

Making Science Education Meaningful for  
American Indian Students:  
The Effect of Science Fair Participation

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## Dedication

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## Abstract

Creating opportunities for all learners has not been common practice in the United States, especially when the history of Native American educational practice is examined (Bull, 2006; Chenoweth, 1999; Starnes, 2006a). The American Indian Science and Engineering Society (AISES) is an organization working to increase educational opportunity for American Indian students in science, engineering, and technology related fields (AISES, 2005). AISES provides pre-college support in science by promoting student science fair participation.

The purpose of this qualitative research is to describe how American Indian student participation in science fairs and the relationship formed with their teacher affects academic achievement and the likelihood of continued education beyond high school. Two former American Indian students mentored by the principal investigator participated in this study. Four ethnographic research methods were incorporated: participant observation, ethnographic interviewing, search for artifacts, and auto-ethnographic researcher introspection (Eisenhart, 1988).

After the interview transcripts, photos documenting past science fair participation, and researcher field notes were analyzed, patterns and themes emerged from the interviews that were supported in literature. American Indian academic success and life long learning are impacted by: (a) the effects of racism and oppression result in creating incredible obstacles to successful learning, (b) positive identity formation and the importance of family and community are essential in student learning, (c) the use of best

practice in science education, including the use of curricular cultural integration for American Indian learners, supports student success, (d) the motivational need for student-directed educational opportunities (science fair/inquiry based research) is evident, (e) supportive teacher-student relationships in high school positively influences successful transitions into higher education.

An overarching theme presented itself embedded within all themes: the importance of understanding the continued resiliency of the American Indian culture as it relates to success. Ultimately, for long-lasting change to occur, teachers and the community must focus on eliminating educational barriers, while supporting academic success, in order to initiate renewal and school wide change.

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Chapter 1

*Introduction*

Science education in the United States has entered the new millennium—a postmodern time when the importance of listening to everyone’s story, along with careful reflection of historically significant themes, can be constructively woven into a global educational plan. This plan motivates, encourages curiosity and promotes a sense of wonder concerning the natural world. To create this new plan, educational leaders will have to listen to the stories of a culturally diverse society, and work together to eliminate oppression and create opportunity for all learners in public schools (Fleming, 2006; Miller & Osborne, 1998).

*Background*

In the United States, creating opportunity for all learners has not been a common practice, especially when the history of Native American educational practice is examined (Bull, 2006; Chenoweth, 1999; Starnes, 2006a). Noel (2002) reminds us that, “any discussion of the education of Native American children must remember the original move to separate American Indians from the rest of society: the forced relocation onto reservations” (p. 19). In 1819, the U.S. Government created a *Civilization Fund* on these reservations that paid for the establishment of missionary schools.

This fund’s focus was the Christianizing of Native students (Noel, 2002). Over the next 100 years, the location of schools for Native students bounced between the reservation and distant boarding schools (Bloom, 1996; Chenoweth, 1999; Noel, 2002). No matter the location of these Native schools, their main agenda was to oppress and

“eliminate the children’s sense of Indian identity, their memory of their religion, language, and their sense of community” (Noel, 2002, p. 29). Not only have three generations of American Indian people had to courageously carry the weight of *historical oppression*, they continue to experience covert, overt and instructional racism both in and out of their educational experiences (Cleary & Peacock, 1998; Lewis and Ippen, 2004).

Chenoweth (1999) tells us that due to this legacy of oppression, “few students of color can be counted among the nation’s high achievers” (p. 16). Therefore, the stories of Native students who courageously chose to take the path towards achievement in science and engineering, within the United States educational system, are important.

Beaulieu (2000) reminds us, “those who endeavored to eliminate Native languages and culture as strategies for educating American Indian and Alaska Native children did not anticipate the long-term viability and tenacity of Native societies and communities” (p.31). Cleary and Peacock (1998) speak of a *cultural awakening*, “for those who have been both participants and witnesses to the regeneration of tribal cultures, to be a part of the cultural and spiritual awakening throughout American Indian country in the past quarter century has been inspiring” (p. 113). During this time of cultural awakening, the U.S. government has also been *awakening* to the idea that this postmodern world cannot afford to leave any child of any culture behind (Beaulieu, 2000; Levinson, Foley, & Holland, 1996).

In order to prevent any American Indian child from being left behind, Congress passed the 1975, *American Indian Self Determination and Educational Assistance Act*. Tribal communities now had more control over the education of their children and

potentially valuable tribal resources. With this increased control, the need for tribal leaders with a strong background in science and technology is mandatory (Hill, 1991). The *American Indian Science and Engineering Society* (AISES) was established in 1977 as a science support group. AISES has often been termed “the college intervention program that works” (Hill, 1991, p. 1). All Indian children, especially the ones that someday may become tribal leaders, have the opportunity to attend summer math and science camps, as well as pre-college academic programs connecting many Native students with science experts in the field (Silas, 2008).

Pre-college support continues along with AISES chapters on many college campuses. This pre-college, college support program is based on three basic principles: (a) value is placed on American Indian culture, (b) high expectations are emphasized, and (c) tribal needs and college achievement are stressed (Hill, 1991; Silas, 2008). Along with their established programs, AISES is now affiliated with *Society for Science and the Public* (SSP) and provides funds and support for student participation in local, regional, national and international science fairs and classroom programs. Preliminary results show that students who participate in AISES science programs are more likely to attend college (Hill, 1991). Finding out what motivates secondary students to participate in AISES science fairs and how participation affects academic achievement may be one of the first steps to promoting academic success for American Indian students.

Since there are predicted manpower shortages in science and technology, we live in a time when limiting anyone is not a luxury we can afford (Bayer Facts of Science Education [BFSE], 1998; BFSE, 1997; Carlone, 2004; DeBoer, 2000; Osborne, 2003;



Woods, 1999). “The National Science Foundation [NSF] estimates that in 2010 as many as one fourth of all jobs will be technologically orientated” (Woods, 1999, p. 3). It is important to find out if a cultural disparity still exists in science interest and future career choices. Determining if the window of opportunity to help young people discover their personal inclination for science still occurs during the middle school years, as Moore found in 1962, is valuable information for educators developing future science standard and curriculum goals for all children.

A study of the effect of student participation in science fair programs, specifically the participation of American Indian students, and the effect of the relationship they develop with their science fair mentor would help provide information necessary to create a new improved educational plan. This cultural exploration examined two secondary school age students who have chosen to participate in science fair events locally, regionally, nationally and internationally.

#### *Problem Statement*

To determine how American Indian student participation in the Society for Science and the Public (SSP) and American Indian Science and Engineering Society (AISES) science fairs and the relationship formed with their teacher affected academic achievement and the likelihood of continued education beyond high school.

#### *Purpose Statement*

The purpose of this qualitative research was to describe how American Indian student participation in science fairs and the relationship formed with their teacher affected academic achievement and the likelihood of continued education beyond high

school. Knowledge of why students choose to participate in these academic endeavors gave clues to motivational factors that may influence future participation, while also providing feedback on the effectiveness of inquiry based science curriculum and the relationships developed between students and their science fair mentor.

### *Research Questions*

To what extent does two American Indian student's participation in science fairs, the leadership exhibited and relationship formed during the teaching and learning process with their mentor, affect academic achievement and the student's drive to continued learning beyond high school?

### *Assumptions*

1. The relationships developed during the learning process affect a student's motivation to learn.
2. Participation in science research and science fair programs will affect student achievement and continued motivation to learn.
3. Academic success in one area of learning can lead to success/motivation to learn in other areas.
4. Factors that increase student motivation will increase student achievement
5. Factors that decrease the amount of racism in schools will have an effect on student achievement.

### *Definitions*

1. Achievement: setting and attaining goals (Argon, 2002).

2. Acculturation: the change in beliefs, values and behaviors of ethnic minority individuals in order to align with the dominant culture as a result of cross-cultural interactions (Farver, Bakhtawar, Bhadha, & Lieber, 2007).
3. Bicultural: person who successfully functions within his/her dominant and non-dominant culture (Garrett, 1996).
4. Enculturation: process of learning and adapting to an individual's home culture (Garrett, 1996).
5. Epistemology: the criteria/methods used to access knowledge and determine validity (Allen & Crawley, 1998).
6. Ethnic identity: the self-identification of an individual with a group; a sense of belonging because of shared attitudes concerning membership and the degree of involvement (Farver et al., 2007).
7. Extrinsic motivation: external factors that motivate an individual including rewards, grades, and public praise (Argon, 2002; House, 2003).
8. Gagoyoti: (two people) " In Cherokee, that's a way of saying, well, you're this and you're that" (Garrett, 1996, p. 19).
9. Holistic methods: initially presenting the big picture followed by specific details. (Cleary & Peacock, 1998).
10. Intrinsic motivation: internal motivating factors that create a desire for self-determination, curiosity, responsiveness to feedback, competence, self-expression, and imitation (Cleary & Peacock, 1998).

11. Motivation: the human ability to direct energy in the pursuit of a goal (Wolters, 2004).
12. Oppression: the results of continued racism as one group or individual “...enslaves and lords over the oppressed (person who experiences racism), abuses the oppressed physically and psychologically, and reminds them they are less” (Cleary & Peacock, 1998, p. 62).
13. Oppression, internalized: individuals within an oppressed group accepting that they are less than the dominant group, whereby the oppressed individuals turn against each other (Pheterson, 1986; Poupart, 2003).
14. Racism: to believe that some races are superior to other races; often associated with the power of the oppressor over the oppressed (Yellow Bird, 1999).
15. Racism, overt: outward acts of racism conferring negative characteristics towards a whole race of people (Cleary & Peacock, 1998).
16. Racism, covert: inward acts of racism that are often concealed in a way that is difficult to measure” (Cleary & Peacock, 1998).

### *Limitations*

The scope of this study was limited to two, self-selected secondary students who have chosen to participate in various SSP and the AISES science fairs. The research findings can not be generalized to all Native Americans. Even though the researcher tried to eliminate bias, this study acknowledges that, “when an individual writes about individuals different from themselves, he or she will write himself or herself into the life of the subjects about whom the individual is writing” (Cresswell, 1998, p. 206).

*Summary*

Chapter 1 explains how continued educational reforms that stress the importance of an unbiased, culturally relevant science curriculum, along with a school-wide inclusion of Native traditions and support from groups such as the NSF, SSP and the AISES, may reduce racism while increasing American Indian student interest in science, achievement, and the likelihood of lifelong learning (Boss, 2003; Nupa, 2003; Stephans, 2003). These topics, as well as the importance of an administrative and teacher leadership team necessary for these types of transformations, will be explored in the following chapters.

In chapter 2, the literature review discusses historical events that have affected the education of American Indian children and the oppression that has occurred, focusing on defining how, where, when and why racism is occurring in school, along with the subsequent effect on student academic achievement (Davis, 2001). A parallel historical story of Native and non-Native science education in the United States illustrates how racism and oppression have played a part in the limited American Indian educational agenda, as well as reports of past and current performance indicators and the educational reforms that have been implemented in hopes of affecting student achievement (Argon, 2002; Argon, 2004; House, 2001, 2003; Sanchez, 2000).

In addition, chapter 2 reports on best practice in science education and the success of elevating the academic performance of secondary and post secondary Native students in educational settings. Specifically, special attention is given to a pending *crisis* facing the United States. In as little as fifteen years, there will be a lack of American born,

high-level scientists and engineers needed to replace our aging workforce (Friedman, 2005). In order to address this crisis, as well as addressing the lack of American Indian students in post-secondary settings, a brief history of American Indian science education in the United States is highlighted, along with the impact of the AISES promotion of student participation in science fairs and inquiry based education in the classroom (AISES, 2005).

Chapter 2 also includes an assessment of intrinsic versus extrinsic cognitive-motivational predictors of academic performance in Native American students, along with learning styles, curriculum, and the environmental and social factors that maintain student motivation (Argon, 2002, 2004; Cleary & Peacock, 1997; House, 2001, 2003; Sanchez, 2000). Lastly, chapter 2 takes a close look at the American Indian Content Standards (AICS) in science and technology in order to understand how they can be applied to American Indian education and science education.

Chapter 3 discusses the ethnographical research design, including a description of the participants featured in this qualitative study, the location of participant interviews, as well as a general description of the process and questions used to collect qualitative information.

Chapter 4 tells the story of two adults, (John and Rita), who participated in science fair events in high school under the mentorship of the investigator. This chapter is organized around the themes that emerged from transcribed sections of the interviews embedded in research. These themes are: racism and continued oppression, identity formation, learning styles and motivation; and ongoing academic achievement.

