultural boundary between the college, where for the most part the cultures are incongruent (Figure 12B). To understand if the addition of CCIS in the treatment courses is characteristic of one or more mediating factor, a closer examination of the control groups may be revealing.

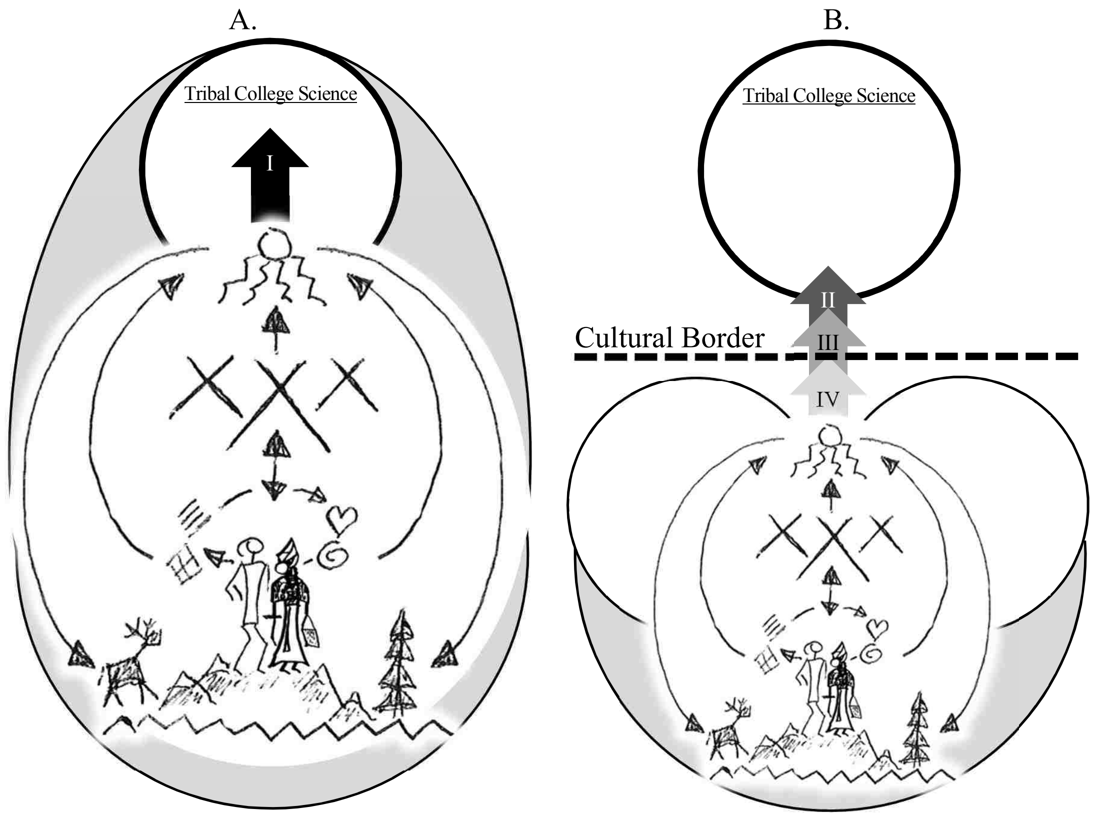

Figure 13. (A) model of a Type I border crossing, showing a student and tribal college epistemology as culturally congruent (Type I crossing). (b) A model of Type II, III, and IV border crossings, showing a student and tribal college epistemology as having a clear cultural border

When comparing the post-ATSSA score for students in the treatment and control courses without differentiation of ethnicity, it is apparent that there was a significant difference in attitudes toward science. However, there was no significant difference between America Indian students and their non-American Indian counterparts in neither the pre- and post-test (Table 6). There was a significant difference in one question found among the American Indians in the control group. The difference in the mean for questions #25, "I do not like science and it bothers me to have to study it," was negative for American Indians in the control group. Since this question response was inversed for scoring computation, the decrease in mean scores reflects an increase toward agreement with the statement after completion of the control course. While the ATSSA only measures one dimension, it is noted that some factor among the American Indian students in the control course contributed to a significant increase in agreement with the statement “I do not like science and it bothers me to have to study it.”

A closer look at the demographics of the sample reveal that of the 34 students in the treatment group, only two (5.9% of the sample) had a declared major that was not a STEM discipline. Additionally, all of the treatment courses in this study are required and discipline specific for the Natural Resources Programs (Hydrology, Wildlife and Forestry). Whereas in the control courses, 13 of 57 students (22.8% of the sample) had a declared major that was not a STEM discipline. Further, of these 17 students, seven were Tribal Historic Preservation majors, where the control course, GEOG 201, is required and a discipline specific course for that degree program. An additional three students in the control courses were Business majors, where MATH 241 is required and a discipline specific course for that degree program. The differences in STEM declared majors may be one factor contributing to the significant difference in attitude toward science between the student-wide sample in the treatment and control courses. It may be thought that STEM declared majors have in some way consciously decided to pursue a degree thus requiring an acceptance of the culture of science. This, while not exclusively, may stand to reason to assume that these students have already formed a positive attitude toward science. In one study, it was found that for African American, Latino and American Indians, the intent to major in STEM fields (as measured in freshman year) was strongly associated with persistence in STEM (Bonous-Harnmarth, 2000). Maltese and Tai (2011) further acknowledged that, while some students turn to a STEM major when they reach college, many students have already made their decisions before arriving to a college or university campus.

The pre-college influencing factors that mediate crossing the cultural science border into the world of science are crucial to understanding why students continue onto college in a STEM major. Costa (1995) recognized four categories of pre-college students in terms of border crossing; (a) ‘Potential Scientists’, cross borders into school science smoothly and naturally implying an invisible border; (b) ‘Other Smart Kids’, manage border crossing to a degree where there is no perceived sense of science being a foreign subculture; (c) ‘I Don’t Know’ students, confront *hazardous* border crossings while gaining skills to cope and survive; and (d) ‘Outsiders’, that are often alienated from school thus making border crossing into the culture of science in school virtually *impossible*. Costa (1995) suggested that “Other Smart Kids” and “I Don’t Know” Students employ a combination of Fatima’s rules (Larson, 1995) to negotiate the border crossing. Aikenhead and Jegede (1999) explain that,

> Other Smart Kids were able to manage their border crossing into the culture of science by playing Fatima’s rules cleverly and/or by constructing science knowledge in mental schemata and storing them in long-term memory accessible only when cued by a science exam. “I Don’t Know” Students also resisted assimilation, but their hazardous border crossings were coped with by conscientiously playing Fatima’s rules rather than by constructing schemata of scientific concepts. (p. 275)

Additional influencing factors are highlighted in Griffith (2010) where the researcher found that first year college students that had previously planned to major in a STEM field tended to have a higher average high school GPA and had completed a large number of AP courses in STEM fields. Also, Wang (2013) found that high school preparation in math and science plays a critical role in developing student interest in pursuing a STEM field influencing entrance into STEM majors. Other pre-college influences driving students to pursue a STEM major are early positive attitudes toward math, high math achievement, math and science course-taking, and math self-efficacy beliefs (Wang, 2013).

Understanding these influencing factors highlights some possible attributes of the participants prior to this study. For example, if the participants viewed the culture of the tribal college as embodying their worldview in as far as how the administration and education strands operate, then the scenario in Figure 12A would be descriptive. This, however, depends on a measure of worldview of the college and the student to confidently state. Largely, the tribal college system emulates a community college model of higher education (Stein, 1992). This provides difficulty for tribal colleges to provide a structure that reflects the unique culture and worldview of tribal people. The founder of the first tribal colleges understood that they "couldn't just prepare tribal students to be proficient in their own cultures" (Stein, 2009, p. 18). It was recognized that the tribal colleges needed to embrace the structure of standard post-secondary education to serve a dual purpose of enhancing culture and to prepare students to live productively in main-stream society (Stein, 2009). Understanding that foundational structure of the tribal college, there remains an unknown as to the varying worldview among the American Indian participants. However, it is likely, and assumed that worldviews are reflections of their respective tribal affiliations. Given that the tribal colleges framework is not crafted from a cultural foundation, it is likely different than that of the American Indian students' worldview. With the results from this study it may be presumed that a Type I crossing would remain possible, yet undetermined. Further examination of the results may reveal more details.

MSLQ: Other considerations that shape attitude toward science are practical motivations that steer students toward considering a STEM major. Federman (2007) found that high school students' likelihood of enrolling in and completing a college degree in a STEM field are associated with early mathematics and science achievement, advanced course enrollment, and students' reports of science being useful in their future. The Motivated Strategies for Learning Questionnaire (MSLQ) used in this study relied on two components, the expectancy and value component. The Expectancy Component measured students' beliefs that they can accomplish a task or the self-efficacy for learning and performance. The Value Components concentrated on the purpose of students' engagement in an academic task. This component measured two subscales, Goal Orientation (a focus on learning and mastery) and Task Value Beliefs (interest, usefulness, and importance the course content) (Pintrich, Marx, & Boyle, 1993).

The belief in yourself to accomplish a task and the purposefulness of the task for American Indian students in the treatment courses as measured by the MSLQ (Table 17) indicated no significant difference from pre- to post-test conditions. Similar to the ATSSA, the mean for pre- and post-groups was generally positive, as indicated by a score greater than 45 (neutral). An evaluation of individual components also revealed insignificant differences (Table 17). The American Indian students in the control group did experience a significant change from the pre- to post-survey in the Value Component for the Goal Orientation and Task Value. These findings suggest the American Indians in the treatment group maintained a relatively positive belief in their ability to accomplish a task and the purposefulness of the task whereas the American Indians in the control group experienced a significant increase in these same factors after the 10-week courses. Further, among the American Indian students in the treatment course, there was a significant difference in the means from pre- and post-responses for question #45 (p=0.05). The difference in the mean for questions #45, "I like the subject matter of this course" provides further evidence that American Indian students view the course positively, lending to their belief in their ability to accomplish a task and the purposefulness of the tasks found in the course.

Another noted significant difference is found in the student-wide treatment and control mean post MSLQ Expectancy Component-Self-Efficacy for Learning and Performance scores. From these results it can be surmised that the treatment group, including American Indian and non-American Indians, exhibited a more positive judgment in their ability to accomplish a task and confidence in their skills to perform a task while holding the beliefs that outcomes are contingent upon their own efforts, rather than external factors (Garcia & Pintrich, 1995). While the American Indians in the control group saw a significant increase in their overall expectance component, the treatment group as a whole scored significantly higher. These results lend to the idea that treatment course students entered and maintained attitudes toward science along with a confidence in their ability to accomplish tasks in the course. However, it is difficult to assess whether the CCIS had an impact to impart these results. Maintenance of these qualities is revealing and helps to shed light on the type of border crossing these American Indian students used and if the crossing achieved positive results.

Course achievement: Research on self-efficacy of American Indian college students indicate that this belief and subsequent confidence is correlated to increased academic achievement, resilience, and persistence (Jackson, Smith, & Hill, 2003; Montgomery, Miville, Winterowd, Jeffries, & Baysden, 2000). An examination of achievement through individual student summative (midterm and final tests) and formative scores (graded reports, essays, quizzes, activities) provided additional answers. When comparing the formative and summative assessment scores for students in the treatment and control courses, it is apparent that there was a significant difference (Figure 8). Treatment course students scored higher than their control course counterparts for both assessment types. This result is echoed when comparing American Indian students in the treatment and control groups (Table 21). This achievement was not isolated to the American Indian students. Their non-American Indian counterparts in the treatment group also outperformed the non-American Indians in the control group for both assessment types.

These results provide further evidence to characterize the border crossing American Indian students perform in these courses. Recall that a Type I crossing (Congruent Worlds/Smooth Transition) requires congruence of worldview, belief systems, existing knowledge, lifestyle, life goals, needs and drivers with the course and its instructor. Also, full-time Natural Resources faculty comprised 10.6% of all faculty with 1.5% (1) American Indian; in this study there were no American Indian faculty teaching treatment or control courses. It may be assumed that the non-American Indian students may be typified by a Type I border crossing as illustrated in Figure 12(A).

Given these results and those discussed previously, American Indian students may be assumed as having epistemologically different foundations than their non-American Indian peers. For example, Fryberg and Markus (2007) found that non-American Indian undergraduate students, particular those of European descent, were more likely than American Indian undergraduates to associate education with the acquisition of knowledge. Whereas American Indians in the same study generated some negative responses and some family-related responses while remaining significantly more likely to associate "family" to "education" (Fryberg & Markus, 2007). This may lead to a stronger assumption that American Indian students are less likely typified by a Type I crossing. More typical may be a Type II (Different Worlds/Boundary Crossings Managed) or a Type III (Different Worlds/Boundary Crossings Hazardous) crossing mediated by pre-existing attitudes toward science, belief in their ability to accomplish a task, and the purposefulness of the tasks found in the course (Figure 14). These findings and the resulting high achievement in the treatment course provide more evident to suggesting that CCI influenced or maintained the American Indian students' attitudes and achievement in Natural Resources science.

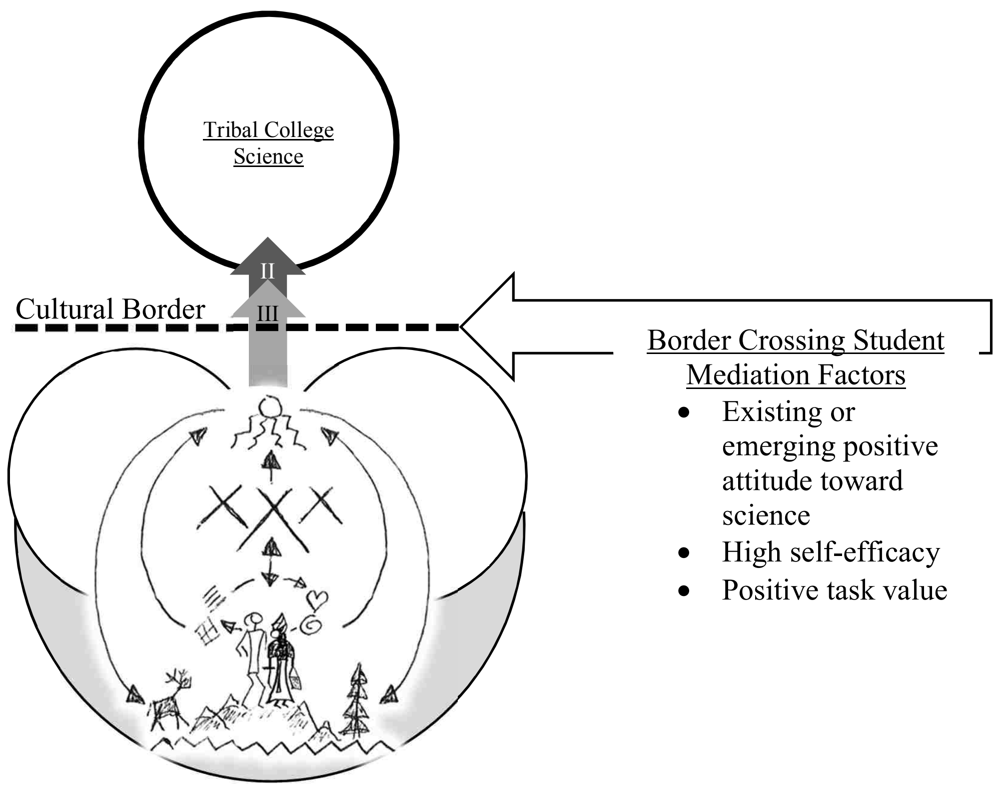

Figure 14. Student mediating factors facilitating Type II and III border crossings

CCI: Tribal colleges are championed as being the forerunners in the integration of Indigenous knowledge and Western Science (Boyer, 2008) and most SKC Natural Resources courses consider traditional knowledge in parallel with mainstream scientific knowledge. It has been recognized that there remains concern about the success of incorporating culture, language and values into the curriculum and pedagogical structures of these programs (Wheeler, 2004). An examination of the results from the post composites CCI survey verify, from the students' perspective, that both treatment and control courses scored similarly. Similarly, post CCI scores for the individual components (Course Content, Instruction and Future Success) were not significantly different between treatment and control courses (Table 16). These results indicate that the students in treatment and control courses did not experience a significant difference in the pre-survey that gauged students' initial evaluation of cultural content, culturally congruent instructional strategies and its benefit to their future success in the classroom and the post-survey gauging the students how well the course embodied these components. In other words, the participants in both groups did not expect cultural content nor value it any less or more than what they were previously accustomed to.

One of the challenges mentioned previously is evaluating how well faculty members implemented CCIS changes. From these results it appears that students felt that treatment course and control course attempts were similar. However, when examining the pre/post CCI results from the treatment courses it is revealed that there is a significant difference in the composite CCI and two of the components (Course Content and Instruction) (Table 16). A similar examination of American Indian student's pre/post CCI scores indicate a significant difference in only the CCI course content. Some notable significant differences are also seen when comparing American

Indian and non-American Indian students in the treatment courses. The American Indian students exhibited significant differences in agreement from their non-American Indian peers on questions #14 “Including oral histories and traditional stories helped me to grasp the science concepts in the course better” and question #22 “The use of Native languages in the course would help me to grasp concepts we study.” These results point to some of the required special conditions in the “teacher's interaction style, the student's role, or the learning activity… similar to what takes place within the student's peer and/or family worlds” (Phelan et al., 1991) that are typical of a Type III crossing (Different Worlds/Boundary Crossings Hazardous).

Additionally, American Indian students' pre/post CCI results show a significant increase in response to question #4 “Collaborating with other students on course activities/assignments improved my understanding of the concepts in this course” and question #22 adding to some other CCIS encouraged in the treatment course. The previous results, suggesting some mediating factor for border crossing, along with the CCIS practice highlighted in this survey may provide additional support to facilitate the students' ability to cross the cultural border (Figure 15). Yet, it is still unclear if students were more characteristic of a Type II crossing where students require added regulation of their own values and beliefs to align with the educational system.

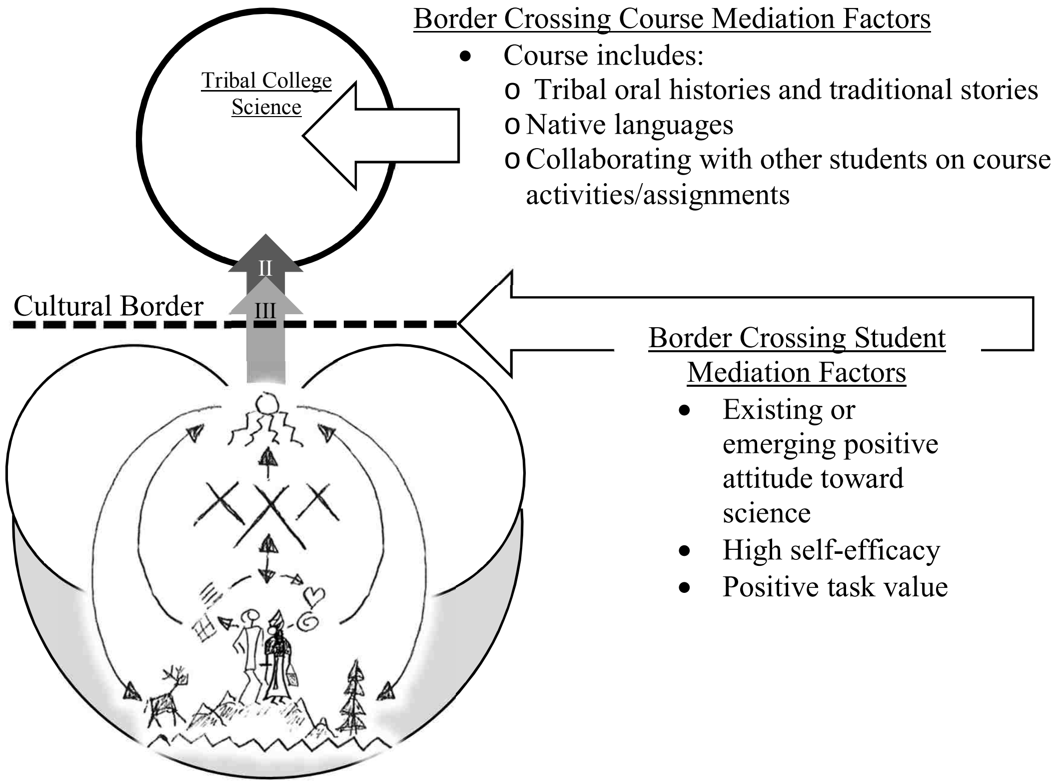

Figure 15. Students and course mediating factors facilitating Type II and III border crossings

Research question two (Q2). Determining the nature of the relationship between CCIS course modifications and changes (or lack of) in American Indian students' science attitudes and achievement at a tribally controlled college required a closer examination of the similarities and differences in certain aspects of the treatment and control courses. First, it is acknowledged that there were many factors that may be attributed to these results that were not captured in this case study.

Theme similarities: When examining the nuances from the student focus groups among the treatment and control courses the common theme "Hands-on real-world applications and examples" and "Course is valuable to my future" surfaced.

Research suggested that holistic approaches in which learning is connected to students' lives provide a bridging between classroom science and their everyday life (e.g. Dori & Tal, 1999; Falk, Koran, & Dierking, 1986; Hofstein & Rosenfeld, 1996). Also, research specific to American Indian students has advocated for similar approaches such as service learning, hands-on learning, and field trips (Cleary & Peacock, 1998). In their review of culturally responsive education for Indigenous youth, Castagno, McKinley and Brayboy (2008) found that some of the most commonly cited learning styles for Indigenous youth comprise of visual, hands-on, connecting to real-life, direct experience and participating in real-world activities. The testimony in these cases give credence to the evidence found in the literature validating the partiality of these activities in the undergraduate science classroom.

These results also exemplify that such activities are not isolated to benefitting only American Indian students, but rather reflect best practice when teaching STEM content such as out-of-class learning environments (Brower & Inkelas, 2007; Fuller, 2006; Mogk & Goodwin, 2012; Orion & Hofstein, 1994; Tal, 2001) and real-world application using authentic data (Barker, Bressoud, Epp, Ganter, Haver, & Pollatsek, 2004; Remillard, 2005).

In the workshops with treatment course faculty the CCIS "Use science activities in which students design solutions to problems relevant to their community" was expressly advocated. This may account for the prevalence of the previously mentioned themes appearing in the treatment focus groups. Understanding why the themes also surfaced in the control focus groups may be explained through an understanding of SKC's overall general education philosophy. All course at SKC are encouraged to develop student learning outcomes that embody the '4Cs' (critical thinking, cultural awareness, citizenship, and communication). These general education objectives are encouraged in all academic areas for development of students' skills in these four areas. Additionally, triannual faculty in-services typically provide an exchange of best practices between junior and senior faculty. However, the efficacy of the course instructor to meet these objectives relies on many factors that were not captured in this study. A closer look at the teaching experience of the instructors in treatment and control course highlighted a wide range of expertise, ranging from two to 34 years at SKC and one to 17 years of other relevant professional and/or teaching experience. Treatment course instructors averaged 14 years of experience at SKC and 8.3 year of other relevant experience outside of SKC. The control course instructors averaged 9.7 years of experience at SKC and 3.7 year of other relevant experience outside of SKC. How these data, and the discussed themes here are linked are difficult to establish given the small instructor sample and external factors effecting instructor self-efficacy (Tschannen-Moran & Hoy, 2001; Vera, Salanova & del Río, 2011).

The link between these two themes may also be attributed to the students' educational choice as discussed previously along with the results from the MSLQ analysis. The MSLQ suggested that American Indians in the treatment group experienced no significant changes in their belief of their ability to accomplish a task and the purposefulness of the task. Whereas the American Indians in the control group experienced a significant increase in these same factors after the 10-week courses.

Further corroborating this finding are results from one study on American Indian college students where the researchers found that on average “American Indian students believed in the instrumental value of education (p. 166)” and “believed that education has a pragmatic purpose in helping them achieve their personal goals” (Okagaki, Helling, & Bingham, 2009, p. 166). Again, validating earlier assumptions that the opinion of the students expressed in the treatment and control course focus groups may reflect a pre-established usefulness of their chosen majors and post-secondary education overall.

This suggests that tribal college science departments could further assist in mediating border crossings for American Indian students through efforts to further develop their STEM department to highlight practical applications that benefit the American Indian students' community. It has been recognized that many tribal colleges face a myriad of roadblocks including securing stable funding, maintaining student enrollments, and recruiting and retaining qualified faculty and staff (Philips, 2003). Yet despite these challenges, tribal colleges award a relatively large number of bachelor's degrees in many STEM fields to American Indian and Alaskan Natives; notably 15.5% of all agricultural sciences degrees and 2.3% of all earth, atmospheric and ocean sciences degrees nationally (National Science Foundation, 2009). This points to the potential for growing this success through stronger departmental emphasis on the practicality of STEM programs for assisting the border crossing for American Indian students at tribal colleges (Figure 16).

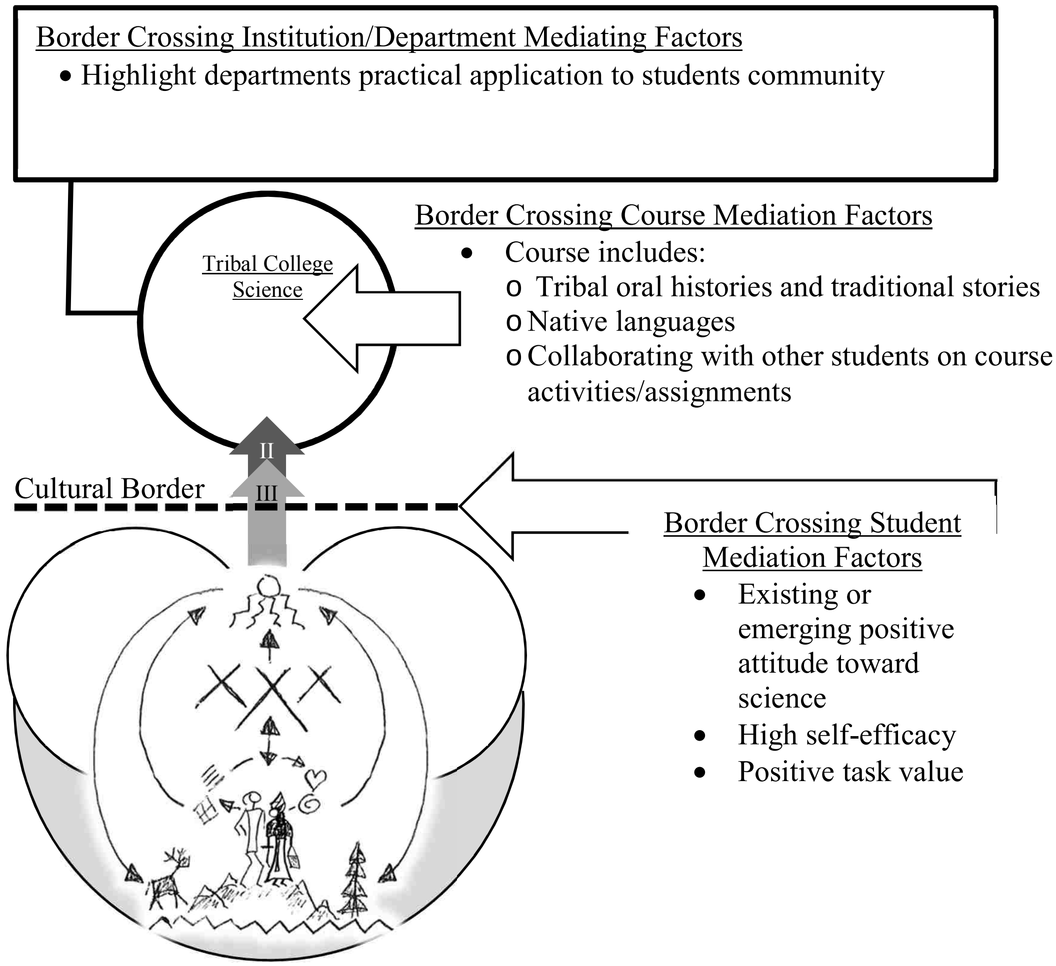

Figure 16. Tribal college science institution/department, science course and student mediating factors facilitating Type II and III border crossings

Theme differences: Some distinctions are noted as reflected by the students in the treatment courses. There were three themes that did not appear in the control course focus groups. The themes "Guest Speakers and Field Trips" and "Cultural Content Covered was Valuable" are assumed to arise from parts of the CCIS that were promoted in the faculty workshops and trainings for treatment course instructors. Instructors made these efforts to provide differentiation between the treatment and control course even though, at SKC, it is encouraged that all faculty craft their courses to consider traditional knowledge, tribal culture and worldviews of Native people.

Initial results from the CCI survey showed that students in treatment and control courses did not experience a significant difference in the pre-survey that gauged students' initial evaluation of cultural content, culturally congruent instructional strategies and its benefit to their future success in the classroom and the post-survey, gauging the students on how well the course embodied these components. However, the researcher captured the opinion of students that stood out during the focus groups. Statements such as “I guess too she brought up more [culturally] traditional stuff for this class than I've had in any of my other classes” and “Having a way for indigenous students to be able to include those vital morals to our lives into our papers, is to me, beautiful and I'd love to see that change in scientific literature for the betterment of planning. But uh, that was definitely my favorite part of the course” provided some evidence that the CCIS may have impacted the nature of the course. However, there were conflicting messages in some of the other courses. One students said, “…I don’t think there’s much culture involved or anything. It definitely wasn’t any stories or anything, or any kind” while another student noted “Yeah, The field trip. Yeah. Besides that, there wasn’t anything cultural.” These statements provide conflicting evidence of the successful implementation of some CCIS, yet highlight the perceived value of field trips and guest/elders from the local and professional community as part of the mediating factors for American Indian students border crossing (Figure 17).