Chapter 5 is an autoethnographical discussion of teacher leadership, primarily the leadership of the investigator, and this leadership's perceived effect on John's and Rita's success. This success includes John's and Rita's continued participation in science fair events in high school, their academic commitment to acquiring a quality, secondary science education, and John's and Rita's successful transition into their current post-secondary experiences. In addition, the chapter details the development and perception of the teacher-student relationships created while working on science fair projects, and the impact it had on John's and Rita's continuation of education beyond high school.

## Chapter 2

### Literature Review

#### *Introduction*

Educators must understand and appreciate that students entering their classrooms bring their own unique set of worldviews (Allen & Crawley, 1998; Warren, 2006). These varied worldviews can lead to negative student interactions; often originating because of a misunderstanding of what it means to be American Indian. Thus, Native students crossing the cultural border into western worldviews often experience racism in a climate of chronic institutionalized oppression. Within a historical context, these constructed, oppressive roadblocks, along with overt and covert institutional racism, diminish the American Indian student's ability to navigate the many cultural border crossings necessary for continued academic success.

#### *Historical Overview of American Indian Education*

As part of the American Indian historical framework, a congressional report in 1969 called Indian education a *national tragedy* (Kelly, 1999). Congress reported the effect of past educational policies and practices used by the federal government to educate American Indian students on reservation missionary schools predominated in the United States until the late 1870's, when the establishment of off-reservation boarding schools prevailed (Noel, 2002). Researching the historical impact of religious missionaries and the self-imposed educational rule of the white man on Native American children in the United States is both a sad, painful journey and a courageous "legacy of cultural persistence" (Davis, 2001, p. 22). This story begins in the late 1820's. Noel



(2002) informed us that the language used to define Native American education in the early 1900's sets the tone that will be used for the next one hundred years. The Indian Affairs Commissioner in 1902 remarked:

Indian reservations were the outgrowth of the policy of the Government in dealing with wild bands of marauding savages who in the early portion of the last century roamed over large sections of the United States. It was a matter of segregating and confining them...upon limited areas, where they could either be under definite surveillance or exterminated as a race.

(Department of the Interior, 1902, pp. 9-10, as cited in Noel, 2002, p. 20)

“This language defines the purpose of educating Native American children from the 1820's to the 1930's” (Noel, 2002, p. 20), setting a tone that encouraged educational practices that led to the establishment of the Civilization Fund in 1819.

*Christian missionary schools.*

The Civilization Fund financed the establishment of Christian missionary schools on government determined Native land, thus altering Native communities with the goal of destroying their very identity. The missionary schools forbade the practice of native cultural traditions, especially spiritual ones, while promoting Christian conversion (Kelly, 1999; Noel, 2002; Stokes, 1997).

*Off-reservation boarding schools.*

Off-reservation boarding schools followed missionary schools in the 1870's. On November 1, 1878, Captain Richard H. Pratt opened the Carlisle Indian School at an abandoned military post in Pennsylvania. Pratt's goal was to "kill the Indian, not the man" (Noel, 2002; Brainwashing and boarding schools, 2004, p.1). Stokes (1997) reported that, "the 1878 Annual Report of the Commissioner of Indian Affairs states that one goal of schools was for the children to be 'removed from the influence of their parents...' (p.xxv-xxvi), so that children would not resume their traditional tribal ways" (p. 576).

Christian educators administrated many of these schools, while some were government run and staffed. The off-reservation boarding school's main goals were to assimilate native children into the white American way of thinking, dressing, working and speaking. Not only separating children from their families for years at a time, but also punishing Native students for speaking and practicing their faith (Allen, 1999; Stokes, 1997). Noel (2002) reported that these oppressive so called educational practices and limitations were used to try and remove the child's sense of Indian identity, the practice of Native religion, language, and their sense of culture and community.

While the U.S. government diligently worked to eliminate Native culture, American Indian children refused to go along with these controls (Davis, 2001). The forced separations of children from all that they knew and loved failed to emotionally separate children from their parents, or bonds between children and their tribal heritage.

The futile attempt to control Native students is collaborated by Bloom's (1996) report on the effect of sports in boarding schools, "sports constituted a complex cultural practice where Native Americans could not only respond to an educational system that was often insensitive, but through which they could also experience pride, mischief, or pleasure, and create new ways of expressing their identities as Native Americans" (p. 45).

### *American Indian Educational Reforms*

American Indians were not allowed to apply for U.S. citizenship until 1924 (Horse, 2005). In order to become a citizen, Native people had to participate in a ceremony of admission that was conducted by an agent from Indian Service. During this event, Indians were instructed that they were to live as white men and women. Indian men said their Indian name for the last time and shot their final arrow. Indian women were given a purse and eagle pin as well as instructed in their role in the home (Biazzaro, 2004).

In 1930, John Collier, the Commissioner of Indian Affairs, set out to reform and ultimately eliminate federal boarding schools (Bloom, 1996; Davis, 2001). In 1950, reform efforts and the resilience of Native children led to the emergence of many famous Native American athletes, such as Jim Thorpe, and nationally ranked football teams and other dominant boys and girls teams (Bloom, 1996). Still, in the 1950's, American Indian students attended federally funded Christian schools. These schools used extrinsic motivational practices, void of anything cultural or meaningful. Corporal punishment and the threat of isolation, affected American Indian learners motivation to learn (Davis, 2001).

The children who attended forced off-reservation boarding school in the 1950's are the parents of many of the students attending today. These parents, understandably so, harbor very little trust in the educational system instructing their children, further affecting the level of student academic success (Cleary & Peacock, 1997). In the late 1960's, the Federal Government pulled all financial support of Christian on-reservation schools; students attended the nearest public school (Bloom, 1996; Davis, 2001). Religious freedoms were not recognized until 1978, when the *American Indian Religious Freedom Act* was passed. Under this law, the Federal Government gave Native Americans the constitutional right to exercise their traditional religious practices (Horse, 2005).

Even with the advent of federal acknowledgement of citizenship and religious rights, and some educational reforms, the Indian Nations at Risk Task Force (1991) found that "our schools have failed to nurture the intellectual development and academic performance of many Native children, as evident from the high dropout rates and negative attitudes toward school" (p.1). Quoting the American Council on Education, Grande (2004) reported:

The trauma of struggling against colonialism in postcolonial zeitgeist manifests most acutely in American Indian Students, the lowest academic performance rates, and the highest college dropout rate, the lowest academic performance rates, and the lowest college admission and retention rates in the nation. (p. 5)

Currently, the goal of educating Native American students contradicts destroying everything Native for American Indian students; however, little effort to promote culturally appropriate teaching methods and curriculum occurs (Allen, 1999). This lack of effort is still evident, even after President Clinton's 1998 historic executive order that required, and continues to require, federal agencies to develop a long-term, comprehensive, Federal American Indian Education Policy. This executive order's mission was to organize services available to American Indian and Alaska Native students with goals of dropout reduction, drug and alcohol prevention, and improved academic performance in reading, math, science and technology. President Clinton voiced a pledge to "...preserve, revitalize, and use Native languages and cultural traditions" (Executive Order 13096, August 6, 1998 as cited in Hollowell & Jeffries, 2004, p. 770) in hopes of reducing the drop out rate while increasing student achievement (Beaulieu, 2000).

Increasing student achievement was still an unrealized goal in 2002. On January 3, 2002, the Federal government enacted the *No Child Left Behind* (NCLB) law in hopes of increasing student achievement. This act was signed into law to make schools accountable for all students (Klein, 2008; Rose, 2004; Sunderman & Orfield, 2008). It states that by 2014 "all children will be proficient in all subject matter and be taught by qualified teachers highly trained in subject matter" (Moores, 2004, p. 347). One of the key flaws in NCLB is that the students most hurt by NCLB's mandated testing are the very students the original law hoped to *not leave behind* (Bracey, 2008; Brooks, Libresco, & Plonczak, 2007; First, 2004; Lee, 2004; Yecke, 2005b).

Making diverse people alike is exactly what the federal government tried to mandate with Federal Boarding School legislation not so long ago. Starnes (2006b), an American Indian Educator, strongly notes a parallel comparison by calling NCLB “the boarding school solution of the 21st Century” (p.388). Starnes reported:

NCLB implementation is not only ineffective; it is detrimental to them [American Indian students]. It threatens academic achievement; guts, effective culturally based programs, and further alienates children and communities....if NCLB is fully implemented, it will leave Indian students further behind.... there is a definite mismatch between NCLB and what works for Native students. (p. 388)

Starnes (2006b) professed that for any kind of NCLB curriculum to work, the changes in focus must include culturally relevant curriculum, something President Clinton eloquently called for in 1998, but has yet to be realized for many public schools (Brooks et al., 2007; Moores, 2004; Rose, 2004).

#### *Oppression and Racism—Past and Present*

While adjusting curricular practices to include expanded cultural inclusion can lead to increased academic achievement for American Indian learners, it is not the only educational adjustment that must be made (Castagno, 2005). Facilitating and encouraging a positive, interactive teacher-student relationship is necessary. Support must be given from administrators, parents, teachers and community members, insisting on facing the effects of racism and institutional oppression on academic achievement in our schools.

Realizing that racism and the effects of historical oppression are alive and well in our public schools and in our communities is the first step toward eliminating their

impact on American Indian students' ability to reach important educational goals, and the future possibility of these students contributing to their tribal communities. Ambler (1991) wrote about racism and how it affects all aspects of Native life, "Despite the fact that we are supposed to live in a supposedly enlightened era, the greatest hurdle to tribal economic and political self-determination continues to be racism" (p. 21). Paulo Friere, the father of oppression theory, says "...we can never be free unless we realize we are enslaved" (Friere, 1970, p. 64).

After interviewing teachers of American Indian students across the country, Cleary and Peacock (1998) organized a discussion of oppression and racism and their effects on American Indian students around five elements: "(a) institutional racism, (b) overt and covert racism, (c) malfunctioning institutions, and (d) communities in trouble" (p. 60). Looking at this structure, the following section will explore institutional racism, overt and covert racism, and look at how historical or remnants of oppression compound the difficulty faced by American Indian students (Castagno, 2005). Racism and oppression are some of the barriers that make it difficult for American Indian students to see themselves in today's standardized science curriculum.

#### *Historical oppression.*

Oppression, in extreme cases, can result in genocide. Initially, five million American Indians lived in North America, after European colonization and subsequent overt acts of genocide; only 250,000 remained (Zinn, 1980). As stated previously, those adults who did survive were forced on reservations, while their children were required to attend federal boarding schools. Even though the boarding school project was abandoned

and children were finally allowed to live with their parents, students continued to be punished for practicing any outward sign of their culture while in school. Students were still forced to wear different clothes, change their spiritual practices, and most importantly, banned from speaking their own language (Bergstrom, Cleary & Peacock, 2003; Castagno, 2005; Grande, 2004).

*Historical grief and anger.*

Lewis and Ippen (2004), in their study of children who have experienced trauma, found that for traumatized children, the loss of family, community, home and all that is physically familiar, including even the landscape and weather of their homeland, is a cause of an extreme sense of grief. Many American Indian children experienced these extreme losses when they were forbidden to speak their language, wear traditional clothes, or practice their religious customs during their forced relocation to boarding schools. They often tried to escape, with many dying before finding home.

The federal government has archived correspondence written to parents by federal officials informing them of their child's death while running away from boarding schools (Cleary & Peacock, 1998). Often, in situations as children fleeing from a boarding school, these children's ability to adapt to loss and separation, Lewis and Ippen speculate, depended on the individual's ability to engage in a healthy mourning process. "One of the mental [well-being] health outcomes of historical trauma response (HTR) is historical, unresolved grief, resulting in a complicated bereavement that may be passed down through generations of children carrying on the legacy of pain" (Lewis & Ippen, 2004, p. 20).



Cleary & Peacock (1998) referred to this legacy of pain and how it can transform over time when he stated, “sometimes it is just generalized anger; historic anger; centuries of anger that is passed down from grandparents to parents to children” (p. 85). A “...deep multigenerational soul wound...on our hearts, and it shows in everything we do. Triumph and tragedy exist together. Love and self-hatred form part of the same circle. We are joyous. We grieve” (Bergstrom et al., 2003, p. 49). This grief and anger can again metamorphose into the self-destructive behaviors of the sub-oppressor, or one who believes they are less, thus thwarting any attempt of leaving this destructive circle of pain (Bergstrom et al., 1998; Lewis & Ippen, 2004). Developing a strong teacher-student relationship while working on projects that encourage one-on-one interactions between the advisor and advisee can assist both teacher and student in overcoming oppressive rifts between cultures, thus thwarting self-destructive behaviors in American Indian science students, working towards harmony and balance in the classroom (Starnes, 2006b).