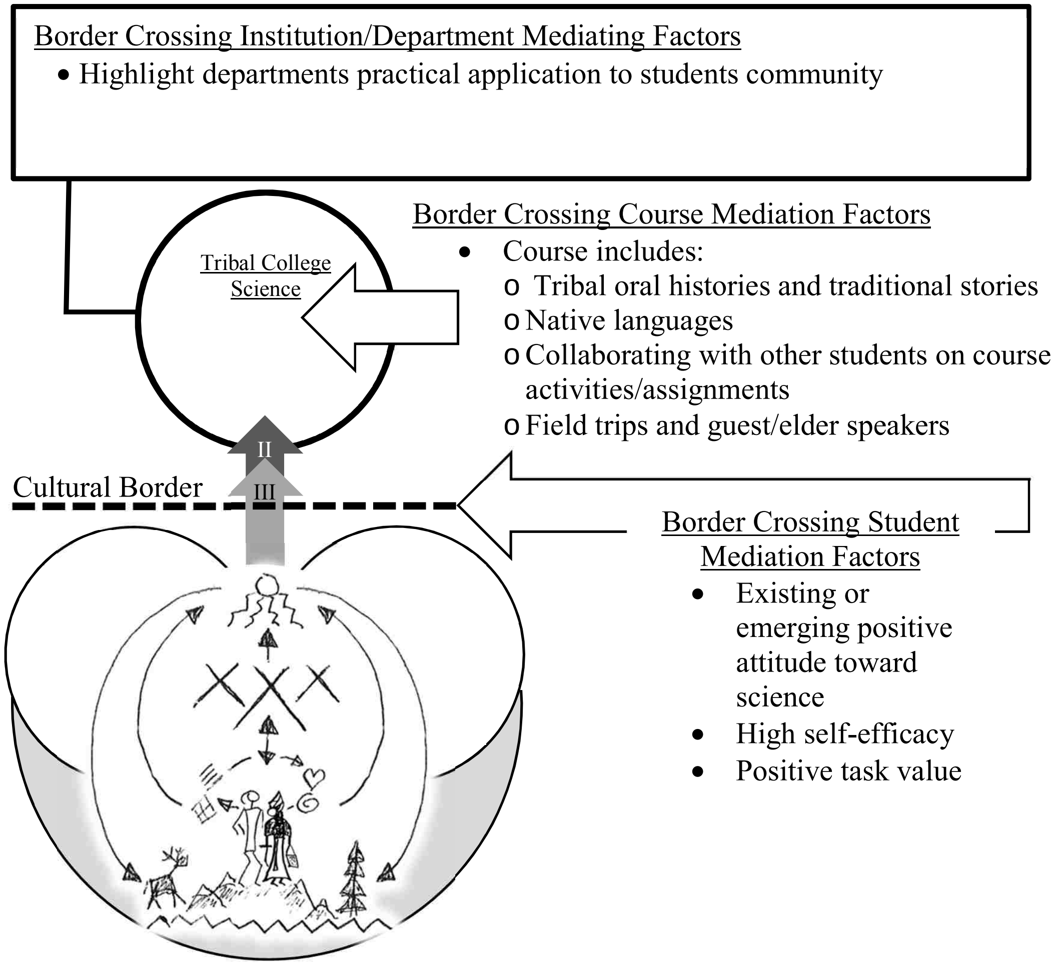

Figure 17. Additional tribal college science institution/department, science course and student mediating factors facilitating Type II and III border crossings

Some suggestions to improve the fidelity of CCIS are drawn from past research. In the status report for The National Academies National Research Council Board of Science Education, Fairweather (2008) recognized professional development as a means to improve faculty teaching. However, Fairweather (2008) recognized that faculty members participating in professional development activities are already "committed to improving their teaching" and have already implemented "somewhat successful pedagogies" (p. 9). A large majority of STEM faculty are resistant to adopting effective teaching strategies due, in part, to institutional value of research over teaching (Fairweather 1996; Massy, Wilger, & Colbeck, 1994) and faculty perception that pedagogical modification equal having less time for research (Fairweather, 2005). Fairweather (2008) suggested that "the greatest gains in learning productivity are likely to come from finding ways to engage this large group of STEM faculty in any form of pedagogy that increases student engagement" (p 10). It is difficult to determine where faculty participants fit in these descriptions. The professional development employed in this study was voluntary, yet monetized, which may have been a motivating factor. One thing is clear, faculty unanimously expressed positive reaction to the approach on this study to improving their instructional practices.

Results specific to American Indian students in the treatment courses provide further insight. The pre- and post-CCI scores for these students indicated a significant difference in their opinion of the CCI course content and its implementation. Overall their scores showed a decrease in the course CCI content component possibly a reflection of some of the neutral and negative comments from the focus group results. However, some notable differences are also seen when comparing American Indian and non-American Indian students in the treatment courses. The American Indian students exhibited significant differences in agreement from their non-American Indian peers in the post-CCI survey on questions #14 "Including oral histories and traditional stories helped me to grasp the science concepts in the course better" and question #22 "The use of Native languages in the course would help me to grasp concepts we study." This may indicate that the attempts by instructors has some but limited effect.

A closer look at the treatment course instructors reveal some stark differences that may provide some explanation. Instructors with the higher RTOP scores and greater relevant experience outside of SKC taught the courses (BIOS 410 and SICD 114), where positive remarks were made from students falling in the themes “Guest Speakers and Field Trips” and “Cultural Content Covered was Valuable.” Negative or non-existing remarks emanated from the courses (ENVS 203 and GEOL 101/102) taught by the instructor with the lower RTOP and least relevant work experience. Another important distinction is that the instructors for BIOS 410 and SICD 114 were female while the instructor for ENVS 203 and GEOL 101/102 was male (See table 22).

The apparent divide between student opinions on some of the CCIS as delineated by instructor gender is significant. Past research on the differences between female and male professors in higher education have suggested that that female professors often place greater value on encouraging student interaction and seeking outside assistance in attempting to improve their teaching whereas male professors place greater value on assessment of students (Goodwin & Stevens, 1993). More recent research reported that female faculty were significantly more likely to incorporate student-centered teaching practices (such as class discussions, reflective journaling and cooperative learning) than their male colleagues (Hurtado et al., 2012; Eagan & Garvey, 2015). Further, Hurtado et al. (2012) in their survey of 23,824 full-time faculty members at 417 four-year colleges and universities found that female faculty (33.8%) were much less likely than male faculty (52.7%) to use extensive lecturing as an instructional method in their classes. These findings align with the case study presented here where the course instructed by the female faculty (BIOS 410 and SCID 114) average RTOP scores (70 and 74, respectively) falling near the middle of the category “Active student participation in the critique as well as the carrying out of experiment” whereas the male faculty (ENVS 203 & GEOL 101/102) averaged an

RTOP score (44 and 38, respectively) falling near the middle of the category of "Lecture with some demonstration and minor student participation". It is also noted that the control course instructors were comprised of an all-male cohort. This may have had unintended consequences given the research on the differences in female and male regarding faculty objectives for undergraduate student learning.

The third theme, "Time Intensive and Course Material Overload", also emerged only in the treatment course. Given the previous discussion, the prevalence of this theme may have been in response to instructor differences. In the course GEOL 101/102 and ENVS 203 the students were split in their impression of the course. Many students in GEOL 101/102 expressed frustration with some of the instructor's teaching activities. Most of the comments were centered on the power-point heavy lectures, inflexible deadlines and excessive assignments. Conversely, the same instructor received fair to neutral remarks for the ENVS 203 course. Some remarks centered on the indifference to the amount of assigned work while others found value in the content and structure of the course. These remarks are consistent with the instructor RTOP score and evaluation of these course.

The remaining treatment courses, BIOS 410 and SCID 114 also received some neutral to negative responses concerning the courses. In BIOS 410, the common concern was effective use of time. One student specifically mentioned that "It felt like it was time-intensive." Similarly, student in SCID 114 converged on the issue of deadlines and submission rates of course papers. However, there was no mention of disparity related to lectures or other activities in these courses. One of the promoted CCIS was flexibility with time (e.g., changed scheduling of instruction to meet individual students' needs). As discussed previously, specific pedagogical changes may not always be embraced by faculty due to institutional pressures or individual professional goals. Also, as mentioned by the faculty participants, the short 10-week quarter, may be insufficient time to fully realize some CCIS. Addressing this is a larger institutional issue where tribal colleges can respond by increasing effective instructional strategies through long term professional development focused on those faculty struggling to realize the importance of CCIS to American Indian students. Also, supporting faculty that are already committed to CCIS through continued access to resources to implement these strategies. Including these additional institutional and departmental components may a determining factor that invite American Indian students to employ a Type II border crossing over the more hazardous Type III border crossing (Figure 18).

These challenges hinge on the effectiveness of the instructors to embrace and implement the CCIS even with the addition of external motivation. The difficulty in assessing instructor efficacy specifically aligning with the concerns of the students is difficult. However, the overarching question relating to students' achievement was evaluated and despite these concerns, the mean formative and summative assessment scores were significantly greater in the Treatment group than for the Control Group. Also, the American Indian students performed at a similar level on summative and formative assessment whereas in the control course American Indian students performed at a significantly lower level than their non-American Indian peers. These results, along with the focus groups themes suggest that despite the difficulty in implementing CCIS and institutional and departmental limitation, there was progress made in finding congruence with American Indian students’ worldview and beliefs.

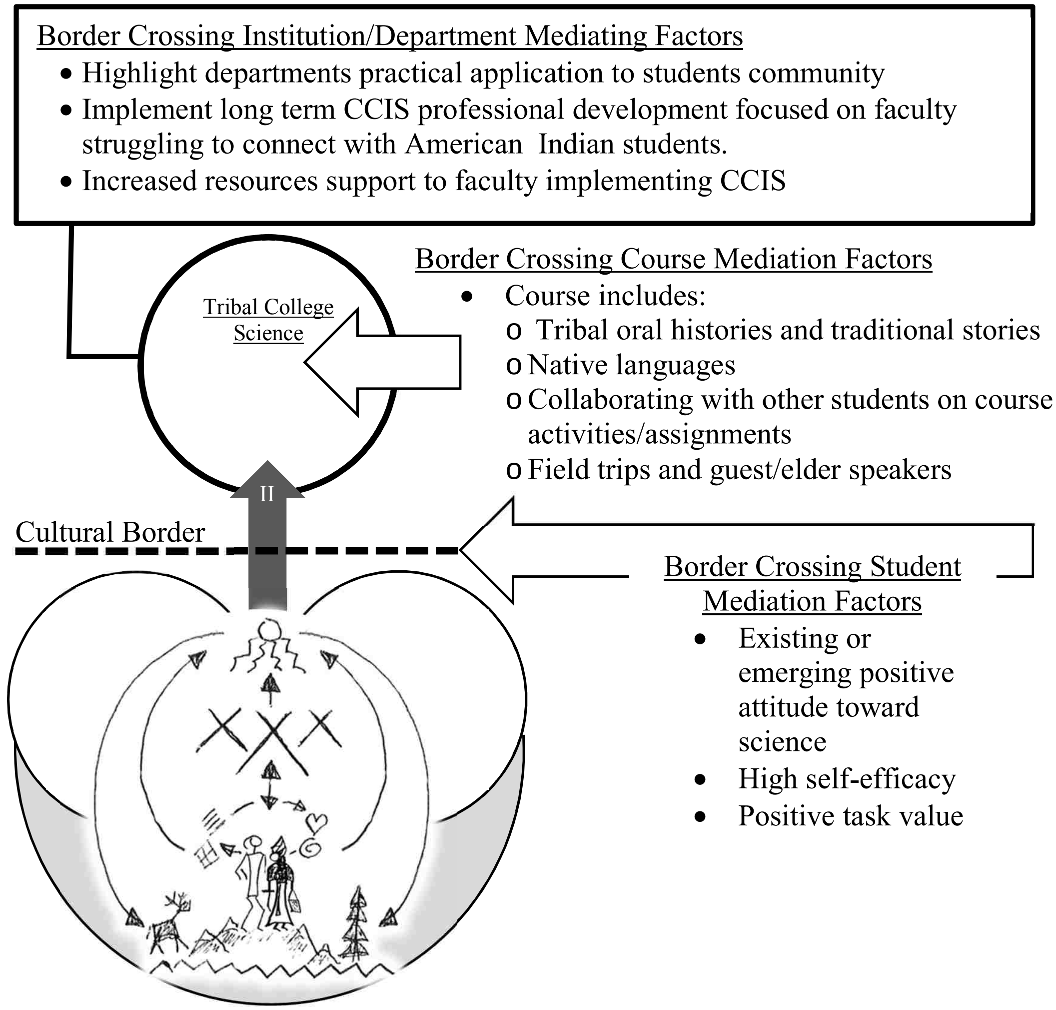

Figure 18. Tribal college science institution/department, science course and student mediating factors specifically facilitating a Type II border crossing

Limitations of the Study

Throughout this study, many potential limitations became apparent. The scarcity of research on STEM education for American Indians at TCUs adds merit to this study, but also highlights the issue of relatively small sample size. The sample size was sufficient to conduct some statistical analysis by aggregating the observations from all the treatment courses. However, to examine the results course by course was limited due to small course enrollment. This limitation was recognized at the beginning of the study but limited more detailed examination of specific CCIS implementation in certain courses. This limitation also hampered further investigation into attitude and achievement as a result of specific instructor demographics. The focus groups assisted to provide additional detail where quantitative data lacked, however these groups were also subjected to the limitation of small course enrollment. In some courses there were as few as five students and during the focus group only two students participated. This limited a complete look at how the students may have responded to the CCIS.

Balancing variables between control and treatment courses also proved to limit the validity of the findings. Participation in the study was voluntary for treatment and control courses. However, the treatment course instructors were compensated for their time invested in course modification outside their normal SKC duties. Control course instructors did not require any time investment aside from limited time to conduct survey and focus groups either during or after their courses. The invitation to participate for control courses was extended to all relevant courses with a hope that a balance of gender and experience was achieved. When the final control courses instructor pool was confirmed, there was a lack of representation by the female science instructors. As discussed in the previous sections, this may have increased the number of uncontrolled variables.

Another limitation was the timeline of the research. SKC course delivery is structured under the quarter system, where the academic year consist of three 10-week quarters. This timeframe provided additional difficulty in scheduling and direct consultation when some CCIS were not working as planned. While efforts were made to provide the minimum of two collaborative consultations, this was not always achieved. The researcher also experienced time limitations due to a full course teaching load and committee obligations. The relatively short quarters also provided additional challenges when scheduling tribal elder and tribal guest speakers. The fast-paced and complicated interworking of the tribal government and associated enterprises created small pockets of time where treatment course schedules and guest schedules could converge. Mitigating time related complication may be resolve through long-term planning of activities starting in prior academic years. Concomitantly, reducing faculty teaching loads, where the typical tribal college faculty course load range from eight to ten courses (AIHEC, 2009), would assist in facilitation of planning for CCIS in course instruction.

Limitations on time were also experienced during the coordination of course observations. The researcher in this study relied on external expertise to conduct the Reformed Teaching Observation Protocol in the courses. The time to gain familiarity with the protocol was not realistic for the researcher so coordination of in-class observations was problematic because the expert was also a full-time faculty member at SKC. Due to this complication, RTOP was not conducted for the control course. This limited full characterization of the teaching strategies employed in the control courses. Without this data it was not possible to triangulate quantitative and qualitative data at the same level as the treatment courses.

Finally, some of the CCIS provided an additional limitation. Taken as a whole and applied over a longer time frame, the CCIS may produce vastly different outcomes. When the CCIS is fragmented, where only select parts are applied, some the CCIS can be validated by research as best practices valuable to students from many ethnicities, class, and discipline. Field trips and hand-on laboratory activities are some of the example surfacing in the themes from the focus groups.

Culturally Congruent Instructional Framework Model

A culturally congruent instructional framework (CCIF) that can be used more widely in tribal colleges and beyond, to improve American Indian achievement in STEM degree programs and, ideally, increase the representation of American Indian people in STEM professions was explored. Three courses in SKC's Natural Resources departments were used to assess some CCIS for beginning undergraduate students (Table 24). Three control courses were tracked to compare specific student responses to CCIS. Near the end of the courses, focus groups were conducted with students and also with participating faculty in the treatment courses. Students achievement in the courses were gathered at the end of the 10-week courses. The surveys ATSSA, MSLQ and CCI were administered pre and post courses for both treatment and control groups. These data were used to answer the following questions:

1. (Quantitative) How does CCI influence American Indian students' attitudes and achievement in natural resources science at a tribally controlled college?
2. (Qualitative) What is the nature of the relationship between CCI course modifications and changes (or lack of) in American Indian students' science attitudes and achievement at a tribally controlled college?

Table 24.
Summary of CCIS Used in Treatment Courses from SKC Natural Resources Departments

GEOL 101/102 Physical Geology and Lab

Section 1: Curriculum Content

4. A **fieldtrip to a site significant** to Montana Indian tribes
6. Science content tied to a **place based context** relevant to a Montana Indian tribe

Section 2: Instructional Strategies

11. Local ***tribal elders or other tribal community members*** are used as guest teachers
12. Use teaching strategies that support Limited English Proficient or Second Language learners (e. g., ***used graphics, models, other visuals***; move from concrete to abstract; make frequent contextualized use of vocabulary)
13. Use alternative forms of assessment like ***authentic assessment***, or ***performance based assessment***
14. Provide specific ***formative feedback*** to each student
17. Provide opportunity for ***students to engage in private practice*** before publicly demonstrating their proficiency

SCID 114 Scientific Literature

Section 1: Curriculum Content

2. **Contemporary issues** relevant to Montana Indian tribes
5. **Traditional science knowledge** from Montana Indian tribes

Section 2: Instructional Strategies

8. Students work in ***collaborative groups***
11. Local ***tribal elders or other tribal community members*** are used as guest teachers
12. Use teaching strategies that support Limited English Proficient or Second Language learners (e. g., ***used graphics, models, other visuals***; move from concrete to abstract; make frequent contextualized use of vocabulary)
13. Use alternative forms of assessment like ***authentic assessment***, or ***performance-based assessment***
21. Use ***observational learning strategies*** (e.g., adult or peer modeling, demonstrations, apprenticeships)

ENVS 203 Weather and Climate

Section 1: Curriculum Content

5. **Traditional science knowledge** from Montana Indian tribes
6. Science content tied to a **place-based context** relevant to a Montana Indian tribe

Section 2: Instructional Strategies

8. Students work in ***collaborative groups***
10. Instructor encourages students to assume responsibility for their learning.
11. Local ***tribal elders or other tribal community members*** are used as guest teachers
12. Use teaching strategies that support Limited English Proficient or Second Language learners (e. g., ***used graphics, models, other visuals***; move from concrete to abstract; make frequent contextualized use of vocabulary)
13. Use alternative forms of assessment like ***authentic assessment***, or ***performance-based assessment***
18. Use science activities in which students design solutions to ***problems relevant to their community***

BIOS 410 Conservation of Biodiversity

Section 1: Curriculum Content

2. **Contemporary issues** relevant to Montana Indian tribes
3. **Historical content** about Montana Indian tribes
4. A **fieldtrip to a site significant** to Montana Indian tribes
6. Science content tied to a **place-based context** relevant to a Montana Indian tribe

Section 2: Instructional Strategies

10. Instructor encourages students to assume responsibility for their learning.
11. Local ***tribal elders or other tribal community members*** are used as guest teachers
12. Use teaching strategies that support Limited English Proficient or Second Language learners (e. g., ***used graphics, models, other visuals***; move from concrete to abstract; make frequent contextualized use of vocabulary)
13. Use alternative forms of assessment like ***authentic assessment***, or ***performance-based assessment***
14. Provide specific ***formative feedback*** to each student
18. Use science activities in which students design solutions to ***problems relevant to their community***

From these results discussed previously, a culturally congruent instructional framework (CCIF) is proposed that seeks to improve American Indian achievement in science courses and maintain or improve attitude toward science (Figure 19). The CCIF suggests three levels of mediation factors that will assist American Indian students in finding congruence with their own values and beliefs to align with the tribal college science department and educational system. At Level I, the most important factors are institutions and departments recognizing CCIS and their value to American Indian student success. This may be realized through funding of frequent professional development for new faculty or faculty who teach courses with low American Indian performance. Additionally, continued support of faculty who have had success in implementing CCIS. This may include time off or incentivizing attendance to cultural events, availability of funding for field trips/guest speaker and increase time flexibility or reduction in workload for course improvements and development.

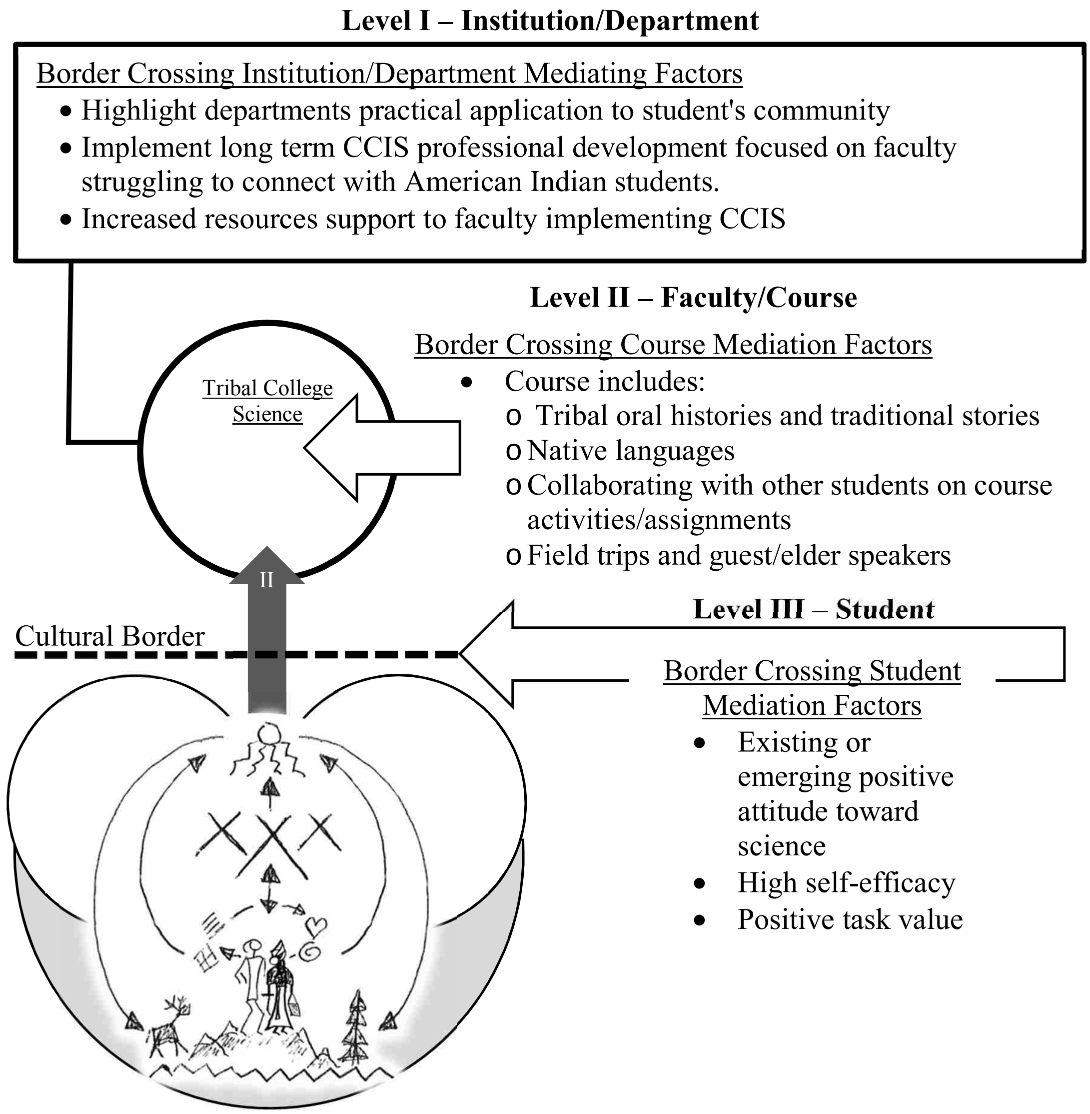

Figure 19. Proposed culturally congruent instructional framework (CCIF) highlighting three levels of mediating factors for Type II border crossing to tribal college science

At Level II, instructors can assist by increasing contact with local tribal elders and professionals to expand their own knowledge of tribal customs and worldviews. These opportunities, supported by the institution/department, could be department wide annual trips with local cultural committees (Salish/Pend d'Oreille or Kootenai) such as the annual bitterroot dig and annual medicine tree trip. Additional events to increase contact could be monthly faculty presentations to CSKT departments and cultural committees. Also, faculty could be supported through enrollment in SKC's language or tribal histories course while receiving course buyout for that term. Finally, faculty can make external professional development opportunities a part of their grantsmanship thereby matching potential institutional support.

Finally, at Level III, the tribal college, its administration, support programs and science department should make efforts to increase developmental programs in math and science that embody CCIS. American Indian students that do not enter the tribal college with high self-efficacy and positive task value should be given the opportunity to enroll in targeted first year math and science courses that align their values and belief with the nature of science.

Addressing these mediating factors at the three levels highlighted in figure 17 is presented as a potential framework for American Indian students to find congruence with their tribal worldview and natural resource science at a tribal college. Facilitating this border crossing is vital as there is a fundamental need for American Indian science experts to manage Indigenous lands and lands beyond the indigenous landscape. The proposed CCIF has the potential to satisfactorily prepare and train American Indian students in modern Western Science disciplines, while recognizing Indigenous societies and American Indian tribes' unique and specific knowledge relating to the environment and local ecosystem.

Recommendations for Future Research

The results of this study provided for a call for more detailed research into CCIS for American Indian undergraduate, particularly at TCU's. One important consideration that this research assumed is that all American Indians' worldviews, belief systems, existing knowledge, lifestyle, life goals, needs and drivers differ from that of their non-American Indian counterparts. Future research should make gains in qualifying these differences to asses with higher resolution the actual level of congruence with the educational institution. This research could further inform successful border crossings.

Additionally, further research on faculty efficacy and institutional support in the implementation of specific CCIS in the context of TCU's is recommended. This study begins to assess the implementation of some CCIS, but lacked the resolution to fully determine its success. The limited findings suggest some CCIS improved achievement, but largely remained inconclusive taking into account unmeasured variables. Future research should focus on closer evaluation of a full range and unified approach of CCIS implementation and faculty efficacy across multiple years. This would increase sample size and allow for multi-year assessments. Many TCU's embrace cultural perpetuation and encourage faulty to engage in including cultural content, yet there remains little research to characterize what institutional supports advance implementation by predominantly non-American Indian faculty. More research on this relationship may reveal additional considerations for future success of CCIS.

Further research lending to the discussion is the nature of the institutional structure of SKC. The impact and efficacy of the CCIS may be dependent on the contact time and situational environment of the courses. SKC has embraced the three-quarter community college structure for the past 40 years. This embeddedness of this educational delivery system may provide an additional confounding factor to the success of CCIS. Broadening the implementation time of CCIS beyond the traditional 3 hour per week course delivery over a 10-week period may enhance the impact of the CCIS. More research on varying the students contact time per course may allow a broader and more comprehensive and immersive experience thus providing a greater versatility in applying the strategies from this study.

Summary

The results from the ATSSA, MSLQ, CCI, achievement data and focus groups highlight some perceptual differences in treatment courses as compared to the control courses. Specifically, treatment and control groups maintained attitudes toward science from pre- to post- course. Treatment course students maintained significantly greater attitudes toward science. There were no differences for American Indian students in attitude change. There are many factors that may be attributed to this. The MSLQ highlighted one possible factor. The mean MSLQ Expectancy Component-Self Efficacy for Learning and Performance scale was significantly greater in the Treatment group than for the Control Group. Additionally, American Indian students agreed more with the statement, “I like the subject matter of this course” after course completion. These results indicate that American Indians in the treatment group maintained a relatively positive belief in their ability to accomplish a task and the purposefulness of the task. The focus group data confirmed some of these quantitative findings. Students in both treatment and control groups agreed that the courses they took were valuable to their future. These results suggest participating American Indian students experienced either a Type II (Different Worlds/Boundary Crossings Managed) or a Type III (Different Worlds/Boundary Crossings Hazardous) crossing since their attitudes did not change, indicating an acceptance of the differences within the culture of science and their own culture. One mediating factor facilitating this crossing was a relative positive belief in their ability to accomplish a task and the purposefulness of the task.

The achievement data also highlights the difference between the treatment and control courses. Treatment course students scored higher than their control course counterparts for summative and formative assessment types. This difference was also found when examining American Indian and non-American Indian students separately. Both groups in the treatment courses out-achieved their peers in the control courses. Given the implied differences in worldviews and beliefs and values of American Indian students to that of their peers it is suggested that both groups benefited from the treatment courses. These data add further evidence that the crossing into the school culture is mediated by the factors mentioned to facilitate positive achievement.

The relationship of the instructor's efficacy to implement the CCIS and the achievement of the American Indian students was discussed. The CCI survey revealed a significant difference in the composite CCI and two of its components (Course Content and Instruction) for the treatment group from pre- to post- survey. This indicated that the students agreed that the treatment course utilized CCIS significantly more than they initially agreed and that it was beneficial to the course. Importantly, the American Indian students exhibited significant differences in agreement from their non-American Indian peers in the treatment course relating to the questions, "Including oral histories and traditional stories helped me to grasp the science concepts in the course better" and "The use of Native languages in the course would help me to grasp concepts we study." These results were confirmed during case study analysis where treatment group students expressed that cultural content was covered sufficiently through activities such as guest speakers and field trips. These data add further evidence that the crossing into the school culture as mediated by specific CCIS factors mentioned and other factors to facilitate positive achievement and the maintenance of attitude toward science.

While there a number of limitations working against the implementation and comparability between the treatment and focus groups, the results suggest further research to elucidate these assumptions.