*Harmony and balance.*

There are many individual American Indian tribes, each with very different histories, languages and cultural practices. Bergstrom et al. (2003), after interviewing tribal members across the United States, found one commonality reveals itself to all American Indians—they need to live a life in harmony and balance:

Living a life in harmony and balance leads to a feeling of wholeness and completeness, which is a way of connecting with our spirituality.

Harmony and balance require individual wellness in all aspects of our being, including our mental, emotional, physical, and spiritual dimensions.

This means it is important to pay attention and try to understand how these four dimensions affects the other. (p. 26)

In summary, the unresolved grief and anger born from past covert and overt acts of oppression resulting in historical grief often breeds self-destructive, internalized oppression. These covert acts of oppressive racism, both externally and internally created, make it very difficult for American Indian people to experience the harmony and balance needed for wellness. Cleary and Peacock (1998) describe this state of dissonance as a lack of "...interdependence of physical, emotional, psychological and spiritual wellbeing" (p. 25).

Often the cultural beliefs and customs that could aid in the healing of this legacy of pain and bring harmony and balance into the lives of many American Indians is are silenced, along with the omission of historical events related to those painful memories and traumatic events (Lewis & Ippen, 2004). Lewis and Ippen (2004), after studying children who have experienced trauma, "...argue that ethnic identity may be a source of psychological protection for young children faced with overwhelming trauma" (p.14). Yet, once historical oppression has been established, the very cultural protection that shields traumatized children can lend itself towards maintaining the sub-oppressive status quo (Wilder, Jackson, & Smith, 2001). Cleary and Peacock (1987) elaborated on this phenomenon when they discussed the Indian crab theory, "...well, with Indian crabs, the first crab starts to get out, and all the others grab its legs and pull it back down in so [that first crab] can't escape" (p. 81). Peacock battled to understand how educators and community members will ever be able to set all Indian crabs free:

I ask myself how we have such intense beauty and such deep pain living side by side, all at the same time? And how and when will we break this great cycle of pain? When will our children stop suffering from the dysfunction in our own communities? It is the great challenge facing the Seventh Generation. (Bergstrom et al., 2003, p. 49)

Lewis and Ippen (2004) found that children who have faced trauma could grow stronger and heal from their experiences. These children can develop “increased empathy along with a greater sense of justice as a means of coping with the trauma of forced integration” (p. 38). They can move beyond being “passive recipients of trauma...to creating a healthy culture of cooperation and caring” (p. 38). Mankiller said it best when she simply stated, “the war for Indian Children will be won in the classroom” (Mankiller as cited in Grande, 2004, p. 11). In the science classroom, the American Indian Science and Engineering Society (AISES) has already marched to the frontline of this important battle. By creating a culturally relevant venue such as the National American Indian Science and Engineering Fair (NAISEF) held annually in New Mexico, AISES helps American Indian students release themselves from the grip of internalized oppression in order to become active participants in their own education and to lead students towards post-secondary academic success.

*Oppression and racism in today's classrooms.*

Cleary and Peacock (1987) reminded us that a lot has changed, but racism is not an ill only of the past, it is alive today, harming schoolchildren and their communities.

Racism, by its very definition, lends itself to a loss of power. Wilder et al. (2001) found in their research on oppression that:

Whenever there are imbalances of power, there tend to be imbalances in opportunities and outcomes. Although there is a tendency for those in power to minimize and blame minority groups for their own misfortune, labeling and faultfinding have not been shown to be effective methods for improving educational outcomes. (p. 1)

Confronting and improving educational outcomes for American Indian students is a difficult task that all educators must face (Grande, 2004). The statistics on the performance of American Indian students for all age levels are staggering, but must be acknowledged for change to occur. Upon entry to kindergarten, American Indian students are one year behind their non-Indian peers in oral language, pre-mathematics and pre-reading skills, as well as having lower general knowledge and classroom behaviors in conflict with the established environment of many public schools (Farkas, 2003).

If American Indian students start kindergarten one year behind their peers in academic performance, then possibly, this delay in achievement may have exponential effects. Kopp (2008), founder and chief executive officer of Teach for America, reported that, by the time 9 year olds below the poverty level reach third grade, over 13 million of these children are three grade levels behind. Research has shown that those students who start behind early tend to fall further behind over time. For example, students who started school one year behind in vocabulary knowledge, finished high school almost four years behind the non-Indian students (Farkas, 2003). Kopp (2008) added to this, reporting that

“...the half of low-income children who do manage to graduate from high school are performing, on average, at the level of eighth-graders who live in affluent communities” (p. 734).

There are many documented factors to this disparity in American Indian student educational outcomes, but research related to covert and overt racism as contributing barriers to educational achievement, though acknowledged, is less prevalent. Overtly, American Indian students are typically tracked into lower curriculum and ability groups (Farkas, 2003; Starnes, 2006b). Many qualitative researchers have found that, American Indian children are categorized and treated as remedial (special education) students. Covertly, American Indian students are called out on behaviors that other students are not penalized for, given less encouragement, and are not held accountable academically as other non-Indian students are (Bergstrom et al., 2003; Farkas, 2003; Grande, 2004).

Acknowledging the value of President Clinton’s mandate for culturally infused curriculum, while also focusing on the effect of oppression and racism in our schools, Grande (2004) brought this discussion full circle when she stated:

In other words, in addition to the development of Native curricula, indigenous educators need to develop systems of analysis that help theorize the ways in which power and domination inform the processes and procedures of schooling. They need pedagogies that work to disrupt the structures of inequality. Consequently, such are the aims of critical pedagogy. (p. 26)

In a global economy, driven by information and innovation, everyone's ideas cannot be overlooked and an economy built on institutional racism, driven from the top-down, may just not work anymore. Houston (2007) reiterated these thoughts when he said "...the remedy for being lost is not to drive faster....You have to stop and change direction." Houston stated that the educational system has not "...failed at their mission....the mission has changed (p. 744).

### *Performance Indicators*

A move toward the formation of a postmodern perspective that all children are important, and the incorporation of the *idea* of a federal mandate that states *No Child [Should be] Left Behind*, can only be a reality if leaders and educators first examine the performance indicators that benchmark where American Indian education is today. An understanding of what was and is can only help educators develop leadership strategies that can change the direction of our educational system. Finally, we must work to heal the wounds of institutional and historical oppression, while dealing with and eliminating racism, and moving towards the maintenance of indigenous languages and culture in our schools (Grande, 2004; McNamee & Miller, 2004).

In the United States, 40% of American Indian students drop out of school before graduation (Cleary & Peacock, 1997; House, 2003). When Native students take the standardized achievement exams, they can lag up to two years behind non-native students (Beaulieu, 2000; Cleary & Peacock, 1997). In 1997, Minnesota had 14,000 Kindergarten through twelfth grade Indian students. Fifty-seven percent of these students failed to complete all of the requirements to graduate from high school (Cleary & Peacock, 1997).

In 1990, 9.3% of American Indian persons 25 years and older had attained a bachelor's degree when compared to the 20.3 % of the total population (Beaulieu, 2000). This disparity has been attributed to high levels of poverty along with defining educational success by the number of students that leave their community for employment or post secondary opportunities many miles from home (Beaulieu, 2000).

These statistics did not change much when undergraduate science education was evaluated. Minority populations, including Native American workers, comprised 24% of the total science related workforce in 1999. These workers only formed “7% of the science and engineering workforce in that year” (Barlow & Villarejo, 2004, p. 1).

Minority students in 2002 were as likely to pursue a degree in science, but not as likely to graduate from college in their intended major (Barlow & Villarejo, 2004).

One current success story of American Indian continued learning is the Tribal College system. Tribal colleges have increased tribal member's access to higher education, resulting in American Indian students going on to obtain bachelors, masters and doctoral degrees in science while maintaining and preserving tribal cultures and languages (Fox, 2006). This type of success needs to be realized and promoted by sound culturally based best practice in middle and high school science classrooms across the United States.

### *Best Practice in American Indian Science Education*

In order to write policies and curriculum that promote best practice in science education and high school and post-secondary completion, a longitudinal study of an undergraduate program designed to increase the likelihood of Native American students

completing in undergraduate, graduate and doctoral degrees in a biological science related field was done (Barlow & Villarejo, 2004). This enrichment program was called, Biology Undergraduate Scholars Program (BUSP). BUSP was designed to offer supplemental tutoring and noncredit science instruction, along with academic and personal advising, peer support and research experience. This study found that the program significantly affected persistence and performance in science and math classes. Participation by students in, science research projects was found to play a large role in the likelihood of graduation in biological fields.

Barlow and Villarejo (2004) also found that, “High school GPA was the single strongest predictor of student performance in college, and SAT scores offered some predictive value” (p. 16). BUSP also found that grade point averages greater than 3.0 were the strongest predictors of students entering doctoral programs.

If high school grade point average (GPA) plays an important role in college success, policies and curriculum need to be developed in our local middle and high schools to enhance academic achievement for Native students. Educational policy and curriculum need to be written that promote cultural grounding in all aspects of education for American Indian and non-Indian students, as well as the need for a better understanding of the American Indian learners’ unique educational needs.

In order to understand the need for culturally aware science curricula and qualified Native American students in science, math and technology, a study was done by Allen and Crawley (1998). They studied the effect of cultural grounding in an ethnographic study on the degree of *cultural* dissonance in a middle school. They



compared the *worldview* of Native American students of the Traditional Kickapoo Band with the worldview encountered in a science classroom. “Worldview may be defined simply as the way people think about themselves, their environment, and abstract ideas such as truth, beauty, causality, time and space” (Allen & Crawley, 1998, p. 113).

Allen and Crawley (1998) found that science textbooks and teachers approached epistemology (ways of knowing) from a positivist approach, the existence of one truth. Native students tended to understand the nature of science having multiple truths, with multiple ways of explaining an observed phenomenon. The Kickapoo students preferred cooperative learning and holistic content that was in conflict with individualized and competitive strategies used in the science classroom. The participating teachers in the study was surprisingly dismayed at the “...extent to which cultural biases were evident in his classroom instruction” (p. 129).

Acknowledging the importance of academic achievement in high school, while trying to diminish dissonance between the worldview of the Native students and the instructional practices in use, is an important educational goal that may lead to improvements over past performance indicators. Currently, an effort is being made by many public schools and American Indian schools to recruit American Indian science teachers, while also promoting the development of culturally based curricula that can be used by all teachers for all students (National Academy of Sciences [NAS], 2006; Weeks & Stepanek, 2003).

Continually, American Indian educational *best practices* need to be developed that lead to the implementation of educational reforms based on sound research and

informed by past practice (Zemelman, Daniels, & Hyde, 1998). In 1987, President Clinton stated that there needs to be efforts to meet the unique educational and culturally related academic needs of Native students—“the goal being that Native Americans can achieve in accordance with the same standards as all other learners” (Beaulieu, 2000, p. 29).

#### *American Indian Science Content Standards*

Understanding that the same educational opportunities have not been available, for American Indian students, the Bureau of Indian Affairs (BIA) developed the American Indian Content Standards (AICS) through their Goals 2000 program. These standards are to assist educators, who are working in all content areas having to align with the National Standards, to reference and integrate Indian content into their already aligned curriculum (Bureau of Indian Affairs [BIA], 2000a). Language and culture are the theme of the AICS, with the understanding that they must be the cornerstone of any reform movement in Indian education (BIA, 2000a).

The AICS in science are not intended to be an end all, but a curriculum enhancement tool for Native and non-Native teachers (BIA, 2000b). The AISES aligns their curriculum with the AICS and the National Science Standards. AISES and the National Science Foundation (NSF) are commitment to scientific inquiry (Hill, 1991; NRC, 1996; Shelby, 2006; Silas, 2008.). The NSF states that “inquiry into authentic questions generated from student experiences is the central strategy for teaching science” (National Research Council [NRC], 1996, p. 31).

The Content Standard A, for grades kindergarten through grade four (K-4), is *Science as Inquiry*. This benchmark asks students to "...develop an awareness that observations and understandings of nature and ecological relationships traditionally formed an essential base of knowledge among American Indian cultures" (BIA, 2000b, ¶1). Science inquiry benchmarks for students grade levels five through eight (5-8) go beyond an awareness of the importance of observation and ecological relationships, to the ability to articulate examples of the use of scientific inquiry through improved technologies employed by American Indians (BIA, 2000b).