These results taken as a whole indicate that some parts of CCIS may have been marginally successful. These results further add to the conclusion that either a Type II (Different Worlds/Boundary Crossings Managed) or a Type III (Different Worlds/Boundary Crossings Hazardous) crossing was characteristic of the American Indian students in this study. Achievement data could suggest that a Type II (Different Worlds/Boundary Crossings Managed) crossing is more typical given that most American Indian students exhibited high or sufficient achievement. Nonetheless, the results suggest that the crossing is mediated by the addition of some parts of CCIS including contemporary issues relevant to Montana Indians, fieldtrips to a site significant to Montana Indian tribes, science content tied to a place based context relevant to a Montana Indian tribe, local tribal elders or other tribal community members as guest teachers, use of local Native language in instructional interactions with students and use of science activities in which students design solutions to problems relevant to the their community (see pgs. 19-20).

The proposed CCIF (Figure 18) suggests three levels of mediating factors to facilitate American Indian students' Type II border crossing.
Institutions/departmental, faculty/course and students level factors are recommended as a three-pronged approach to improving American Indian students' attitudes and achievement in natural resources science at a tribally controlled college.

References

Aikenhead, G. S. (1996). Science education: Border crossing into the subculture of science. *Studies in Science Education, 27*(1), 1-52. doi:10.1080/03057269608560077

Aikenhead, G. S. (2001). Students' ease in crossing cultural borders into school science. *Science Education, 85*(2), 180-188. doi:10.1002/1098-237X(200103)85:2%3C180::AID-SCE50%3E3.0.CO;2-1

Aikenhead, G. S., & Jegede, O. J. (1999). Cross-cultural science education: A cognitive explanation of a cultural phenomenon. *Journal of Research in Science Teaching, 36*(3), 269-287. doi:10.1002/(SICI)1098-2736(199903)36:3%3C269::AID-TEA3%3E3.0.CO;2-T

Aikenhead, G. & Michell, H. (2011). *Bridging cultures: Indigenous and scientific ways of knowing nature*. North York, ON: Pearson Canada Inc.

Ambler, M. (1998). Assessing the dream: Student achievement in a cultural environment. *Tribal College: Journal of American Indian Higher Education 10*(2). [Online article] Retrieved from http://tribalcollegejournal.org/category/issues/10-2-assessing-student-learning-in-a-cultural-environment/

American Association for the Advancement of Science (AAAS). (1989). *Project 2061: Science for all Americans*. Washington, DC: AAAS.

American Indian Higher Education Consortium (AIHEC). (2009). *AIHEC AIMS fact book 2007: Tribal colleges and universities report.* Retrieved from http://aihec.org/resources/documents/AIHEC_AIMS_Factbook2007.pdf

Antonellis, J. (2013). Third space for cultural relevance and conceptual understanding in the tribal college science classroom. In *Mellon tribal college research journal: Volume 1, 2013*. Denver, CO: American Indian College Fund.

Au, K. H. (1993). *Literacy instruction in multicultural settings*. Orlando, FL: Harcourt Brace & Jovanovich.

Au, K. H., & Kawakami, A. J. (1994). Cultural congruence in instruction. In E. R. Hollins, J. E. King, & W. C. Hayman (Eds.), *Teaching diverse populations: Formulating a knowledge base. (Vol. 1944)* (pp. 5-24). New York, NY: State University of New York Press.

Babco, E. L. (2003). *Trends in African American and Native American participation in STEM higher education.* New York, NY: Commission on Professionals in Science and Technology.

Bahr, K. S., & Bahr, H. M. (1995). Autonomy, community, and the mediation of value: Comments of Apachean grandmothers, cultural change, and the media. In C. K. Jacobsen (Ed.), *American families: Issues in race and ethnicity* (pp. 229-260). New York, NY: Garland.

Bailey, T., & Graves, K. (2016). Gender and education. *Review of Research in Education, 40*(1), 682-722. doi:10.3102%2F0091732X16680193

Banks, J. A. & Banks, C. A. (2009). *Multicultural education: Issues and perspectives*. New York, NY: Wiley.

Barbatis, P. (2010). Underprepared, Ethnically Diverse Community College Students: Factors Contributing to Persistence. *Journal of Developmental Education, 33*(3), 14-24. Retrieved from ERIC (EJ942872).

Barker, W., Bressoud, D., Epp, S., Ganter, S., Haver, B., & Pollatsek, H. (2004). *Undergraduate Programs and Courses in the Mathematical Sciences: CUPM*

Curriculum Guide, 2004. Mathematical Association of America. Retrieved from ERIC (ED497964).

Barnes, C. J. (2006). Preparing preservice teachers to teach in a culturally responsive way. *Negro Educational Review, 57*(1/2), 85. Retrieved from ERIC (EJ751108).

Barnhardt, R. & Kawagley, O. (2005). Indigenous knowledge systems and Alaska Native ways of knowing. *Anthropology and Education Quarterly, 36*(1), 8–23. Retrieved from https://www.fws.gov/nativeamerican/pdf/tek-barnhardt-kawagley.pdf

Berardi, G., Burns, D., Duran, P. H., Gonzalez-Plaza, R., Kinley, S., Robbins, L., Williams, T., & Woods, W. (2002). Science and culture in a curriculum for tribal environmental management: The TENRM program at the Northwest Indian College. *American Indian Culture and Research Journal, 26*(3), 47-64. doi:10.17953/aicr.26.3.w7678036k4v4326u

Battiste, M. (2002). *Indigenous knowledge and pedagogy in First Nations education: A literature review with recommendations*. Ottawa, ON, Canada: Indian and Northern Affairs.

Blalock, C. L., Lichtenstein, M. J., Owen, S., Pruski, L., Marshall, C., & Toepperwein, M. (2008). In pursuit of validity: A comprehensive review of science attitude instruments 1935-2005. International Journal of Science Education, 30(7), 961-977. doi:10.1080/09500690701344578

Bonous-Hammarth, M. (2000). Pathways to success: Affirming opportunities for science, mathematics, and engineering majors. *The Journal of Negro Education, 69*(1/2), 92-111. Retrieved from ERIC (EJ636428).

Boyer, P. (2008). *Tribal college and university profiles: New directions in math and science.* Pablo, MT: Salish Kootenai College Press.

Boykin, A. W., Tyler, K. M., Watkins-Lewis, K., & Kizzie, K. (2006). Culture in the sanctioned classroom practices of elementary school teachers serving low-income African American students. *Journal of Education for Students Placed at Risk, 11*(2), 161-173. doi:10.1207/s15327671espr1102_3

Brower, A., & Inkelas, K. (2007). Assessing learning community programs and partnerships. In B. Smith, & L. Williams (Eds.), *Learning communities and student affairs: Partnering for powerful learning.* Washington, D.C.: National Association of Student Personnel Administrators.

Cajete, G. (1999). *The Native American learner and bicultural science education*. Retrieved from ERIC (ED427908).

Cardell, G. W., Cross, W. C., & Lutz, W. J. (1978). Peer learning among Indian students: Extending counselor influence into the classroom. *Journal of American Indian Education, 17*(2), 7–12. Retrieved from http://www.jstor.org/stable/i24395784

Castagno, A. E., & McKinley, B., & Brayboy, J. (2008). Culturally responsive schooling for indigenous youth: A review of the literature. *Review of Educational Research, 78*(4), 941-993. doi:10.3102%2F0034654308323036

Cleary, L., & Peacock, T. (1998). *Collected wisdom: American Indian education.* Boston, MA: Allyn & Bacon.

Clough, M. P. (2006). Learners' responses to the demands of conceptual change: Considerations for effective nature of science instruction. *Science & Education, 15*(5), 463–494. doi:10.1007/s11191-005-4846-7

Costa, J. (1995). An empirically-based review of the concept of environmental scanning. *International Journal of Contemporary Hospitality Management, 7*(7), 4-9. doi:10.1108/09596119510101877

Creswell, J. W. (1998). *Qualitative inquiry and research design: Choosing among five traditions*. Thousand Oaks, CA: Sage.

Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five traditions*. Thousand Oaks, CA: Sage.

Cummingham, A. F., & Redmond, C. 2001. *Building strong communities: Tribal colleges as engaged institutions.* Alexandria, VA: American Indian Higher Education Consortium.

Cummins, J. (1996). *Negotiating identities: Education for empowerment in a diverse society*. Ontario, CA: California Association for Bilingual Education.

Deloria, V., & Wildcat, D. R. (2001). *Power and place: Indian education in America*. Golden, CO: Fulcrum Resources.

Delpit, L. (1995). *Other people's children: Cultural conflict in the classroom*. New York, NY: The New Press.

Demmert W. G., & Towner J. C. (2003). *A review of the research literature on the influence of culturally based education on the academic performance of Native American students*. Portland, OR: Northwest Regional Educational Laboratory.

Dori, Y. J., & Tal, R. T. (1999). Industry-environment projects: Formal and informal science activities in a community school. *Science Education, 84*, 95–113. doi:10.1002/(SICI)1098-237X(200001)84:1%3C95::AID-SCE7%3E3.0.CO;2-W

Doyle, A., Kleinfield, J., & Reyes, M. (2009). The Educational aspirations/attainment gap among rural Alaska native students. *The Rural Educator, 30*(3), 25-33. Retrieved from ERIC (EJ869312).

Eagan, K., Hurtado, S., Figueroa, T., & Hughes, B. (2010). *Examining STEM pathways among students who begin college at four-year institutions.* Retrieved from https://sites.nationalacademies.org/cs/groups/dbassesite/documents/webpage/dbasse_088834.pdf

Eagan Jr, M. K., & Garvey, J. C. (2015). Stressing out: Connecting race, gender, and stress with faculty productivity. *The Journal of Higher Education, 86*(6), 923-954. doi:10.1080/00221546.2015.11777389

Erickson, F. (1997). Culture in society and in educational practices. In J. A. Banks & C. A. Banks (Eds.), *Multicultural education: Issues and perspectives* (pp. 32-60). Needham Heights, MA: Allyn & Bacon.

Faircloth, S. C., & Tippeconnic, J. W. (2010). *The dropout/graduation rate crisis among American Indian and Alaska Native students: Failure to respond places the future of Native Peoples at risk*. Los Angeles, CA: The Civil Rights Project/Proyecto Derechos Civiles at UCLA.

Fairweather, J. S. (1996). *Faculty work and public trust: Restoring the value of teaching and public service in American academic life*. Boston, MA: Allyn & Bacon.

Fairweather, J. S. (2005). Beyond the rhetoric: Trends in the relative value of teaching and research in faculty salaries. *Journal of Higher Education, 76*(4), 401-422. doi:10.1080/00221546.2005.11772290

Fairweather, J. S. (2008). *Linking evidence and promising practices in science, technology, engineering, and mathematics (STEM) undergraduate education*. Board of Science Education, National Research Council, The National Academies. Retrieved from https://www.nsf.gov/attachments/117803/public/Xc--Linking_Evidence--Fairweather.pdf

Falk, J. H., Koran, J. J., & Dierking, L. D. (1986). The trips of science: Assessing the learning potential of science museums. *Science Education, 70*, 503–508. doi:10.1002/sce.3730700504

Federman, M. (2007). State graduation requirements, high school course taking, and choosing a technical college major. *The BE Journal of Economic Analysis & Policy, 7*(1) [Online article]. doi:10.2202/1935-1682.1521

Fishman, J. A. (1991). *Reversing language shift: Theoretical and empirical foundations of assistance to threatened languages.* Bristol, UK: Multilingual Matters.

Flesch, R. (1948). A new readability yardstick. Journal of applied psychology, 32(3), 221.

Fradd, S. H. & Lee, O. (1997). Teachers' voices in program evaluation and improvement: A case study of a TESOL program. *Teaching and Teacher Education, 13*(6), 563-577. doi:10.1016/S0742-051X(97)80001-7

Froelich, K. (2006). *Elementary/special education: Perceptions of graduates* (Unpublished Doctoral Dissertation). University of North Dakota, Grand Forks, ND.

Fryberg, S. A., & Markus, H. R. (2007). Cultural models of education in American Indian, Asian American and European American contexts. *Social Psychology of Education, 10*(2), 213-246. doi:10.1007/s11218-007-9017-z

Fuller, I. C. (2006). What is the value of fieldwork? Answers from New Zealand using two contrasting undergraduate physical geography field trips. New Zealand Geographer, 62(3), 215-220.

Garcia, T., & Pintrich, P. R. (1995). *Assessing students' motivation and learning strategies: The motivated strategies for learning questionnaire*. Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco, CA. Retrieved from https://files.eric.ed.gov/fulltext/ED383770.pdf

Gardner, H. (2011). *The unschooled mind: How children think and how schools should teach*. New York, NY: Basic Books.

Gay, G. (2000). *Culturally responsive teaching: Theory, research, and practice*. New York, NY: Teachers College Press.

Gay, I. R., Mills, G. E., Airasian, P. W. (2012). *Educational research: Competencies for analysis and applications* (10th ed.). Boston, MA: Pearson.

Germann, P. J. (1988). Development of the attitude towards science in school assessment and its use to investigate the relationship between science achievement and attitude towards science in school. *Journal of Research in Science Teaching, 25*(8), 689-703. doi:10.1002/tea.3660250807

Gilbert, W. S. (2005). *Native science connections research project: Integrating relevant cultural knowledge into the science curriculum for grades 4-6th*. Retrieved from http://www2.ed.gov/rschstat/research/pubs/oieresearch/conference/gilbert_200501.pdf

Gilbert, W. S. (2010). Developing culturally based science curriculum for Native American classrooms. In J. Reyhner, W. S. Gilbert, & L. Lockard (Eds.), *Honoring our heritage: Culturally appropriate approaches for teaching indigenous students* (pp. 43-55). Flagstaff, AZ: Northern Arizona University.

Goodwin, L. D., & Stevens, E. A. (1993). The influence of gender on university faculty members' perceptions of "good" teaching. *The Journal of Higher Education, 64*(2), 166-185. doi:10.1080/00221546.1993.11778421

Gordon, B. (1993). African American cultural knowledge and liberator education: Dilemmas, problems, and potentials in a postmodern American society. *Urban Education, 27*(4), 448-470. doi:10.1177%2F0042085993027004008

Graybill, S. W. (1997). Questions of race and culture: How they relate to the classroom for African American students. *The Clearing House, 70*(6), 311-319. Retrieved from http://www.jstor.org/stable/30185874

Griffith, A. L. (2010). Persistence of women and minorities in STEM field majors: Is it the school that matters? *Economics of Education Review, 29*(6), 911-922. Retrieved from http://digitalcommons.ilr.cornell.edu/workingpapers/122/

Gutiérrez, K. D., & Rogoff, B. (2003). Cultural ways of learning: Individual traits or repertoires of practice. *Educational Researcher, 32*(5), 19–25. doi:10.3102/0013189X032005019

Hall, M. (1996). Full circle: Native educational approaches show the way. *Journal of Experiential Education, 19*(3), 141–144.