The AICS stated that students grade level nine through twelve (9-12), should be aware of, and able to articulate, an understanding that scientific inquiry is a process used to solve a problem while employing the steps of the scientific method (BIA, 2000b). From this *understanding*, students should be able to infer how similar, but not identical, the current process of inquiry is when related to past investigated and explained natural phenomena (BIA, 2000b).

#### *American Indian Technology Content Standards*

The AICS in technology for all grade levels asks educators to show students how technological advancements have been applied to traditional Native tools, and technologies such as a pump drill. In addition, students should be able to explain how new advances in technology advance scientific knowledge, and how new scientific knowledge advances new technologies. The science and technology standard E4 asks students to apply this standard to "contemporary Indian communities in such areas as natural resources development, management and conservation" (BIA, 2000b, ¶41).

Wakshul (2005) interviewed Daniel Wildcat, a Yuchi member of the Muscogee Nation of Oklahoma. Wildcat understands that with advancements in technology comes responsibility. Wildcat said that "...being connected does not only mean that schools and their students are just hooked up to batteries, satellites and high-speed Internet connections," (p. 40) but can also mean students are culturally woven into a rich historical tapestry; an ever-changing vision that can be celebrated, but possibly never exactly replicated. Advances in technology, culturally grounded with community connections, will allow all students to gain the knowledge they need and the means to use it. John Dewey, a pioneer in education reform, once said, "never separate knowing from doing" (Dewey, 1934, p. 48). Classrooms ethically grounded in technology will not only provide knowing, through the technology made available, but will also provide a means for students to do.

The data provided by national standards testing can be used to provide school leaders with important indicators of student performance; however testing is not the only type of data that can be used to evaluate the impact of culturally infused science and technology curriculum. Attendance, discipline referrals, school report cards, examples of teacher practice, written observations, student work, science fair participation, and digital videos can also provide a strong assessment of student achievement and active classroom participation. First, teachers need to know students; relationships are the foundation from which educators can assess and build innovative individualized curriculum (Wakshul, 2005).

*American Indian Science Curriculum*

In order to produce innovative culture based curriculum, Richau wrote an educational handbook in 1981 for science teachers of Native American students. Richau reminded science educators that science, though often, "...perceived as alien to Indian culture and usually taught as remote from daily existence [is] recognized for its potential to bridge the cultural gap and necessary for the struggle for self-determination and tribal survival" (Richau, 1981, p. iii). Richau stressed that positions dealing with resource management and development on the reservations are in need of Native American educated in science and technology (Richau, 1981).

Since then other science educators have been working to write culturally inclusive science curriculum, such as *The Handbook for Culturally Responsive Science Curriculum*, which addressed the federal science academic standards. Stephens (2003) reported these curricular reinforcements are a new and exciting prospect for educators who want to make "academically sound and culturally meaningful connections between Native culture and language and core subjects like math, science, social studies, history and literacy" (Weeks & Stepanek, 2003, p.1).

Currently, Ness, Bequette, and Olson (2007) from the University of Minnesota, Cloquet Public Schools as well as educators/elders from the Fond du Lac Band of Ojibwe are working together to develop a curriculum based on the National Standards and the AICS. This collaboration, called *Project Intersect*, integrates American Indian arts into math, science, and language arts education. Some goals of this curriculum are to "...build on what teachers are already doing ...by intersecting quality American Indian arts

activities with existing curriculum to further improve student achievement,” while also increasing the motivation of American Indian learners (Ness et al., 2007, p. 24).

#### *Motivation and the American Indian Learner*

Once a culturally responsive, standards-based science curriculum is in place, educators must focus on motivating individual American Indian learners to succeed in science. Successful learning occurs when a student sets goals, and achievement occurs when the goals are met (Argon, 2002; Wolters, 2004). Motivation to reach those goals may be a large predictor of future academic success (Church, Elliot, & Gable, 2001). Bartholomew (2007) stated, “Motivation may be more important for student success than even the teacher’s knowledge of the content being taught” (p. 593). Many studies of American Indian learners show that what motivates the non-native student to set and finally achieve a goal may not be true for a native student (Cajete, 1988; Cleary & Peacock, 1998).

Barron and Harackiewicz (2001), psychology professors from the University of Wisconsin-Madison, did research on multiple goal perspectives. They found while learning, intrinsic motivation can be more beneficial than extrinsic, but there is added benefit in a combination of mastery and performance goals or extrinsic and intrinsic motivational factors. Marzano, Waters, & McNulty (2005) developed and defined activities that would harness students’ intrinsic motivation. They came up with four action steps a school can take to increase student intrinsic motivation to learn: provide feedback on learning, use engaging techniques, teach students about motivation and “...provide opportunities for students to work on long-term projects of their own design”

(Marzano et al., 2005, p. 97). Long-term science inquiry projects, such as projects that are presented at National American Indian Science and Engineering Fairs (NAISEF) appear to satisfy Marzano et al.'s criteria to increase American Indian student intrinsic motivation. However, it is stressed that simply giving time for long-term projects does truly tap into internal motivation unless students have the freedom to select the topics and set goals they are truly interested in, and are allowed the necessary time and resources for completion (Marzano et al., 2005). Constantly reminded of ridged state and national academic standards, many educators worry that the time allowed for long-term projects would diminish their ability to teach content material. Marzano et al. (2005) stated that research suggests that the loss of time to academic content may be made up by the "halo effect" ...or the "...energy and engagement created by these tasks might spill over into traditional academic subject areas" (p. 96).

The NRC in 1996 stated that the goal of science education as a discipline is to "...enhance all students' scientific literacy; that is, to help students grasp essential science concepts, to understand the nature of science, to realize the relevance of science and technology to their lives, and to willingly continue their science study in school, beyond school" (NRC, 1996, p. 31). Finding out if the American Indian Science and Engineering Society's (AISES), and their long-term promotion of student participation in school science fair programs, is helping educators reach these National goals is important for the future of all American Indian and non-American Indian learners.

*History of Science Education—American Indian Science and Engineering Society*

Currently, the American Indian Science and Engineering Society strives to promote culturally responsive science and engineering curriculum in classrooms across the United States. This path towards a culturally responsive science curriculum has been long and arduous. In the early 1900's, Dewey thought science instruction should be a part of a liberal education because of the power it gave individuals to act independently (DeBoer, 2000). However, when the first American Indian boarding school opened its doors, General Pratt did not concern himself with the science education of these students (Brainwashing and boarding schools, 2004; Noel, 2002). Because of this exclusionary history, the AISES has been working since 1977 to change science education for American Indian students. Before AISES, the number of American Indian students who entered science and engineering fields were far below the national average. Since 1987, these numbers have shown some improvement (AISES, 2005; Hill, 1991; Silas, 2008).

During the time AISES was trying to improve Native student access to science; the United States called for science education reform. In 1989, reformers held that the United States was not doing enough to prepare students to compete in the highly technical and scientific, international work force (American Association for the Advancement to Science [AAAS], 1989). As a result, the U.S. government took an active role in educational reform by publishing the *National Science Education Standards* (NSES) in 1996. National Standards were written so that all students could attain science literacy by mastering a set of content standards. At this time, the NSF thought the best way to teach science was through inquiry-based problems initiated by student-generated



questions. With the National and American Indian Science Standards in mind, the American Indian Science and Engineering Society initiated a secondary school science fair program to promote scientific inquiry and science in American Indian classrooms (Hill, 1991; Silas, 2008).

The American Indian Content Standards' (AICS) position is that students grade level nine through twelve (9-12) should be aware of, and able to articulate an understanding that scientific inquiry is a process used to solve a problem while employing the steps of the scientific method (Bureau of Indian Affairs [BIA], 2000b). The concept that inquiry-based teaching should be a main corner stone of science and mathematics education is not new (Eisenhart & Edwards, 2004; Huziak-Clark, Hook, Nurnberger-Haag, & Ballone-Duran, 2007).

As early as 1910, Dewey, an early progressive educator, professed that inquiry-based learning should be a "...critical pedagogical element of science classrooms" (Dewey, 1938, p. 42). In 1996, the National Science Education Standards (NSES) "...argued that inquiry needs to be a central strategy of all science curricula" (NRC, p. 311). In 2000, the NRC found that when students use scientific inquiry in the classroom there is increased learning for understanding, along with enhanced student comprehension of science concepts (Huziak-Clark et al., 2007). Recently, Mosley and Ramsey (2007) defined scientific inquiry as a *constructivist* method of instruction that "...encourages students to discover or construct information by themselves instead of having teachers directly reveal the information" (p. 49).

The NSF, very aware of the lack of American Indian and non-American Indian students entering college in pursuit of degrees in science, has initiated a program in hopes of using inquiry based education to improve science, math, engineering and technology learning opportunities for all students. Aune and Weber (2007) stated that these opportunities will "...enable students to discover, explore and solve real-life problems through the integration of science, technology, engineering and mathematical [STEM] content." In order for a state to have an "innovative capacity," there must be a "STEM-literate workforce" (p. 1). This workforce is defined as one in which employees are "...creative problem solvers, innovators and inventors who are able to think logically and adapt to changes driven by new kinds of technology" (Aune & Weber, 2007, p. 1). A critically low number of American Indian students are graduating from college with advanced degrees in science, math, engineering and technology and may find being a member of a STEM-literate workforce difficult (Finkel, 2005).

The AISES is also working to promote and support American Indian high school and college student participation in a STEM related field. AISES, a private, non-profit organization nurtures the building of community by bridging science and technology with traditional Native values (Silas, 2008). Starnes (2006a), an American Indian educator, commented on the importance of cultural infusion in the science classroom. She asserted that "Whether the approach is referred to as culturally responsive, nativized, place-based, culturally infused, or bottom-up, an astonishing amount of data illustrate that when students' culture is tapped in the classroom, it builds a bridge to school success" (p. 386).

The challenge facing classrooms and society is to create culturally relevant methodologies that incorporate rapid technological advancements while considering economic, moral and environmental factors (Slattery & Rapp, 2003). The NSF and the concerned leaders in science who wrote *Above the Gathering Storm* and *Women for Science* warned us that the United States will soon face a severe shortage of high-level scientists and engineers. As the current technical population is aging, the numbers of students entering technical programs in college is declining. Before now, the United States has been able to fill jobs of retired workers with the help of recruited scientists from outside the United States (Inter Academy Council [IAC], 2006; NAC, 2006).

Lately, because of innovative advancements in countries other than the United States, many of the scientists previously might have immigrated to the United States for high paying technical jobs are now able to find good jobs in their own country. The NSF predicts that within fifteen years, the United States may no longer be the world's leading producer of scientific innovation and technology. Surprisingly, in 2004, Congress cut funding for the NSF at a time when the need for more scientists and engineers was increasing (Friedman, 2005; IAC, 2006; NAS, 2006).

The AISES is one of the organizations working to circumvent Friedman's (2005) *quiet crisis*. Their goal is to promote Native academic achievement in science. On their educational website, (American Indian Science and Engineering Society [AISES], 2005) explained their mission:

In view of the high dropout rates and low college enrollment and graduation rates of American Indians compared with all other ethnic

groups in the United States, and the severe under-representation of American Indians in the science and engineering fields, these Native professionals resolved to create an organization that would identify and remove the barriers to academic success for Native students. (¶5)

The American Indian Science and Engineering Society (AISES) helps American Indian and Alaska Native students prepare for careers in science, technology, and engineering by working to remove barriers through the implementation of a mixture of educational programs. Support is given to American Indians and Alaska Natives, from middle school through graduate school in the form of financial, academic and cultural initiatives. AISES also supports students by sponsoring the annual National American Indian Science and Engineering Fair (NAISEF) while also providing culturally appropriate curricula, publications and professional development activities that enhance the ability of teachers to work effectively with Native students (AISES, 2005).

#### *Science Fairs in the Classroom and Community*

The American Indian Science and Engineering Society science fairs are just some of many science fairs that occur across the United States each year. Many teachers notice a positive effect on learning when they use science fair projects to teach students the process of scientific inquiry (Barth, 2007; Manley, 2008; Weaver, Messmer, Storm & Weaver, 2007; Watson, 2007). Since the first student science fair occurred in the United States in 1928, other science educators have wondered if student participation in science fair events really enhances science literacy in the classroom and if educational time and money should be spent on student participation in science fair events (Bellipanni & Lilly,

1999; Craven & Hogan, 2008; Wilson, Cordry & Uline, 2004; Yasar & Baker, 2003).

With new National Science Standards to fulfill, many science teachers are worried that the time it takes for students to do science fair projects may take precious time away from learning the content material necessary for standardized tests. Very few studies have been done on the impact of science fair on student performance (Cavanagh, 2004; Davidson & Sterling, 1998; Wilson et al., 2004).

Yasar and Baker (2004) completed a study on seventh grade science students that evaluated if science fair participation affected their understanding of the scientific method and attitudes towards science. Their results indicated that in the areas of attitude and scientific method understanding, the students that participated in science fair had higher test scores than the non-participants, but the differences were not statistically significant.

Similar findings were found when Pine et al. (2005) later did a comparative study of 1000 fifth grade students. In this study, 500 students were instructed using hands-on inquiry based curricula, while 500 students were instructed using textbook curricula. The student's ability and understanding of scientific inquiry were evaluated by their ability to perform four inquiry based hands-on activities as well as a multiple-choice test. Again, no statistical differences were found between the two groups of students for both assessments. So what do these findings mean when it comes to the impact of science fair and inquiry based curricula on student learning?

Dewey (1948) answered this question when he described the relationship between knowledge and experience. Dewey explained that scientific experimentation as a process

uses both rational and creative thinking. When we “think we know” some content (p. 112), it must be “viewed in the context it was created and the present context between the learner and his or her environment” (Dickinson, 2006, p. 23). This assumes a seventh grade student that read a text book about the scientific method and can recite the method’s steps has a different understanding than the student from the seventh grade that conducted an inquiry-based science fair project using the scientific method on a topic of their choice. They both may have scored the same on a multiple choice test, but what they know about the scientific method is different (Dewey, 1948; Dickinson, 2006).

Assuming, students participating in science fair are doing real science by using the process of the scientific method to do hands-on science inquiry, an explanation of what these terms mean needs to be stated. Dickinson (2006) tied this understanding of the scientific method to the process of scientific inquiry, “To have information is to be able to state a fact, but using the information to solve a problem is inquiry; the learner is motivated by the use of the information, not the finding of it” (p. 25). Dewey (1938) confirmed the significance of the process of scientific inquiry, but also validated the structure offered by the scientific method when he stated, “Without rules, there is no game” (p. 59). Dickinson added that in order for students doing scientific inquiry to develop new ideas, thinking should begin in unorganized creative ways. She also stated the “...process of thinking should be structured and teacher directed” (p. 25). This is where the steps of the scientific method can be of use.

In the middle school through high school science classroom, all projects, not just the ones that advance to upper level science fairs, follow the scientific method (Barth,

2007; Manley, 2008; Wilson et al., 2004). The National American Indian Science and Engineering Fair is affiliated with the Society for Science and the Public (SSP). SSP (2008) has created a checklist for teachers and students that are working on science fair projects. The main items this list includes are:

1. Teachers will help students focus on an appropriate topic and project that interests the student.
2. Students build on the knowledge with further research.
3. Students develop a hypothesis and design a plan for: (a) making observations, (b) collecting data, (c) interpreting data and observations, (d) analyzing data and observations, and (e) drawing conclusions.
4. Students finalize the project for presentation and create an attractive exhibition board.
5. Students practice their presentation and prepare to answer judges' questions.
6. Students present their project at their school's science fair. (p. 112)

Many science educators across the United States use the basic structure of the scientific method to help them facilitate the development and use of student generated questions while performing inquiry based science fair projects. In a search of the literature, Alexander (2008) reported on the affect of student participation in science fair on student performance in a science classroom. Alexander surveyed over 1300 high school students throughout the United States who had and had not participated in science

fair events. Using a five point Likert scale, he found that 91% of the students that participated in science fair events fell within the two categories of strongly agreed to agreed that they were highly motivated to do work in their science classroom and were interested in taking more science course electives. Comparatively, only 35% of the students that did not participate in science fair had the same response. On the same survey, these same students, reported that 78% of the students that participated in science fair and 38% of the students that did not, felt they would be pursuing a science related career in the future.

Motivated by these encouraging statistics, science educators may want more information about the rich history of science fair in the United States as well as how that looks in the classroom. In 1950, 22 years after the first official science fair in the United States, the first annual International Science and Engineering Science Fair (ISEF) occurred in Philadelphia. At this fair there were 13 *affiliated* fairs that sent 30 students to participate. Currently, the fifty-ninth fair occurred in Atlanta, Georgia. At this 2008 fair, 500 affiliated science fairs sent 1,529 students from 56 countries. These students were made up of 52% males and 48% females from grades nine through twelve. The student's science fair project boards were judged by 536 professional scientists and engineers who awarded the students over four million dollars in prizes and scholarships (Glidden, personal communication, July 29, 2008).

The Society for Science and the Public (SSP) partners with Intel along with other corporate sponsors, academic, government and science focused sponsors to provide support and awards for the Intel ISEF each year (Intel International Science and



Engineering Fair [Intel ISEF], 2008). Intel ISEF is the highest level science fair in the world that high school students can attend. They may start this journey at their local high school, leading to the local regional affiliated fair. If successful, they advance students to a state and then national fair (Science for Society and the Public [SSP], 2008; Yasar & Baker, 2003). All fairs from the regional, state, national and international level can be affiliated with Intel ISEF. To be affiliated, the fair must pay a fee, which entitles them to give out ISEF sponsored awards and to send two individuals and one team, as well as two alternates to the international fair. All affiliated fairs must have a scientific review committee that makes sure all students follow the rules and safety guidelines set up by the international fair (SSP, 2008).

The National American Indian Science and Engineering Fair (NAISEF) has two Intel ISEF affiliations. This means NAISEF can send four individuals, two teams, and four alternates to the international fair. Both American Indian participants in this ethnographic study attended the NAISEF and one of the two attended Intel ISEF three years in a row (AISEF, 2005).

### *Summary*

Learning begins at birth and continues until death, but there are many obstacles that all learners, especially Native American learners, face. These obstacles include: (a) the past and present effects of racism, (b) the continued oppression of non-dominant cultures, (c) the exclusive educational policies limiting access to knowledge, (d) the lack of understanding regarding differing needs of diverse learners, (e) the lack of intrinsic motivation to learn, and (f) the implications of cross cultural identity development on

successful learning. With all of these barriers for American Indian learners, can programs such as AISES and Intel ISEF provide the necessary opportunities through local, regional, state, national, and international science fairs to enhance student learning, and how does the relationship American Indian students develop with their science fair mentor affect academic achievement and life-long learning?

## Chapter 3

### Method

#### *Introduction*

The purpose of this ethnographic qualitative study was to determine if programs such as AISES and Intel ISEF provide the necessary opportunities through local, regional, state, national, and international science fairs to enhance student learning, and to look at how the relationship American Indian students develop with their science fair mentor affects academic achievement and life-long learning? The original question this study anticipated answering using ethnographic storytelling was: To what extent did two American Indian student's participation in science fairs and the relationship formed during the teaching and learning process affect academic achievement and that student's drive to continue learning beyond high school?

Telling a story depends on the teller's worldview, which is bound by the narrator's interactions with other worldviews. During kindergarten through high school and post secondary academic experiences, American Indian students cross back and forth between multiple worldviews. While on this journey, they face many road blocks toward continued academic success. Telling the stories of students who succeed is important. Oral tradition, or ethnographic storytelling, can be an important vehicle for delivering information about the American Indian cultural experience (Garrett, 1996).

#### *Qualitative/Ethnographic Research*

Educators are always searching for the best methods to increase student learning in the science classroom. Teachers leaving behind random curricular ideas can find

sound, educational research that informs and expedites science learning. Valentine and Cooper (2005) commented on the type of research that needed to be done to promote learning "...we believe experimental research in social science should focus on a specific goal: to try to determine if some intervention causes changes in some outcome" (p. 8). In order to help teachers, educational researchers need to look hard at what research design will meet these goals.

*Quantitative vs. qualitative research.*

In order to decide on the best research design/method, Eisenhart (2005), a qualitative educational researcher, discussed the difference between quantitative and qualitative educational research. Most educational research is done in hopes of searching for the *cause* of some educational *outcome*. To realize this cause, researchers can take a quantitative approach. In this approach, a change is made in an independent variable, such as American Indian science fair participation, and then multiple measurements are taken to determine if a change occurred in the dependent variable, such as academic performance. Eisenhart (2005) explains that, "Qualitative research, in contrast, tends to investigate causal *processes*; that is how x [science fair participation] influences y [academic achievement and life long learning]" (p. 245).

The type of research chosen leads to different types of questions, which determine the designs and methods used. Quantitative questions look at if a change in one variable causes a change in another, while qualitative looks closely at how one variable influences an outcome (Eisenhart, 2005). Since 2001, with the implementation of the No Child Left Behind Act (NCLB), the Federal Government, in order to insist on accountability, has

encouraged quantitative experimental designs. Cohen, Raudenbush, and Ball (2003) argue that both quantitative and qualitative designs have a place in educational research. “Descriptive [qualitative] studies of resources used can be used to generate hypothesis about the effects of resource use on instruction...” (p. 128) these hypotheses then can be tested systematically—that is, experimentally.

*Qualitative interpretive methods.*

Interpretive research is often the term used to describe a family of qualitative participant observational research methods (i.e. ethnography, case studies and phenomenology). Ellis (2003) defines qualitative methods as a general term that describes:

...a variety of research techniques and procedures associated with the goal of trying to understand the complexities of the social world in which we live and how we go about thinking, acting, and making meaning in our lives. These research practices emphasize getting close to those we study, attempting to see the world through participant eyes, and conveying the experience in a way faithful to their everyday life. (p. 25)

*Ethnographic/Phenomenological Research Design*

In order to determine how science fair participation has affected two American Indian students’ academic achievement and life long learning, this study used an ethnographic participant/observation qualitative research design grounded in phenomenology (Ellis, 2003; Hegel, 1977). Ethnography is a qualitative form of research that focuses on the sociology of meaning through researcher/participant observation and

interactions within a cultural context. A phenomenology experimental design is also centered on meaning, but only within the context of the phenomenon (Ellis, 2003; Garson, 2008).

When both research methods are combined, the researcher focuses on the socio-cultural phenomena occurring within a community, selecting research informants who have experienced the phenomena. This dual method works towards “maximizing the participants’ rendering” of their experiences (Cleary & Peacock, 1987, p. 257). Cresswell (1998) thinks that the “...researcher reduces the experience to a central meaning or the ‘essence’ of the experience....in order to reveal common cultural understandings related to the phenomena under study” (p. 206; Garson, 2008, ¶1). In order to enhance this research, an autoethnographic examination of interactions between the researcher and participant is included.

In this study, these described experiences will include high school American Indian student participation in local, regional, state, national (American Indian Science and Engineering Society [AISES]) and international (Society for Science and the Public [SSP]) science fairs. As well as examining the relationship formed by the students with their science research teacher/mentor while participating in science fairs; ultimately, determining the effect of these experiences on the likelihood of continued education beyond high school.

*Ethnography and the evolution of defining culture.*

Ethnography essentially means the “writing about or describing people and culture, using firsthand observation and participation in a setting or situation. The term

refers both to the process of doing the study and to the written product” (Ellis, 2003, p. 26). The concept of culture in research and social science has changed over the years, as has its meaning and contextual setting. Eisenhart (2001b) reminded ethnographers that “...when culture is used in a research design, its meaning must be clear so it can inform the research methods that will be employed” (p. 16). In order to understand how the meaning of culture has changed over time, it is essential to understand the economic forces that shaped the experiences of everyday life.

In the early 1900’s, the push to compel the production of an efficient workforce, over skilled individual expertise, influenced who had privilege and who did not, categorically defining the cultural context of the time, influencing society and the educational system. Taylor developed the theory of scientific management in 1911, creating the structural functional cornerstone in Burrell and Morgan’s 1979 organizational paradigm that attempted to draw and define the modern economic boundaries placed around our schools, institutions, and communities.

These boundaries created social forces that tended to “suppress, neutralize, or even negate the effects of merit in the race to get ahead (McNamee & Miller, 2004, p. 6). McNamee and Miller (2004) termed this force “social gravity,” a force which tended to “...keep people in the places they already occupy” (p. 6). Based on Marxist *base and superstructure*, these *borders*, or the lines between what is *in* and what is *out (inside/out)*, are hegemonically drawn “...to keep in place fundamentally unequal and unjust social and political relations” (Martusewicz & Reynolds, 1994).

Starting in the 1920's, along with the invention of the motor car, Fordist economic principals continued to promote efficiency and productivity, along with continued cultural isolation. The social lines drawn because of these economic factors continued to define the cultural borders of the communities that lived within their boundaries (Eisenhart, 2001b). Not until the 1960's, with the start of the United States (U. S.) civil rights movement, and the advent of cultural wars that occurred on college campuses across the U. S., did these rigid borders begin to break down. During the 70's, anthropologists defined culture as a "...relatively enduring, coherent and bounded 'way of living' (Eisenhart, 2001b, p. 17). They separately used terms such as "black, white, native and school culture" (Clement, Eisenhart, & Harding, 1979, p. 15). Levinson, Foley and Holland (1996) also defined culture, during this time of rigid cultural borders, "... as a static, unchanging body of knowledge 'transmitted' between generations" (p. 13).