Haukoos, G. D., & Satterfield, R. (1986). Learning styles of minority students (Native Americans) and their application in developing a culturally sensitive science classroom. *Community Junior College Quarterly of Research and Practice, 10*(3), 193-201. doi:10.1080/0361697860100304

Heavy Runner, I., & DeCelles, R. (2002). Family education model: Meeting the student retention challenge. *Journal of American Indian Education, 41*(2), 29-37. Retrieved from http://pieducators.com/sites/default/files/Student-Retention.pdf

Hilberg, R. S. & Tharp, R. G. (2002). *Theoretical perspectives, research findings, and classroom implication of the learning styles of American Indian and Alaska Native students*. Retrieved from ERIC (ED468000).

Hilberg, R. S., Tharp, R.G., & Degeest L. (2000). The efficacy of CREDE's standards-based instruction in American Indian mathematics classes. *Equity & Excellence in Education, 33*(2), 32-40. doi:10.1080/1066568000330206

Hofstein, A., & Rosenfeld, S. (1996). Bridging the gap between formal and informal science learning. *Studies in Science Education, 28*(1), 87-112. doi:10.1080/03057269608560085

Hollins, E. (2008). *Culture in school learning: Revealing the deep meaning* (2nd ed.). New York, NY: Routledge.

Howard, T. C. (2003). *Culturally relevant pedagogy: Ingredients for critical teacher reflection*. Columbus, OH: Ohio State University.

Huffman, T. (2001). Resistance theory and the transculturation hypothesis as explanations of college attrition and persistence among culturally traditional American Indian students. *Journal of American Indian Education, 40*(1), 1-23. Retrieved from http://www.jstor.org/stable/24398349

Huffman, T. (2003). A comparison of personal assessments of the college experience among reservation and non-reservation American Indian students. *Journal of American Indian Education, 42*(2), 1-16. Retrieved from http://www.jstor.org/stable/24398757

Hurtado, S., Eagan, M. K., Pryor, J. H., Whang, H., & Tran, S. (2012). *Undergraduate teaching faculty: The 2010–2011 HERI faculty survey*. Los Angeles, CA: University of California, Higher Education Research Institute.

Irvine, J. J. (1990). *Black students and school failure: Policies, practices and prescriptions*. New York, NY: Greenwood.

Jackson, A. P., Smith, S. A., & Hill, C. L. (2003). Academic persistence among native American college students. *Journal of College Student Development, 44*(4), 548–565. Retrieved from https://scholarsarchive.byu.edu/facpub/1591

James, K. (Ed.) (2001). *Science and Native American communities.* Lincoln, NE: University of Nebraska.

Jolly, E. (1996). *Inferential leadership: Lessons from Native American storytelling*. Retrieved from ERIC (ED394543).

Jordan, C. (1985). Translating culture: From ethnographic information to education program. *Anthropology and Education Quarterly, 16*(2), 104-123. doi:10.1525/aeq.1985.16.2.04x0631g

Kimmerer, R.W. (2002). Weaving traditional ecological knowledge into Biological Education: A call to action. *BioScience, 52*(5), 432-438. doi:10.1641/0006-3568(2002)052[0432:WTEKIB]2.0.CO;2

Kincaid, J. P., Fishburne, R. P., Rogers, R. L. & Chissom, B. S. (1975). *Flesch-Kincaid Grade Level*. Memphis, TN: United States Navy.

Krogh, L. B. & Thomsen, P. V. (2005). Studying students' attitudes towards science from a cultural perspective but with a quantitative methodology: Border crossing into the physics classroom. *International Journal of Science Education, 27*(3), 281–302. doi:10.1080/09500690412331314469

Ladson-Billings, G. (1995). But that's just good teaching! The case for culturally relevant pedagogy. *Theory into Practice, 34*(3), 159-166. Retrieved from http://links.jstor.org/sici?sici=0040-5841%28199522%2934%3A3%3C159%3ABTJGTT%3E2.0.CO%3B2-E

Lam-Phoon, S. A. (1985). *A comparative study of learning styles of Southeast Asian and American Caucasian college students on two Seventh Day Adventist campuses* (Unpublished doctoral dissertation). Andrews University, Berrin Springs, MI.

Larson, J. O. (1995). *Fatima's rules and other elements of an unintended chemistry curriculum*. Paper presented at the American Educational Research Association annual meeting, San Francisco, CA. Retrieved from ERIC (ED387318).

Lee, J., Donlan, W., & Brown, E. D. (2011). American Indian/Alaskan Native undergraduate retention at predominantly white institutions: An elaboration of Tinto's Theory of college student departure. *Journal of College Student Retention, 12*(3), 257-276. doi:10.2190/CS.12.3.a

Lee, O. (2005). Science education and student diversity: Synthesis and research agenda. *Journal of Education for Students Placed at Risk, 10*(4), 433-440. doi:10.1207/s15327671espr1004_5

Lee, O. & Buxton. C. (2010). *Diversity and equity in science education*. New York, NY: Teachers College Press

Lee, O., & Fradd, S. H. (1998). Science for all, including students from non-English-language backgrounds. *Educational Researcher, 27*(4), 12-21. doi:10.3102/0013189X027004012

Lee, O., & Fradd, S. H. (2002). Instructional congruence to promote science learning and literacy development for linguistically diverse students. In D. R. Lavoie &

M. W. Roth (eds.), *Models of science and teacher preparation: Theory into practice* (pp. 109-126). New York, NY: Springer International Publishing.

Lee, O., Luykx, A., Buxton, C. & Shaver, A. (2007). The challenge of altering elementary school teachers' beliefs and practices regarding linguistic and cultural diversity in science instruction. *Journal of Research in Science Teaching, 44*(9), 1269-1291. doi:10.1002/tea.20198

Lipka, J., Parker, J., Yanez, E. (2005). Factors that affect Alaska Native students' mathematical performance. *Journal of American Indian Education 44*(3), 1-8. Retrieved from https://jaie.asu.edu/sites/default/files/443_2005_1_lipka_et_al.pdf

MacIvor, M. (1999). Redefining science education for aboriginal students. In M. Battiste & J. Barman (Eds.), *First Nations' education in Canada: The circle unfolds* (pp. 73-98). Vancouver, BC: University of British Columbia Press.

Maltese, A. V., & Tai, R. H. (2011). Pipeline persistence: Examining the association of educational experiences with earned degrees in STEM among US students. *Science Education, 95*(5), 877-907. doi:10.1002/sce.20441

Martella Jr., R. R. (1994). Not in my State's Indian reservation: A legislative fix to close an environmental law loophole. *Vanderbilt Law Review, 47*(6), 1863-1904.

Massy, W., Wilger, A., & Colbeck, C. (1994). Department cultures and teaching quality: Overcoming "hallowed" collegiality. Change 26: 11-20. doi:10.1080/00091383.1994.9938496

Matthews, M. (1994). *Science teaching: The role of history and philosophy of science*. New York, NY: Routlage

Matthews, C. E. & Smith, W. S. (1994). Native American related materials in elementary science instruction. *Journal of Research in Science Teaching, 31*(4), 363–380. doi: 10.1002/tea.3660310406

McAllister, G., & Irvine, J. J. (2000). Cross cultural competency and multicultural teacher education. *Review of Educational Research, 70*(1), 3-24. Retrieved from https://www.jstor.org/stable/1170592

McComas, W. F., Clough, M. P., & Almazroa, H. (1998). The role and character of the nature of science in science education. *Science & Education, 7*(6), 511-532. doi:10.1007/0-306-47215-5_1

McComas, W. F., & Olson, J. K. (1998). The nature of science in international standards documents. In W. F. McComas (Ed.), *The nature of science in science education: Rationales and strategies* (pp. 41–52). Dordrecht, The Netherlands: Kluwer Academic Publishers.

McDonald, D., McDonald, T., & McAvoy, L. (2000). *Tribal wilderness research needs and issues in the United States and Canada.* USDA Forest Service Proceedings RMRS-P-15-Vol-2. Retrieved from https://www.fs.fed.us/rm/pubs/rmrs_p015_2/rmrs_p015_2_290_294.pdf

McKeachie, W. J., Pintrich, P. R., Smith, D. A., & Lin, Y. G. (1986). *Teaching and learning in the college classroom: A review of the research literature*. Ann Arbor, MI: The University of Michigan.

Mogk, D. W., & Goodwin, C. (2012). Learning in the field: Synthesis of research on thinking and learning in the geosciences. Geological Society of America Special Papers, 486, 131-163. doi:10.1130/2012.2486(24)

Montgomery, D., Miville, M. L., Winterowd, C., Jeffries, B., & Baysden, M. F. (2000). American Indian college students: An exploration into resiliency factors revealed through personal stories. *Cultural Diversity and Ethnic Minority Psychology, 6*(4), 387-398. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/11089314

More, A. J. (1987). Native Indian learning styles: A review for researchers and teachers. *Journal of American Indian Education, 27*(1), 17-29. Retrieved from http://www.jstor.org/stable/24397988

Murk, P. (1994). *Learning styles and lessons from the medicine wheel: A Native American philosophy, a proposed integrated model*. Retrieved from ERIC (ED 378387).

Nabhan GP. (1997). *Cultures of habitat: On nature, culture and story.* Washington DC: Counterpoint Press.

National Academy of Sciences. (2011). *Expanding underrepresented minority participation: America's science and technology talent at the crossroads.* Retrieved from http://download.nap.edu/cart/download.cgi?&record_id=12984&free=1

National Council of Teachers of Mathematics. (2004). *Final report: Achievement gap task force.* Retrieved from https://my.nctm.org/uploadedFiles/About_NCTM/Board_and_Committess/achievement gap.pdf

National Indian Education Association. (2007). *2007 annual report*. Retrieved from http://www.niea.org/profile/annualreport2007.pdf

National Research Council (1996). *National science education standards*. Washington, DC: National Academy Press.

National Science Teachers Association. (2000). *NSTA's position state on multicultural science education*. Retrieved from http://nsta.org/about/positions/multicultural.aspx

National Science Foundation. (2009). *Women, minorities, and persons with disabilities in science and engineering*. Arlington, VA: National Science Foundation.

Nelson-Barber, S., & Trumbull-Estrin, E. (1995). Bringing Native American perspectives to mathematics and science teaching. *Theory into Practice, 34*(3), 174–186. doi:10.1080/00405849509543677

Nieto, S. & Bode, P. (2015). School reform and student learning: A multicultural perspective. In J. A Banks & C. A McGee Banks (Eds.), *Multicultural Education: Issues and Perspectives* (9th ed.) (pp. 258-274). Hoboken, NJ: Wiley.

Nieto, S. M. (2002). Profoundly multicultural questions. *Educational Leadership, 60*(4), 6-10. Retrieved from ERIC (EJ659144).

Nuby, J. F. (1995). *Learning styles: A comparative analysis of the learning styles of Native American and African American secondary students* (Unpublished doctoral dissertation). University of Alabama, Tuscaloosa, AL.

Okagaki, L., Helling, M. K., & Bingham, G. E. (2009). American Indian college students' ethnic identity and beliefs about education. *Journal of College Student Development, 50*(2), 157-176. Retrieved from ERIC (EJ835643).

Orion, N., & Hofstein, A. (1994). Factors that influence learning during a scientific field trip in a natural environment. *Journal of Research in Science Teaching, 31*(10), 1097-1119. doi:10.1002/tea.3660311005

Ozmon, H. A., & Craver, S. M. (1980). *Philosophical foundations of education* (4th ed.). Columbus, OH: Merrill.

Pacala, S., & Socolow, R. (2004). Stabilization wedges: Solving the climate problem for the next 50 years with current technologies. *Science, 305*(5686), 968-972. doi:10.1126/science.1100103

Pease-Pretty on Top, J. (2003). *Native American Language Immersion: Innovative Native Education for Children and Families*. Denver, CO: American Indian College Fund.

Pewewardy, C. (2002). Learning Styles of American Indian/Alaska Native Students: A Review of the Literature and Implications for Practice. *Journal of American Indian Education, 41*(3), 23. Retrieved from https://www.jstor.org/stable/24398583

Phelan, P., Davidson, A. L., & Cao, H. T. (1991). Students' multiple worlds: Negotiating the boundaries of family, peer, and school cultures. *Anthropology & Education Quarterly, 22*(3), 224-250. Retrieved from http://www.jstor.org/stable/3195764

Philips, S. U. (1972). Participant structures and communicative competence: Warm Springs children in community and classroom. In C. B. Cazden, V. P. John, & D. Hymes (Eds.), *Functions of language in the classroom* (pp. 370-394). New York: Teachers College Press.

Philips, S. U. (1983). *The invisible culture: Communication in classroom and community on the Warm Springs Reservation*. New York: Longman.

Phillips, J. L. (2003). A tribal college land grant perspective: Changing the conversation. *Journal of American Indian Education, 42*(1), 22-35. Retrieved from https://jaie.asu.edu/sites/default/files/421_2003_3_phillips_0.pdf

Piburn, M., & Sawada, D. (2000). *Reformed Teaching Observation Protocol (RTOP) Reference Manual. Technical Report*. Retrieved from ERIC (ED447205).

Pintrich, P. R. (1991). *A manual for the use of the motivated strategies for learning questionnaire (MSLQ).* Retrieved from ERIC (ED338122).

Pintrich, P. R., Marx, R. W., & Boyle, R. A. (1993). Beyond cold conceptual change: The role of motivational beliefs and classroom contextual factors in the process of conceptual change. *Review of Educational Research, 63*(2), 167-199. doi:10.3102%2F00346543063002167

Pransky, K., & Bailey, F, (2002). To meet your students where they are, first you have to find them: Working with culturally and linguistically diverse at-risk students. *The Reading Teacher, 56(*4), 370-383. Retrieved from http://www.jstor.org/stable/20205211

QSR International, (2012). NVivo 10. Retrieved from
http://www.qsrinternational.com/products_nvivo.aspx.

Remillard, J. T. (2005). Examining key concepts in research on teachers' use of mathematics curricula. *Review of Educational Research, 75*(2), 211-246. doi:10.3102/00346543075002211

Riggs, E. M., & Alexander, C. J. (2007). Broadening participation in the earth sciences. *Journal of Geoscience Education, 55(*6), 445-446. doi:10.5408/1089-9995-55.6.445

Saunders, W., Goldenberg, C., & Hamann, J. (1992). Instructional conversations beget instructional conversations. *Teaching and Teacher Education, 8*(2), 199-218. doi:10.1016/0742-051X(92)90009-R

Sawada, D., Piburn, M., Falconer, K., Turley, J., Benford, A., & Bloom, I. (2000). *Reformed teaching observation protocol (RTOP) (ACEPT Technical Report No. IN00-1).* Tempe, AZ: Collaborative for Excellence in the Preparation of Teachers.

Sawada, D., Piburn, M., Judson, E., Turley, J., Falconer, K., Benford, R., & Bloom, I. (2002). Measuring reform practices in science and mathematics classrooms: The reformed teaching observation protocol. *School Science and Mathematics, 102*(6), 245-253. doi:10.1111/j.1949-8594.2002.tb17883.x

Sawada D. (2003). *Reformed teacher education in science and mathematics: An evaluation of the Arizona Collaborative for Excellence in the Preparation of Teachers*. Phoenix, AZ: Arizona State University Document Production Services.