In the 1980's and 90's, postmodern thought, along with the advent of mass transit and the exponential growth of technology and global media, increased cultural border crossings, resulting in the formation of permeable boundaries, dulling the 1970's definition of culture (Eisenhart, 2001a, 2001b). This uncertainty surrounding the idea of culture promoted the postmodern idea of abandoning it completely (Abu-Lughod, 1991, as cited in Eisenhart, 2001b). Possibly, as stated before by Houston (2007), reminding educators what to do if an idea or policy is not working, "You have to stop and change direction" (p. 744).



Possibly, as students in our postmodern world traverse across multiple cultural boundaries, the static definition of culture should be rethought. In 1996, Levinson et al. defined culture as a continual process of creating meaning in social and material contexts...[where culture] “is continually produced, even as it is reproduced” (p. 13). Further, they defined cultural production as the “processes by which new texts, new cultural artifacts and commodities, such as art, music, and video are created” (p. 13). Eisenhart (2001a) gave a post-structural critique of culture; she professed that the idea of culture should be separated from “social group” and focused more on identity (p. 213).

*The “new” post-structural ethnography—autoethnography.*

The idea that ethnographers, while thinking about culture, should focus on identity, holds true for this study’s participants, John and Rita. They have similar yet different cultural boundaries to cross while they are continually developing their bicultural American Indian identities. Eisenhart (2001a), a long time ethnographer, stated “...individuals who live between social groups...have become a central focus of attention...Living at the junctures of different traditions, these individuals must make sense of their lives by crossing, blending, negotiating, or transcending the boundaries of tradition” (p. 214). This understanding points toward investigations of identity that trace the ways individuals construct and use meanings of self within historically specific contexts.

This study worked to understand the meanings derived from John’s and Rita’s interviews within the context of science fair participation, at the local, regional, state, national and international American Indian and non-American Indian science fair events.

While John, Rita and I participated in these experiences, we moved across the cultural borders of science fair events, as well as across the boundaries set by our homes, school, tribal reservation, and city community. As we traversed across these boundaries, our identities were formed and transformed.

Eisenhart (2001b) wondered, "...if understandings of culture are varied or changing and ethnography is the methodology for studying culture, why hadn't there been more discussion of the corresponding variations or changes in method" (p. 16)? In these new ethnographic methodologies, interviewing, participant observation, and artifact collection are at the core of what it means to do ethnography, but Eisenhart (2001b) proposes that only when the ethnographic researcher is intimately "...part of the groups, activities, conversations, and connections [will]...we stand some chance of grasping what is meaningful to them" (p. 23). This can be accomplished when the participants help to set the research agenda (field notes, audio tapes and artifact gathering), thus giving the research "descriptive validity" (Eisenhart, 2005, p. 252). Eisenhart also proposes, that the researcher should be a part of the research process by disclosing their own "...views, commitments, and social position, or to become the subject of the research" (Eisenhart, 2001a, p. 219). This process has been often called interpretive, narrative autoethnography.

Ellis (2003), an autoethnographic researcher, defines autoethnography as "...a research method in which the author writes in the first person, in order to make herself or himself the object of research" (p. 30). The autoethnographer writes about the "personal in relationship to culture....[in order to] display multiple layers of consciousness" (p. 37).

Some autoethnographic text can be written as short stories, poetry, fiction, and novels. They are stories driven by history and social structure and serve as a platform for dialogue, emotion, embodiment of spirituality and self-consciousness. Ethnography and autoethnography are about the process, while autoethnography is also about what is produced from the process (p. 38).

While researchers are considering how to study an educational phenomenon, they need to know that quantitative research methods are not the only way to understand an educational phenomenon. Qualitative methods also offer a rich array of opportunities for sound research and improved science classroom learning (Ellis, 2003).

#### *Research Method Overview*

This study used an ethnographic participant/observation qualitative research design grounded in phenomenology in order to exemplify meaning from described experiences (interviews) within a cultural context (Hegel, 1977). Three ethnographic research methods were incorporated: participant observation, ethnographic interviewing, artifact gathering, and researcher introspection, or autoethnography (Eisenhart, 1988; Ellis, 2003).

These described experiences included high school American Indian student participation in local, regional, state, national (AISES) and international (SSP) science fairs, as well as the relationship formed with their science research teacher/mentor while participating in science fairs; ultimately, determining the effect of these experiences on the likelihood of continued education beyond high school.

*Participants*

The participants in this ethnographic study are one adult male and one adult female American Indian tribal members of the Fond du Lac Band of Ojibwe who attended a rural public high school in northeastern Minnesota, and participated in science fairs. Participant informed consent (Appendix A) was obtained before the research began audio-taping the interviews. Participants' names were changed.

This ethnographic study examined the interactions between the participants and their mentor. Their mentor is an Educational Policy and Administration Doctoral (EdPA) candidate/student from the University of Minnesota (U of M). She has been a middle school/high school science teacher for thirteen years. Her students have participated in science fair research events (National American Indian Science and Engineering Fair [NAISEF], Minnesota Academy of Science State Fair, Intel International Science and Engineering Fair [ISEF]). Currently, the students' science fair mentor is the Northeastern Minnesota (NE MN) Regional Science Fair Director, as well as a member of the region's scientific review committee. The NE MN Regional Fair is a high school/middle school student event. The science fair mentor's doctoral educational policy and administration program has a focus on multicultural issues and leadership.

*Educational Setting*

While small when viewed from a metropolitan perspective, the public school district that the participants in this study attended is in the largest city (population 12,000) in the county. It is a rural community district in northeastern Minnesota and serves 2,472 resident and non-resident K-12 students, of which 428 are American Indian (virtually all

of which identify with the Ojibwe heritage). American Indian students, and students who are eligible for free or reduced lunch in the district, are disproportionately represented in terms of having the greatest needs. The dynamics of rising poverty, along with eroding tax bases and concerns about increasing youth criminal activity in this area, contrast sharply with the city's outstanding achievements in educational progress and historical appreciation (Minnesota Department of Children, Families & Learning [MDCFL], 2000; Minnesota Department of Education [MDE], 2004; Yecke, 2005a).

The Fond du Lac Band of Chippewa Indian Reservation is adjacent to the local public school. American Indian students choose to either attend the local public or tribal (kindergarten through twelfth grade) schools. Often, resources between the two schools are shared. The tribal school has transported and financially sponsored many of the public school American Indian students for multiple science fair events.

### *Interview Procedures*

Once the University of Minnesota's Human Subject Committee approval was granted (See email approval in Appendix B), both participants were audio-taped individually. The interviews were held in an agreed upon, neutral setting (local restaurant). To determine the impact of the relationship developed with the participants and their science fair educator during the teaching and learning process on the likelihood of American Indian students' continuing education beyond high school, three interviews approximately 2-3 hours long were conducted. During the first interview the questions were centered on early science fair experiences. During the second interview the questions focused on specific details regarding the teaching and learning process of

scientific research and past science fair events. The third interview asked the participants to look back and reflect on the meaning of science fair participation in the participants' life (Appendix C).

During the interviews, open-ended questions allowing the participant to guide the narrative were incorporated, such as: Tell me about your science fair experience...; Tell me about your science fair mentor (the researcher)...; Tell me about your career goals.... The researcher reevaluated observations (field notes) from the participants' high school science fair research and experiences. The researcher searched for artifacts by collecting written or graphic materials available on participant science fair involvement.

These interview methods were also used by Hopwood (2004) while performing a multi-method case study. He found that semi-structured interviews have been shown to produce a wide array of responses. These responses have been shown to be particularly useful when participants were allowed to engage in conversational interviews, often giving freer longer responses. Follow-up interviews have been proven helpful, allowing the researcher and participants to glean meaning from the interviews in an ongoing process.

Eisenhart (2001b) reported that in order for qualitative research to have descriptive validity, participants and researchers must agree that the research is concretely accurate. Therefore, in this study, the participants knew parts of their interviews would be transcribed and reported in the thesis, but as stated before, upon request, the names given in the thesis were changed to protect the subjects' identities. The audio recordings, field notes, artifacts and written transcripts will be kept on an external

jump drive for three years. The jump drive is password protected. Copies of the interviews were given to the subjects for evaluation and feedback. The researcher is the only individual to have access to the collected interview data besides the participants.

While all of the above methods were taking place, autoethnographic researcher introspective data were collected. "In this manner, the ethnographer tried to account for sources of emergent interpretations, insights, feelings, and the reactive effects that occurred as the work proceeded" (Eisenhart, 1988). The three interviews, interview transcription, artifact gathering and researcher field note taking took approximately three months.

#### *Interview recruitment.*

Past American Indian students who were mentored by the principal investigator of this study were chosen. The subjects needed to be in the final planning stages for a post high school experience and/or have graduated from high school with post graduation plans, or already enrolled in post high school educational settings. The primary researcher approached the potential subjects in a private setting (no other individuals within hearing distance) and asked if they were willing to participate in this study.

The researcher asked participants what name they wanted used when the primary investigator reports the results. Participants were told that all transcribed results would be stored in a locked cabinet in the researcher's residence and that they could decide to not answer a question and stop the interview at any time. Participants were given an informed consent form to evaluate. After the participants had time (at least 24 hours) to consider the request and look over the consent form (Appendix A), they were approached and

asked if they had decided if they wanted to sign the form and participate. All participants involved in this research (one adult male and female) signed informed consent forms before this ethnographic research began.

#### *Interview interpretations.*

An examination of the interview transcripts, and researcher field notes were used to "analyze events, find patterns, and create models from data" all within a cultural context (Ellis, 2006, p. 27). Fischman (2001) validated the use of photographs by stating "...that photographs can be material for interpretation (evidence)...images have the potential of making our work not only more comprehensive and clear, but also politically more relevant...images carry information in the constant battle for meaning" (p. 31). Research participants were given a copy of interview transcripts, artifacts and researcher field notes in order to encourage participant feedback.

#### *Risk/Benefit Analysis*

The benefits of this research are that educators and students will be able to understand how participation in SSP affiliated science fair events, including, but not limited to, AISES fairs, affects the likelihood of American Indian students' continued education beyond high school. Also, educators and students will be able to better understand how the teaching and learning process that occurs during participation in science fair research events affects academic achievement and the likelihood of continued education beyond high school. Participants knew during the interview process that they could stop at any time; participants chose the name used for their interview transcription, and they were informed that all data and transcripts would be kept confidential. The



doctoral candidate/student researcher is trained in qualitative research and interview methods.

### *Bias/Trustworthiness of Data*

The researcher of this study is not an American Indian. Also, I had a long standing student-teacher science fair mentor relationship with John and Rita. It is impossible for me to eliminate my own biases and perceptions from this research. This story is told only through the eyes of the researcher, using the participants' and researcher's words, understanding that many individuals may have told a different story, based on their own biases and experiences.

### *Conclusion*

The following chapters will focus on John's and Rita's narrative, or the stories that they told, including narrative analysis, assuming that a good story itself is theoretical. Ellis (2003) reminded researchers that:

When people tell their stories they employ analytic techniques to interpret their worlds....Thinking with a story means to experience it as affecting your life and to find in that experience a truth about your life. In thinking about a story, we reduce the story to content and then analyze it, hoping to find larger categories, themes or patterns. (pp. 195-197)

Storytelling is an educational methodology that has been used by American Indian communities since the beginning of time (Starnes, 2006a). In this study Rita's, and John's narratives will be woven into a story that explores their science fair participation, the relationship formed during the teaching and learning process, as well as both

processes effects on academic achievement and life long learning. This section will conclude by telling the researcher's story as it relates to John's and Rita's from a teacher leadership context. Garrett (1996) wrote that:

It is through stories that many American Indian people learn, and it is through learning that we come to an understanding of ourselves, the world around us, and our relationship to everything in that world. Soliciting a person's story involves creating an opportunity to understand that person's life-experience as he or she understands it, with any given story, the importance of relationship cannot be overlooked. (p. 7)

## Chapter 4

## Results

*Introduction*

In order to do an ethnographic study of how American Indian science fair participation, and the relationship developed with a mentor/teacher, impacted the participants' current and future academic success, two American Indian students, John and Rita, were interviewed. These interviews, along with the autoethnographical inclusion of their mentor's thoughts, will be offered.