Semken, S. C., & Morgan, F. (1997). Navajo pedagogy and Earth systems. *Journal of Geoscience Education, 45*(2), 109-112. doi:10.1002/sce.20279

Sievert, R. C. (2014). *Development of an instrument for assessing culturally congruent science teaching* (Doctoral dissertation). Retrieved from Graduate Student Theses, Dissertations, & Professional Papers (No. 11149).

Sievert, R., LaFrance, J., & Brod, R. (2011). Development, validation, and preliminary use of the culturally congruent instruction survey. Proceedings from the *2011 American Educational Research Association National Conference*. Retrieved from http://hs.umt.edu/bssp/documents/conferencePresentations/AERA_Dev_and_Valid_CCI_2010.pdf

Shade, B. J., Kelly, C., & Oberg, M. (1997). *Creating culturally responsive classrooms*. Washington, DC: American Psychological Association.

Shamos, M. H. (1995). *The myth of scientific literacy*. New Brunswick, NJ: Rutgers University Press.

Singh, N. K. (2011). Culturally appropriate education: Practical and theoretical implications. In J. Reyhner, W. S. Gilbert & L. Lockard, (Eds.), *Honoring our* *heritage: Culturally appropriate approaches for teaching indigenous students* (pp. 11-42). Flagstaff, AZ: Northern Arizona University.

Salish Kootenai College (2014). *SKC Faculty Handbook 2013-2014*. Pablo, MT: Salish Kootenai College.

Smiley, R., & Sather, S. (2009). *Indian education policies in five Northwest Region states (Issues & Answers Report, REL 2009 No. 081).* Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Northwest. Retrieved from https://ies.ed.gov/ncee/edlabs/regions/northwest/pdf/REL_2009081.pdf

Smith, B. L., Stumpff, L. M., & Cole, R. (2012). Engaging students from underrepresented populations: The enduring legacies Native cases initiative. *Journal of College Science Teaching, 41*(4), 60-68. Retrieved from ERIC (EJ983130).

Stein, W. J. (1992). *Tribally controlled colleges: Making good medicine.* New York, NY: Peter Lang Publishing, Inc.

Stein, W. J. (2009). Tribal Colleges and Universities: Supporting the Revitalization in Indian Country. In L. S. Warner & G. E. Gipp (Eds.), *Tradition and culture in the millennium: Tribal colleges and universities* (pp. 17-34). Charlotte, NC: Information Age Publishing, Inc.

Swisher, K. G., & Dehyle, D. (1987). Styles of learning and learning of styles: Educational conflicts for American Indian/Alaskan Native youth. *Journal of Multilingual and Multicultural Development, 8*(4), 345-360. doi:10.1080/01434632.1987.9994296

Taconis, R. & Kessels, U. (2009). How choosing science depends on students' individual fit to 'Science Culture'. *International Journal of Science Education, 31*(8), 1115–1132. doi:10.1080/09500690802050876

Tal, R. T. (2001). Incorporating field trips as science learning environment enrichment–an interpretive study. *Learning Environments Research, 4*(1), 25-49. doi:10.1023/A:1011454625413

Tharp, R. G. & Gallimore, R. (1991). The instructional conversation: Teaching and learning in social activity. Retrieved from https://escholarship.org/uc/item/5th0939d

Tharp, R. G., & Yamauchi, L. A. (1994). *Effective instructional conversation in Native American classrooms*. Retrieved from ERIC (ED 372896).

Trueba, H. T., & Wright, P. G. (1992). On ethnographic studies and multicultural education. In M. Saravia-Shore & S. Arvizu (Eds.), *Cross-cultural literacy: Ethnographies of communication in multiethnic classrooms* (pp. 299-338). New York, NY: Garland.

Tschannen-Moran, M., & Hoy, A. W. (2001). Teacher efficacy: Capturing an elusive construct. *Teaching and Teacher Education, 17*(7), 783-805. doi:10.1016/S0742-051X(01)00036-1

Tuyay, S., Jennings, L., & Dixon, C. (1995). Classroom discourse and opportunities to learn: An ethnographic study of knowledge construction in a bilingual third-grade classroom. *Discourse Processes, 19*, 75-110. doi:10.1080/01638539109544906

Tyler, K., Uqdah, A., Dillihunt, M., Beatty-Hazelbaker, R., Conner, T., Gadson, N., Henchy, A., Hughes, T., Mulder, S., Owens, E., Roan-Belle, C., Smith, L., & Stevens, R. (2008). Cultural discontinuity: Toward a quantitative investigation of a major hypothesis in education. *Educational Researcher, 37*(5), 280-297. doi:10.3102/0013189X08321459

United Nations Educational, Cultural and Scientific Organization (UNESCO), 2009. *World Report: Investing in cultural diversity and intercultural dialogue.* Paris, France: UNESCO

United Nations Environment Programme (UNEP). (2007). *Global environmental outlook GEO-4.* Nairobi.: UNEP.

Vera, M., Salanova, M., & del Río, B. M. (2011). Self-efficacy among university faculty: How to develop an adjusted scale. *Anales de Psicología/Annals of Psychology, 27*(3), 800-807. Retrieved from http://revistas.um.es/analesps/article/view/135531

Villegas, A. M. (1991). *Culturally responsive pedagogy for the 1990s and beyond*. Retrieved from ERIC (ED339698).

Van Der Velder, P. (2009). *What do we owe the Indians?* [Online article] Retrieved from http://www.historynet.com/what-do-we-owe-the-indians.htm

Vogt, L. A., Jordan, C., & Tharp, R. G. (1987). Explaining school failure, producing school success: Two cases. *Anthropology & Education Quarterly, 18*(4), 276-286. Retrieved from http://www.jstor.org/stable/3216657

Wang, X. (2013). Why students choose STEM majors: Motivation, high school learning, and postsecondary context of support. *American Educational Research Journal, 50*(5), 1081-1121. doi:10.3102/0002831213488622

Weber, R., Butler, T., & Larson, P. (Eds.) (2000). *Indigenous people and conservation organizations: Experiences in collaboration.* Washington DC: World Wildlife Fund.

Weinstein, C., Curran, M., & Tomlinson-Clarke, S. (2003). Culturally responsive classroom management: Awareness into action. *Theory into Practice, 42*(4), 269-276. Retrieved from ERIC (EJ761508).

Wheeler, G. (2004). Emergence, alliance, and vision: The tribal college and beyond. *Indigenous Nations Studies Journal. 5*(1), 1-14. Retrieved from https://www.researchgate.net/profile/Gary_Wheeler3/publication/41126755_Emergence_Alliances_and_Vision_The_Tribal_College_and_Beyond/links/5756e4ea08ae5c654903fd43/Emergence-Alliances-and-Vision-The-Tribal-College-and-Beyond.pdf

Yazzie, T. (1999). Culturally appropriate curriculum: A research-based rationale. In K. G. Swisher and J. Tippeconnic III (Eds.) *Next steps: Research and practice to advance Indian education.* Charleston, WV: ERIC Clearinghouse on Rural Education and Small Schools.

Yin, R. K. (2003) *Case study design and research: Design and methods* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Appendix A: Survey Instruments

Students Survey: Perception of CCI, Attitude and Motivation

SKC Natural Resources Student Survey – [Quarter and year ex. Winter 2014-15]

The SKC Natural Resources Science faculty members are conducting research on how to modify their instruction to better support students' learning. The course [*course number and name ex. ENVS 202 – Introduction to Wildlife Management*] that you are currently taking is part of the research study. The following survey is designed to collect information about the effectiveness of the course from the students' point of view. We ask that you please complete the following anonymous survey by circling the answer that best reflects your opinion. Do not write your name on the survey. <u>Your answers will be **completely anonymous and confidential**</u>. We greatly appreciate your participation.

Please use the scale below to rate your opinion about each statement in this survey. Circle the option that best reflects your opinion on each statement.

1= Strongly disagree
2 = Disagree
3 = Neutral/No Opinion
4 = Agree
5 = Strongly Agree
NA = Not applicable (Did not occur in this course)

Perception of Culturally Congruent Instructional Methods (CCI)

1. The inclusion of culturally relevant topics in this course helped me learn better. .

1 = SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

2. This course helped me to think deeply by encouraging me to consider my own worldview compared to that of others.

1 = SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

3. Studying topics that are important to my community improved my learning in this course.

1 = SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

4. Collaborating with other students on course activities/assignments improved my understanding of the concepts in this course.

1 = SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

5. The flexibility of the course schedule improved my ability to learn in this class.

1 = SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

6. Having a voice in decisions regarding the course (e.g., on the structure of activities, deadlines, assignments, etc.) made this course more valuable to my learning.

1 = SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

7. The class atmosphere made it easier for me to participate in class discussions.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

8. The inclusion of guests from the tribal community to help teach this course enhanced my learning.

1 = SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

9. Timely feedback from the instructor on my progress in the course improved my learning.

1 = SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

10. The instructor's use of visuals, like graphs, diagrams, videos, photographs, and symbols, help improved my understanding of course concepts.

1 = SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

11. My interest in the course increased when we studied knowledge and skills that I can apply as a future professional.

1 = SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

12. Using tribally relevant issues to illustrate environmental concepts help me to understand the course concepts better.

1 = SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

13. Studying both Indigenous Science knowledge and Western Science knowledge helped me to understand the concepts in this course better.

1 = SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

14. Including oral histories and traditional stories helped me to grasp the science concepts in the course better.

1 = SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

15. In this course I understood concepts better when I had to apply my knowledge to solve complex problems.

1 = SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

16. This course improved my confidence in my ability to understand science concepts.

1 = SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

17. This course improved my confidence in my ability to succeed in a science profession..

1 = SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

18. This course increased my interest in pursuing a science related degree.

1 = SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

19. This course increased my interest in pursuing a science profession.

1 = SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

20. Working with tribal professionals in this course helped me to grasp the concepts we studied.

1 = SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

21. The use of Native languages in the course increased my interest in the course.

1 = SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

22. The use of Native languages in the course helped me to grasp the concepts we studied.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

23. Please briefly describe 1 or 2 activities or assignments from this course that you found valuable in supporting your learning and explain what made them valuable.

Attitude Toward Science in School Assessment (ATSSA, Germann, 1988)

24. Science is enjoyable.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

25. I do not like science and it bothers me to have to study it.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

26. During science class, I usually am interested.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

27. I would like to take more science courses.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

28. If I knew that I would never take another science course again, I would feel sad.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

29. Science is interesting to me and I enjoy it.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

30. Science makes me feel uncomfortable, irritable, restless, and impatient.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

31. Science is fascinating and enjoyable.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

32. I have a good feeling toward science.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

33. When I hear the word science, I have a feeling of dislike.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

34. Science is a topic that I enjoy studying.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

35. I feel at ease with science and I like it very much.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

36. I feel a definite positive reaction toward science.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

37. Science is boring.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

Motivated Strategies for Learning Questionnaire, value component and expectancy component modules (MSLQ, McKeachie et al., 1986).

38. In a course like this, I prefer material that challenges me so I can learn new things.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

39. In a course like this, I prefer material that arouses my curiosity even if it is difficult to learn.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

40. The most satisfying thing for me in this course is trying to understand the content as thoroughly as possible.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

41. In a course like this, I prefer assignments that I can learn from even if they don't guarantee a good grade.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

42. I think I will be able to use what I learn in this course in other courses.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

43. It is important for me to learn the course material in this class.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

44. I am very interested in the content area of this course.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

45. I like the subject matter of this course.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

46. Understanding the subject matter of this course is very important to me.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

47. I believe that I can earn a good grade in this course.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

48. I am certain that I can understand the most difficult material in this course.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

49. I'm confident I can understand the basic concepts taught in this course.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

50. I expect to do well in this class.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

51. I'm certain I can master the skills being taught in this class.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

52. Considering the difficulty of this course, the instructor, and my skills, I think I will do well in this course.

1= SD	2 = D	3 = Neutral	4 = A	5 = SA	NA

Appendix B: SKC IRB

IRB NEW PROTOCOL

Project Title:	Research on American Indian Science Education (RAISE)

Investigator Information:

Principal Investigator:	Regina Sievert	Secondary Investigator or Project Supervisor*:	Co-PI Shandin Pete
Department:	Science	Department:	Environmental Science
Department Phone:	275-4995	Department Phone:	275-4896 (Bill Swaney)
Contact Phone:	275-4995	Contact Phone:	275-4205
Contact Address:	SKC IMSI Office Box 70	Contact Address:	SKC Beaverhead Building Box 70
City/State/Zip:	Pablo, MT 59855	City/State/Zip:	Pablo, MT 59855
E-Mail Address:	Regina_Sievert@skc.edu	E-Mail Address:	Shandin_Pete@skc.edu

* Student projects must be submitted with a faculty member listed as Secondary Investigator or Project Supervisor.

Principal Investigator is:

X	Faculty		Staff		Student
	Outside Researcher		Other (Please specify:)		

Type of Project:

X	Research		Grant Activity		Class Project
	Other (please specify):				

Does the research involve an outside institution/agency other than SKC*?	Yes [ ] No [X]

If yes, please list the institutions/agencies. * Has Written Permission been obtained from the cooperating institutions/agencies? If so, please attach.

Project Information:

Present/Proposed Source of Funding:	NSF TCUP Broadening Participation in Research		
Anticipated Project Start Date:	September 1, 2012	Anticipated Project End Date:	August 31, 2015

*Please attach a copy of the funding application.
* You may not start this project until IRB approval is received.

Type of Review Requested:

Please check your response to each question.

	Yes	X	No	1. Does the research involve prisoners?
	Yes	X	No	2. Does the research involve using survey or interview procedures with children (under 18 years of age) that is not conducted in an educational setting utilizing normal educational practices?
	Yes	X	No	3. Does the research involve the observation of children in settings where the investigator will participate in the activities being observed?
X	Yes		No	4. Will videotaping or audio tape recording be used?
	Yes	X	No	5. Will the participants be asked to perform physical tasks?
	Yes	X	No	6. Does the research attempt to influence or change participants' behavior, perception, or cognition?
	Yes	X	No	7. Will data collection include collecting sensitive data (illegal activities, sensitive topics such as sexual orientation or behavior, psychological characteristics, or other data that may be painful or embarrassing to reveal)?
X (Upon IRB approval)	Yes		No	8. For research using existing or archived data, documents, records or specimens, will any data, documents, records, or specimens be collected from subjects after the submission of this application?
	Yes	X	No	9. Can subjects be identified, either directly or indirectly, from the data, documents, or records?
	Yes	X	No	10. Does the research involve potentially culturally sensitive topics pertinent to the Confederated Salish and Kootenai Tribes?

Please check the category of review. Note that the SKC IRB will make a final determination of the review category.

	Exempt
X	**Expedited**
	Full Board
	Cultural

Description of Subjects:

Total number of participants who are minors (less than 19):	None – We will exempt minor students from the study.
Total number of participants who are adults:	Estimated 500

What are the participants' characteristics? If study participants are restricted to one gender, one race/ethnicity, or other single demographic characteristics, include the rationale.