The participants' science fair mentor noticed high levels of success for students through the American Indian Science and Engineering Society (AISES) science fairs and the *International Science and Engineering Fairs* (ISEF). Students, while doing their project, worked hard, initiated work sessions outside of the normal school hours, and in the end produced quality work beyond their expectations. Why was this type of success occurring when many American Indian students in the mentor's school and throughout the United States were struggling? These ponderings led to further examination of the research into American Indian post-secondary success and the need for change.

The focus of these qualitative stories is to describe science fair participation, especially, the interaction students have with their science fair mentor. Also, what in particular about science fair and the relationships the students developed with their science fair mentor may be helping students pursue post-secondary academic programs? The two student interviews will be organized around factors that emerging research identifies as barriers American Indian learners often face: (a) racism and continued

oppression, (b) difficulties in identity formation, (c) the lack of best practice in science teaching and learning styles, (d) learning and motivation, and (e) the lack of parent and teacher leadership.

### *Short Student Biographies*

Before the issues facing these two American Indian students (Rita and John) are discussed, a short biography of each student will be told.

#### *John's biography.*

At the time of the interview, John had just finished his last days of high school. Academically, his grades had not always been as good as he would have liked them to be; therefore he was very glad to have graduated. After sitting down in a local restaurant for the first interview, I asked John if he could tell me a short version of his life history: where he was born, his cultural background, and a little about his family:

Ok, my name is John, I was born and lived in [an adjacent larger city] until I was 6 years old and then I moved to [the smaller city] I live in today. I have lived in [my current location] since that move. I have four sisters and three brothers; I am the youngest in my family. I am 19 and just finished high school.

I am Native American. My father is full-blooded Ojibwe Indian, which makes me half. My mother is white or Norwegian or something. My Dad is twelve years older than my mom. He was born in the old Fond du Lac hospital in 1941. My mom was born in Wisconsin in 1953. She moved around a lot. She lived in Quantomino Bay, Cuba, for her teenage

years. My grandpa did air plane surveillance. My mom went scuba diving a lot. My dad pretty much worked for a construction company since they opened.

My dad had to retire due to kidney failure and he has been on disability since 1996. He had a kidney transplants two years ago. My cousin donated a kidney to him. They were pretty much a perfect match, so there was not a worry about rejection, a 96% match. He is doing well now. He has not been having any problems at all. He is like a totally different person now. Before he was sick all the time and now, he is healthy.

My Dad has a master's degree in psychology. He was a counselor at UMD [University of Minnesota Duluth] for a little bit, back in the late 80's. He quit because he could not handle the whiney people. My mom went to the local tribal college to get her degree in nursing, RN. She worked at a nursing home until they shut it down and then they moved her to [another nursing home] where she works today.

This fall I will be starting my generals at our local Tribal College. Then I will move on to the university for my three years of criminology and police officer's training.

*Rita's biography.*

Rita had a higher level of success during her high school career. She graduated in the top ten percent and had been attending a locally acclaimed private college for two

years. She received an invitation to apply to Harvard, but was not accepted in the end. Both of John's and Rita's parents attended and graduated from college; a family accomplishment for both of these science fair participants that is not often realized by a high percentage of American Indian students (Finkel, 2005; Grande, 2004). Rita was in my first ninth grade physical science class. In that class, students were required to do a science research project, but they did not have to participate in any science fair events unless they chose to do so. Rita described her life up to the time of the interview:

My name is Rita and I went to the [local public school] all my life. I am twenty years old. I participated in science fair for four years. I am going to a [distant private school] and I am going to be a junior this fall.

My mother went to a local private college and graduated with a degree in business management. Now she is a personnel officer for the county. While my father went to vocational school to be a physical therapy assistant, he worked as an iron worker. After he graduated, he continued, and still is an iron worker.

My grandpa is enrolled [in the local American Indian Tribe], but my grandmother is not. My mom is enrolled, so I am the descendent of an enrollee, so that entitles me to health care and medications. A lot of different things on the Rez, except I am not enrolled myself. So I do not qualify for financial aid for college like my Mom did. My Mom's entire education was paid for because she is Native American.

Up until going to college I have always lived on the reservation. I mean, a lot of my friends are Native American. Being in a city near a reservation, it is a really unique experience. Not many towns are part of a reservation, or that close to a reservation where there are those interconnections. I could have gone to [the local tribal] school; I mean it is a mile away from my house.

Now I am going to a [urban, distant private college]. I am majoring in Biochemistry. I just completed my second year. I hope to work in a rural pharmacy; more of a clinical setting in a pharmacy. Not like big sales or distribution by any means. Maybe try a hospital. I hope to go to pharmacy school and become a pharmacist.

### *Racism and Oppression*

This section will begin by using John's words to tell the story of how racism has affected his life in school, while participating in science fair and in the community. Rita's story and perspective will follow John's. Additionally, John's and Rita's science fair advisor will describe the impact her mentoring had within the context of each theme.

#### *Legacy of oppression—John's family.*

John's father and sisters were taken from their mother when John's father was three years old. The authorities determined that his mother was not able to care for them. Separated from his sisters, John's father jumped from foster home to foster home, all over the United States. John's father not only lost his family, but also ties to family members

who could have shared cultural knowledge and language. John passionately spoke of all that had happened to his father during childhood:

They tried to brainwash him, when he did come back to his home, he could not speak Ojibwe anymore. He could understand it if someone talked to him, but he could not speak it. At the age he returned to his family, it was pretty much impossible to get his Ojibwe language back. Even at my age it is hard.

John's father followed the path of many relocated American Indian children. Cleary and Peacock (1997) tell us that because "Many American Indian children who were stripped of cultural practices and surroundings could not bear the extreme grief they experienced because of forced relocation to federal boarding schools. They escaped in hopes of finding their families..." (p. 63). John's father's efforts to return home echo the stories of his ancestors:

He [my dad] said, basically, most of the families were nice to him. He was never really in a boarding school. He was just fostered out. They did not allow any contact with your birth parents. When he was 17, he had a 21-year-old girl friend. They took off trying to come back to Minnesota. They pulled him over in South Dakota and took him back. He was just trying to get back home. All of his three sisters were with his Mom when he was able to get back. He is not really bitter about it, he wishes they did not take him away, but we go down and see his Mom all the time now.



*Legacy of oppression—John at school and in the community.*

John discussed the overt and covert incidences of racism and violence in his life. He feels frustration because of the negative American Indian stereotypes that exist and the lack of understanding people have for each other. John reported:

I remember often when we are hunting near Mille Lacs Lake. A white guy would be in our deer stand. We'd asked him what he was doing. We'd tell him that this is Indian property. When we came back the next day the tree would be cut down, or the deer stand destroyed. Stuff like that.

A couple of my cousins went hunting in Wisconsin and some white guys shot at them. My cousin was sitting in his tree stand and bullets went right next to his head. Those two white guys were trying to take him out. One was standing up shooting at him and one was sitting down. My cousin's Dad yelled at him to take his orange off. The two guys ran away.

A couple years ago in a town called Onedia- we went there to go netting. There was this big protest and a billboard that said, "Save a walleye, net an Indian." We don't even take out that much fish; they take out more than we do. You put your net out and some white guy will come up and cut your boogies off, stuff like that. Drive over the net to chew it up.

After sharing his early experiences with covert acts of racism, John began to describe himself, his family, and what they like to do together. John explained:

My family spends a lot of time together at Mille Lacs Lake. All my cousins hunt and fish there. My dad is a member of the Mille Lacs band. He just had a birthday and he became an elder. He now has a parking spot when we go to Mille Lacs, he is not so sure he wants to use it, be that old. My family spends a lot of time together, they help and support me.

I know my reservation owns the whole Mille Lacs Lake. [When people protest about our spearing and netting] they do not know what they are doing. They do not know that by their actions they are putting their own fishing in jeopardy. We could boot them off the lake and then they would not be able to fish there, only Indians. No one believes this.

A long legacy of historical oppression compounded by continued racism plays out in many ways. Cleary and Peacock (1998) examined these effects. One such effect they identified as “delayed adolescence” “...in which the internal struggle for identity continues well into middle age” (p. 83). John, though experiencing this delay, is able to overcome because of parental teachings and support:

When I was young (middle school), when people would say racist stuff, I would get in fights a lot. Once when my cousin and I were at the drinking fountain and a kid said a racist comment, my cousin and I punched the kid. I was immature then. My Dad helped me. He told me he used to beat up racist people, but then he matured.

Now when white people say racist things at the mall, it does not really affect me anymore. White people are really afraid of Indians. I think

people that call Indians names are just afraid. They are trying to prove they are not afraid. My Dad helped me see this.

*Internalized and sub-oppression—John.*

Even though John was very successful at the National American Indian Science Fair, he chose not to attend the local regional science fair that is open to American Indian and non-American Indian students. When I asked him why this was, he said:

I did not want to go to the non-Native fair and get criticized. Being Indian, people might judge me using all the stereotypes about being Indian. They may think I am dumb, a drunk or an addict. At the Indian fair, I did not feel any of that. I did not want to get arrested for beating up some white kid.

*Legacy of oppression—Rita's family.*

Both Rita and her mother have blond hair and blue eyes and often say they never really have experienced incidences of overt racism in their lives. However, Rita's mother has told Rita stories of how her American Indian grandfather constantly had to overcome many obstacles:

My mother often tells me that my grandpa is so *scrappy* because he always had to prove himself. He was always in fights. If he wanted to be on the basketball team he had to work harder to prove he was good enough to make the team. My mother said she did not have those experiences, but throughout her life she has always felt she has "one foot in each world, but does not belong in either one."

Rita experienced the type of disconnect her mother spoke of when participating in American Indian Science fair events:

Um, I just felt out of place. I guess I have always felt out of place. I go with my grandma and grandpa who are enrolled, to pow wows and Native American events, all kinds of stuff out at the Reservation Business Center (RBC). I spent a lot of time out at the RBC when I was a kid; playing at the pool etc. Yet, now when I go places for American Indian events, I feel uncomfortable in a way. I feel like I am not accepted. It is probably a stereotype in my own mind. I mean-I have white skin and blonde hair. I just did not fit in at the Native American Science Fair. I felt unwanted, or looked at, gawked at. I felt they were looking at me like, "You're not Native American."

One summer I went to a National Native American Conference in Washington, D.C.. I felt the same way there. It is not like I had to deal with real uncomfortable situations. It is just like I always felt unwanted, like people were looking at me and thinking, "Are you Native American?"

*Internalized and sub-oppression—Rita.*

Historical anger is often associated with sup-oppression and is the byproduct of the loss of a healthy grieving time (Lewis & Ippen, 2004). Cleary and Peacock spoke to this grief:

Many say that the losses suffered as a result of colonization were so great that people continue to grieve; that communities suffer from the effects of

historic grief: that the grief is one of the self-destructive characteristics of the sub-oppressor...leading to alcoholism, drug abuse, poverty, crime, racism, class conflict, etc.. (1997, p. 78)

This grief unrealized is the most secretive form of covert sub-oppression. Bergstrom et al. (2003) comment on the effects of this form of sub-oppression on wellness, stating that “Covert acts of oppressive racism [make] it impossible for American Indian people to experience the harmony and balance needed for wellness....from a lack of grief and healing these wounded souls turned inward and outward towards a time of incompleteness” (p. 29). Linda LeGarde Grover in Bergstrom et al. (2003) also comments on the effects of historical anger and how she sees it affecting her Native community:

...even in times of great happiness, there is great sadness. Even in times of great sadness, there is great happiness....I ask myself how we have such intense beauty and such deep pain living side by side, all at the same time? And how and when will we break this great cycle of pain? When will our children stop suffering from the dysfunction in our own communities? It is the great challenge facing the Seventh Generation.” (p. 49)

Rita did not realize that her words mirrored the words spoken by Grover while she discussed her life at college:

It is just like while I am doing things I get overwhelmed and I don't seem happy. When I accomplish things I am happy. At the same time, I might

act depressed or sad about certain things, though. I never have fun at college, because I never feel like I am ever done!

I am glad I am done with the classes I have taken, but at the same time, I do not want to wish my college experience away, but I need to have things completed and I always feel there is something more—there is something more. Something more I have to do. I am pretty stressed a majority of the time. I am happy when I get breaks and summer comes. But now I am taking a class this summer and that is somewhat disappointing. It is like; “ok now you get to take another harder class.” I don’t know it is just kind of stressful in that way. It is just how I feel.