Participants are potentially any adult students enrolled in SKC science courses that have been modified to improve their cultural congruency. These students may be science or non science majors. The courses have not been definitively identified, though several have been suggested (see the attached proposal).

Special Considerations:
Do any of the following considerations apply to the proposed research?
If yes, please check all appropriate blanks below.

X	Audio taping (focus groups)		Videotaping	X	Archival/Secondary Data Analysis		Cultural materials
	Photography	X	Web-based research (Research involving online surveys, email, or other electronic communication.)		Biological Samples		Protected Health Information

Project Personnel List:
Please list the names of all personnel working on this project, starting with the principal investigator and the secondary investigator/project advisor. Research assistants, students, data entry staff and other research project staff should also be included. Note that all personnel must complete human subjects and cultural training. See the SKC IRB site for more information.

Name of Individual:	Project Role:	Status at SKC (faculty, staff, student, co-investigator from other institution, etc)	Human Subjects Protection and Cultural Training Certification*
Regina Sievert	**PI – Lead Researcher**	**Faculty**	**Renewed 08/07/12**
Shandin Pete	**Co PI – Project manager**	**Faculty**	

* Attach certificate of Human Subjects Protection and Cultural Training, or note certificate is on file in the SKC IRB office.

Required Signatures:

Your signature indicates agreement that the study will be performed in accordance with the Salish Kootenai College Institutional Review Board policies.			
Principal Investigator:		Date:	
Secondary Investigator/Project Advisor:	[signature]	Date:	**8-7-2012**

3

FOR OFFICE USE ONLY
INITIALS OF IRB CHAIR:
DATE APPROVED:

Part B:
PROJECT DESCRIPTION

1. Describe the significance of the project.

What is the significance/purpose of the study? (Please provide a brief 1-2 paragraph explanation in lay terms.)

The study is investigating the efficacy of culturally congruent instruction (CCI) in improving SKC students' science achievement. As a group, American Indians are underachieving in STEM compared to their non Indian peers. This study hopes to gather evidence that CCI is valuable for use with our students. Positive results will be used to modify SKC courses to improve their ability to support student learning.

2. Describe the methods and procedures.

Describe the data collection procedures and specifically what participants will have to do.

- Course grades will be collected by the project manager. Names will be removed and ID numbers will be assigned.
- Course evaluations will be collected.
- Course completion rates will be compiled.
- Student work samples will be collected for select assignments. Names will be removed and ID numbers assigned.
- Classroom observations of instruction will be conducted and assessed using the Reformed Teaching Observation Protocol (see attached). Names will not be used; ID numbers will be assigned.
- Additional documentation of course instruction (course outlines, syllabi) will be collected.
- Participants will complete online surveys and participate in focus groups. No names will be used. ID numbers will be assigned.

How long will this take participants to complete?

Less than 2 hours per quarter. The study will be conducted every quarter for three years.

Exactly where (physical location) will the study take place?

In select SKC classrooms and possibly on personal computers in other locations for completion of online surveys.

3. Describe recruiting procedures.

How will the names and contact information for participants be obtained?

Names and contact information will be obtained from completed informed consent forms

How will participants be approached about participating in the study?

The study will be described in their first class meeting. Students will be given the option to voluntarily participate. They will be asked to sign informed consent forms but may opt not to participate.

Will follow-ups or reminders be sent? If so, explain.

Follow ups will be sent as needed, particularly when additional data are requested, for example through the completion of an online survey or participation in a focus group.

***Please submit copies of recruitment flyers, ads, phone scripts, emails, etc. These require IRB approval.**

4. Describe Benefits and Risks.

Explain the benefits to participants or to others.

Evidence collected through this study has the potential to improve instruction so that student achievement in STEM increases.

Explain the risks to participants. What will be done to minimize the risks? If there are no known risks, this should be stated.

There are no risks to participants since no sensitive data will be collected, participation is voluntary, and all information will be anonymous and confidential. No names will be attached to any data; ID numbers will be used. Data will be stored on SKC's secure server.

5. Describe Compensation. Will compensation be provided to participants?

If students are asked to participate in data collection that requires their personal time outside of class, for example in focus groups, they will be compensated.

X Yes No

If 'Yes', please describe amount and type of compensation, including money, gift certificates, extra course credit, etc.

Students will be given checks for $25/ hour for work done during their personal time.

6. Informed Consent

How will informed consent/assent be obtained?

Hardcopy forms will be distributed and explained. Students who choose not to sign the forms will not participate in the study. These forms will be developed as part of the project work, if it is funded.

****Please attach copies of informed consent/assent forms, emails, and/or letters. Please refer to the SKC IRB website for information which must be included in informed consent materials.**
*** Please note SKC IRB policies concerning assent and parental permission for participants under the age of 18.**

7. Describe how confidentiality will be maintained.

How will confidentiality of records be maintained?

All data will be de-identified so that it cannot be connected to any individual. All names will be removed and only ID numbers will be used. Data will be stored on the SKC server. NO IP addresses will be collected.

Will individuals be identified? No. All names will be removed from data. Identification numbers will be used.

How long will records be kept? Seven years

Where will records be stored? On the SKC server

Who has access to the records/data?

Only the PI and co-PI will have access to the data.

How will confidential information be destroyed after the study is finished

Any files containing confidential information will be deleted.

For web-based studies, how will the data be handled? Will the data be sent to a secure server? Will the data be encrypted while in transit? Will you be collecting IP addresses?

No IP addresses will be collected. Data will be encrypted. Data will be stored on the SKC server.

If transcriptions are required, how will transcriptions be handled? Who is doing the transcriptions? Please attach a copy of the confidentiality agreement that transcriptionists will sign.

Little or no transcription will be required. Only the project personnel (Sievert and Pete) will handle any transcription.

* *For studies utilizing Protected Health Information (PHI; e.g., information obtained from a hospital, clinic, or treatment facility), how will this PHI data be obtained and*

safeguarded? Please provide a copy of the release of authorization that will be used to obtain permission from the participant for the agency/institution to release protected health information for project purposes or a letter from the agency/institution documenting agreement to provide protected health information for project purposes.

8. Plans for Publication.

How will the results of this project be reported? For example, will they be published, presented at conferences, sent to other agencies or individuals, or distributed in other ways?

We intend to submit an article for publication and to present the results at professional conferences as appropriate.

9. Copies of questionnaires, survey, or testing instruments.

Please list all questionnaires, surveys, and/or assessment instruments/measures used in the project.

Many of the surveys and interview protocols that will be used will be developed as part of the project's work. Please find attached the Reformed Teaching Observation Protocol, which will be used in conducting classroom observations of instruction.

Please submit copies of all research instruments, tools, surveys, etc.

Appendix C: Focus Group Guideline

Student Focus Group Guideline

Introduction to the Focus Group for [*course name and number*]

My name is [*researcher name*] and I am a [*job description*] and researcher here at SKC. I thank you for joining us today for this focus group. The purpose of this group conversation is to obtain your opinions and thoughts on the [*course name*] courses you are taking with [*course instructor*]. This work, funded by the National Science Foundation, is part of a research study that the Environmental Science instructors and I are conducting to try and identify the types of instruction that are most effective in supporting student learning in science. In this focus group, we would particularly like to hear your ideas on the course you are winding up now with [*course instructor*].
I want to emphasize before we begin that your participation in this activity is voluntary; you are not required to participate and if you would like to leave please do so now.
Along with the focus group, we are going to give you a paper survey to complete. Any information you give us, either today in this focus group or on surveys, is completely confidential. Your name or any other identifying information will not be attached to the information; it will be totally anonymous. We will use the feedback you give us in our analysis to try and tease out how different types of instruction affects students' learning. We hope to use the information to make our course instruction here at SKC as valuable to our students' learning as possible.
If you complete both the focus group today and the survey, you will be compensated $30 for your effort. Compensation will be in the form of a check, mailed to the address that you specify. The survey will only take about 15 minutes to complete. We will not ask for your name on the survey but we will put an ID # on it so we can keep track of who is eligible for payment. Please sign the sign in sheet with your name next to the ID number on your survey. Please bring the completed survey and submit it to me at your next class meeting.
This focus group will be informal. I will be asking the whole group questions, particularly regarding the course content and class activities and I would like you folks to tell me how you feel they influenced your learning. Focus groups work best if people share the floor so we can get as many opinions as possible but please note that you are not required to speak. I will be taking notes and I will also record the session. The recording serves as a backup in case I need to check on something in my notes. The notes and the recording will not be shared with your instructor.

1. Let's start with your overall impressions about the courses [*course title and number*]. How do you feel about these courses so far, generally speaking?

   Possible probes:
   - Are you enjoying them?
   - Do you feel like you are learning a lot?
   - Do you feel confident in your understanding of the course material so far?

- Is the information in the course valuable to you?

2. The courses contained a number of different types of activities including [*CCI content and pedagogy included in the course*]. Which type(s) of activities did you feel were most effective in helping you understand the course material?

Possible probes:

- In your opinion, what was it about these activities that made them effective in supporting your learning? What about them seemed to be most valuable?

- Which activities did you find least effective? Why do you think they weren't effective in helping you learn the material?

- Were there some things you would like to do more or less of? Why?

- Do you feel that the lectures are valuable? What do you like or dislike about them? (videos, photos, real world issues, definitions, etc.). Do you feel that there are obvious connections across lectures that help to integrate the course concepts (to generate a big picture understanding of geology)?

- Labs are often interactive and collaborative but also often guided by [*instructor*]. They are deliberately designed to help you develop critical thinking skills. Do you think they are effective in doing this? Why or why not?

- Vocabulary proficiency is a big part of science courses. Do you feel that the use of vocabulary embedded in the lecture that [*instructor]* tries to do with this course is working for you?

3. [*Question developed specifically toward one CCI methods*] Was it helpful? Did you feel like you understood it? Do you have any suggestions for changes that would make it more useful and understandable exercise?

4. [*Question developed specifically toward one CCI methods*] Was it helpful to the course? Why or why not?

5. Now I want to focus on the course content. What are your impressions about the material you are studying in these courses?

Possible probes:

- Is the content appropriate and worthwhile?
- Is it relevant to you as a student and future professional?
- Was the material presented in a context that helped you make a connection to real world issues?

- Were the concepts presented in a manner that helped you make connections between them, so that you built up a big picture of [*course discipline*], as opposed to isolated and unconnected ideas?

6. Let's talk about the course environment now. Remember your responses are confidential and anonymous.

    - Did you feel comfortable in the class?
    - Did you feel at ease in participating?
    - Did you find the atmosphere is relaxed and welcoming?
    - Did you feel like the interactions in the class are pleasant?
    - What kinds of things do you feel would have made the course environment more effective for you in trying to learn the material?
    - Did you feel that anything about the class atmosphere was a problem for you or others in focusing on learning?

7. Now I would like to hear your thoughts on a few more items to round out this discussion. Please remember that none of your answers will be identifiable with you to anyone outside of this room.

    - What kinds of things does [*instructor*] do that you feel really support your learning? What are his strengths as an instructor that help you understand the course material?

Possible probes:

- Is he approachable, for example, if you want to ask a question in class or get some help outside of class?
- Do you feel respected during class activities?
- Do you believe that he cares about your success in the class? Why or why not?
- What kinds of things do you feel [*instructor*] does that are particularly valuable in supporting your confidence in studying of [*course discipline*]?
- Do you have any suggestions for other things that [*instructor*] could do to improve your learning and confidence in the [*course name*] course?

Appendix D: Reformed Teaching Observation Protocol

Reformed Teaching Observation Protocol (Sawada et al., 2000)

Reformed Teaching Observation Protocol (RTOP)

Daiyo Sawada — External Evaluator
Michael Piburn — Internal Evaluator

and

Kathleen Falconer, Jeff Turley, Russell Benford and Irene Bloom
Evaluation Facilitation Group (EFG)

Technical Report No. IN00-1
Arizona Collaborative for Excellence in the Preparation of Teachers
Arizona State University

I. BACKGROUND INFORMATION

Name of teacher ______________________ Announced Observation? ______________________ (yes, no, or explain)

Location of class ____ (district, school, room)

Years of Teaching ____________________ Teaching Certification ____________________ (K-8 or 7-12)

Subject observed ____________________ Grade level ______________________________

Observer __________________________ Date of observation _______________________

Start time _________________________ End time ________________________________

II. CONTEXTUAL BACKGROUND AND ACTIVITIES

In the space provided below please give a brief description of the lesson observed, the classroom setting in which the lesson took place (space, seating arrangements, etc.), and any relevant details about the students (number, gender, ethnicity) and teacher that you think are important. Use diagrams if they seem appropriate.

2000 Revision

p 1 of 1

Record here events which may help in documenting the ratings.

Time	Description of Events

III. LESSON DESIGN AND IMPLEMENTATION

		Never Occurred				Very Descriptive
1)	The instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.	0	1	2	3	4
2)	The lesson was designed to engage students as members of a learning community.	0	1	2	3	4
3)	In this lesson, student exploration preceded formal presentation.	0	1	2	3	4
4)	This lesson encouraged students to seek and value alternative modes of investigation or of problem solving.	0	1	2	3	4
5)	The focus and direction of the lesson was often determined by ideas originating with students.	0	1	2	3	4

IV. CONTENT

Propositional knowledge

6)	The lesson involved fundamental concepts of the subject.	0	1	2	3	4
7)	The lesson promoted strongly coherent conceptual understanding.	0	1	2	3	4
8)	The teacher had a solid grasp of the subject matter content inherent in the lesson.	0	1	2	3	4
9)	Elements of abstraction (i.e., symbolic representations, theory building) were encouraged when it was important to do so.	0	1	2	3	4
10)	Connections with other content disciplines and/or real world phenomena were explored and valued.	0	1	2	3	4

Procedural Knowledge

11)	Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.	0	1	2	3	4
12)	Students made predictions, estimations and/or hypotheses and devised means for testing them.	0	1	2	3	4
13)	Students were actively engaged in thought-provoking activity that often involved the critical assessment of procedures.	0	1	2	3	4
14)	Students were reflective about their learning.	0	1	2	3	4
15)	Intellectual rigor, constructive criticism, and the challenging of ideas were valued.	0	1	2	3	4

2000 Revision

V. CLASSROOM CULTURE

	Communicative Interactions	Never Occurred				Very Descriptive
16)	Students were involved in the communication of their ideas to others using a variety of means and media.	0	1	2	3	4
17)	The teacher's questions triggered divergent modes of thinking.	0	1	2	3	4
18)	There was a high proportion of student talk and a significant amount of it occurred between and among students.	0	1	2	3	4
19)	Student questions and comments often determined the focus and direction of classroom discourse.	0	1	2	3	4
20)	There was a climate of respect for what others had to say.	0	1	2	3	4
	Student/Teacher Relationships					
21)	Active participation of students was encouraged and valued.	0	1	2	3	4
22)	Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence.	0	1	2	3	4
23)	In general the teacher was patient with students.	0	1	2	3	4
24)	The teacher acted as a resource person, working to support and enhance student investigations.	0	1	2	3	4
25)	The metaphor "teacher as listener" was very characteristic of this classroom.	0	1	2	3	4

Additional comments you may wish to make about this lesson.