*Racism and oppression—Science fair mentor.*

I am John’s and Rita’s science fair mentor and am not an American Indian, but many of the students in my classroom are. Originally, while facilitating student research, my American Indian students were reluctant to participate in non-American Indian science fair activities. I wanted to increase Native student participation in science fair events, while also enhancing American Indian science classroom participation. After talking to a retired science fair educator, I was informed that he had heard of an American Indian Science fair. I completed a Google search for *American Indian science fair* and the site for the American Indian Science and Engineering Society ([www.aisis.org](http://www.aisis.org)) appeared on the screen. On the site were lists of contact people by state. I emailed a few of the names listed for my state, and the *next day*, at school, an American Indian educator from the local tribal college and our school district’s director

of American Indian Education came knocking at my door. The AISES's coordinator for the local tribal college just happened to be one of the people I randomly emailed.

My original goals, when I initiated participation in American Indian science fair events, were to increase Native student participation in science fair as well as increase their engagement in my science classroom. Both of these goals were met after the first year of participation. Giving my American Indian students an academic venue that reduced the level of racism and oppression experienced, while also embedding aspects of Native culture in my classroom, though not my initial intent, were a benefit I had not anticipated.

Even though there was an increase in American Indian participation in science fair, not all of the teachers were as excited about this prospect as I was. Past boarding school and institutional racist practice make it difficult for Native parents and students to see the advantage of academic achievement in public schools (Farver, 2008). Consequently, many of the Native students I work with are behind or failing in school. Many of the teachers who work with the same students are frustrated when the American Indian students leave school to attend the American Indian science fairs. I often mediate between the Indian education coordinator and the teachers, while advocating for American Indian student participation. To avoid these confrontations, the American Indian educator and I make sure, well in advance of any science fair, that students are getting lists of missing assignments and parents are informed.

Table 1

*Racism and Oppression Interview Summary*

Study participants/ family member	Description
John's father	Was removed from his family and put in foster care. He lost the knowledge of his culture and Ojibwe language. Supported and gave John advice on how to deal with racist events.
John	Appearance indicates his American Indian heritage. Experienced covert acts of racism from the non-American Indian community. He did not participate at the non-American Indian science fair events, because he worried he would be judged negatively.
Rita's mother	Appearance does not indicate her American Indian heritage. Feels she has a "foot in both worlds but does not belong in either." She is an enthusiastic supporter of Rita's participation in science fair.
Rita	Appearance does not indicate her American Indian heritage. She experiences covert acts of oppression at Native science fair events. Feels she is unwanted at American Indian science fairs and does participate in non-American Indian science fairs. Historical oppression (anger) makes it difficult for her to feel happy about accomplishments.



To help John and Rita overcome the effect of racism and ongoing oppression I investigated the possibility of their involvement in the American Indian Science and Engineering science fairs. This mission, though unintended, also appeared to create a safe identity shaping environment.

### *Identity*

After transcribing John's and Rita's interviews, a theme or issue facing them was unexpectedly and continuously reported; their struggle with identity formation. Because of the lack of background information investigated before the interviews took place on American Indian identity formation, what John and Rita report will strongly be supported with what research has to say in chapters 4 and 5. The American Indian Science and Engineering Society has a working definition of who is American Indian enough to compete in their science fair. John and Rita spoke of the challenges they have faced, and their concerns over how their tribal leaders defined what it meant to be considered a *real* Indian. They struggled with who was in charge of deciding this consideration, and how that would affect not only themselves, but their children and grandchildren.

Farver et al. (2007) stated that American Indian children constantly ask themselves "Where did I come from? Who am I? What do I want to become?" Not being able to answer these questions, especially during adolescence, results in "... identity confusion, which is accompanied by feelings of alienation, isolation, and uncertainty" (p.7).

*Enculturation of the American Indian identity—John.*

John, from day one of his life, began the process of enculturation into his Ojibwe identity. John previously discussed how he and his family do everything together. They go to pow wows, fish, camp, hunt and gather on the reservation near Mille Lacs Lake for cultural celebrations. He described how some of his siblings and his mother faced many of the sub-oppression issues that Rita faced. They may not *look* Indian, but they are. Not only because of genetics, but because of how they have lived their lives:

Like my sister, she has blond hair and blue eyes. White looking as can be, but she is enrolled. My brother is a red headed *white* looking guy. They may look white, but you can tell they are Indian. To white people they may seem white, but they know Indian ways. They grew up like that. My Mother is *Norwegian* or something, but she is a *white* Indian. She lives the same way as my dad, my family. I consider my Mom an Indian. I think she learned this once she moved here from Cuba and lived with my Dad and my family.

We are all into the same stuff, hunting, ricing, and the spiritual ways. Other people do not really get that. They think it is kind of weird. I feel comfortable with this. I don't know. I am just more comfortable around my own people. You know, other Indians. In the end, even if I move away, I would not want to live anywhere else besides the rez.

*Enculturation of the American Indian identity—Rita.*

Rita, whose appearance does not indicate her American Indian heritage, has lived her whole life on the Indian reservation. She attended family celebrations, pow wows and spent a lot of her free time in the summer at the tribal community center interacting with other American Indian children. She mirrored many of John's words while he described his *white* Indian siblings, in Rita's words:

I have always lived on the reservation; I mean a lot of my friends are Native American. Being in [my town], it is a really unique experience. Not many towns are a part of a reservation, or that close to a reservation where there are so many interconnections.

I think my Native identity has been passed down from my Grandpa and my Mom. I think that belonging does not depend so much on your blood quantum, but on your family. My grandpa would always bring me to pow wows when he was babysitting me. He would always bring me to the RBC. My Mom still stays connected, she may not go to too many pow wows anymore, but she always goes ricing every year.

*Gogoyoti/two people—The struggle to find yourselves—John.*

Enculturation (identify with your home culture) can lead to integration or a move towards a bicultural identity. Integration occurs when a person maintains aspects of their native culture, but is working to acquire some of the dominant culture (Farver et al., 2007; Garrett, 1996; Jackson, 2004). John, who rarely shows high levels of emotion, had to pause and appeared *choked-up* while answering the following two questions. How has

growing up half American Indian and half Scandinavian, being bicultural, affected your life? Do you feel like you fit into both worlds? In John's words:

Do you mean being Indian one time and white the other time [long pause]? I don't know, not really. I mean, [long pause] it is really *hard* being Indian. You know what I mean [long strained pause]? A lot of people think badly of us. All that crime, all those bad things people think Natives can do. People think it can rub off or something. They say, "All Indians are like that you know." If I go to a larger town or to the mall, some people walk by and they say, "There's one of those Native mob kids." They say things like that. If I really was a Native mob kid I would have walked up to them and punched them.

When I am at my public school, I feel like I have to become like a *white* Indian, but when I am at the rez school they call me a white Indian. I don't know they are just weird. There are so many Indians that try to walk around like a gangster person. I don't know why they do this. I know it is hard being an Indian, but do they have to be a gangster Indian. It looks stupid. So many kids from the Tribal school do this.

When his science mentor asked him how he could see people change this situation in the future, he said, "I don't think you can."

Identity development for American Indian adolescents can be delayed when compared to other non-American Indian students. American Indian children are often forced to view themselves and their community through an imposed lens fogged by

persistent racism and oppression in their lives. During high school, John's fogged lens caused him to exaggerate one of many wonderful characteristics that make him who he is today.

During the interview, John appeared to have a transformational revelation about how his love of humor and desire to be *really* seen for who he is often interrupted learning opportunities in the classroom:

I messed up in school. I was too busy [in the classroom] trying to make people laugh. I was the class clown. Even though I was not doing well in school, it was important to make my friends laugh. My humor allowed people to see through the Indian and see a regular funny person, you know. When I make people laugh, they are looking at me and not the color of my skin.

Again, John's story reiterated the importance of parental support and guidance in both identity formation and academic achievement. During John's junior year in high school, he tried to turn his life around. When he decided to stop being the *class clown* and work toward the goal of making it to the National American Indian Science Fair, John met with much resistance:

In eleventh grade I was trying to move away from being the class clown, being more serious. Then people would tell me I was grouchy. My Mom and Dad told me it was a sign that I was growing up. You can't be the funny guy forever, you know. Yes, I mean. I had to get serious for the science fair. I knew that if I stayed the class clown I would never have

made it to the national science fair. I was able to do some pretty cool stuff, you know. I was ready to be more than just a jokester.

I had to be more focused. When I was at science fair, I had to act mature when I was talking to all those science and math dudes. Also, I did not want to let the guy from NASA that sent me the Mars' soil, down.

*Gogoyoti/two people—The struggle to find yourselves—Rita.*

After attending an American Indian preschool and having predominately Native friends, Rita saw her self as a little Native girl. As Rita matured, she began to notice she did not look like the other Native children she had played with all her life. Rita spoke about this time of identity confusion:

I went to a Native American Head Start Program and I had a lot of Native American friends when I was there. Then we transitioned to the other school. So my base of friends when I was younger was Native Americans. I never felt like I did not belong when I was little.

When I was older, I would look at myself and say, "Wow I am really white and I have blonde hair, boy I do not look like a Native American." I am sure people don't talk about me. I just feel they are looking at me and thinking, "Why is this girl in the Native American Science Fair?"

*Defining a real Indian—John.*

So what does it mean to be an American Indian? Legally, because American Indian tribes are of a sovereign nation, "...tribal governments are the sole authority that

can determine who is or is not a member, or citizen, of a tribal nation” (Horse, 2005, p. 63). Many tribes ascribe that “A ‘real’ or ‘true’ Indian must have a minimum amount of Indian blood [blood quantum]” (Bizzaro, 2004, p. 63).

One of the most urgent concerns and or questions that John and Rita both shared were surrounding tribal enrollment. How are, and will, tribal elders on their reservation, and in the United States, determine who is a *true* Indian and who is not? When I asked John how he thought the issue of who is an Indian and who is not, according to tribal rules, will be resolved, he stated:

I don’t know, pretty soon all Indians will be blond haired and blue eyed. I am a half Native and then my kids might only be a quarter. My kids, kids will not even be able to be enrolled. This will happen soon. Maybe if they don’t look at percentages. Percentages are how the elders want to determine who is enrolled. It seems they are wiping themselves out. Pretty soon there will not be any Indians left.

My brother just got enrolled. My brother is 26 and my sister is 24. I think that if your parent is enrolled you should be able to be enrolled. I think [the process of] who can be enrolled should be changed. If your Mom is an Indian, then you should be enrolled too, so enrollment could be passed down. I have friends that live on the reservation, but they cannot be enrolled because their Mom is only a quarter.

*Defining a real Indian—Rita.*

Many American Indians of Native descent have no way of proving their exact blood quantum and/or enrolled tribal status. Rita, a non-enrolled, mixed-blood American Indian of undetermined percentage, understands these concerns:

As I stated before, my grandpa is enrolled, but my grandmother is not. My mom is enrolled, so I am the descendent of an enrollee. No, no I am not a high enough blood quantum.

You have to be a quarter to be enrolled. There is a debate about my grandfather's mother's blood quantum percentage. My great grandmother, they do not know how much Native American she was. This brings my grandfather's apparent quantity of Native American-ness down. Which brings my mom's down, so I am slightly below the blood quantum of twenty five percent.

I think the Minnesota Board of Native Americans, I am not sure exactly what this is called, and the RBC deals with who is enrolled. I know it is a highly debated topic, because my cousins are in the same situation. I know their mom is actively fighting this. My cousins are younger than me, like ten years old. She is actively trying to get things changed and get back-pay for people who are very close descendants of enrollees.

Enrollees get per capita every year. When you turn 18, you get the per capita from when you were born in back-pay. Then every year after



that you get your per capita. That is a certain amount of money the tribe puts away for you. When you turn 18, you get all of the money for the first 18 years of your life, and then every year after that. My mom gets her per capita, which is a set amount of money that changes depending on things. In the past, it was less and now they have increased it and she gets a check for that every year. This depends on your blood quantum.

I have qualified for a couple Native American Scholarships through AISES [the American Indian Science and Engineering Society], but certain scholarships I cannot apply for because I am not enrolled. Where as the others that I have been able to win or participate in I have to show proof of my descent from an enrollee. I do not even know when they first started paying attention to who was what amount of Native American. I suppose when money became involved it became an issue. That's the truth too.

At this point in time, the debate arguing about blood quantum is so ridiculous. There are so few Native Americans born today that actually have high enough blood quantum to even meet their standards. It is just funny, it is like they are trying to make this super exclusive group, but it is like your group is shrinking, times are changing. People don't just meet and fall in love with and have children with other Native Americans to keep the Native American blood flowing. It is not like that. Because there

are people fighting to get the blood quantum issue changed there is a possibility that this will be different in the future.

*Identity formation—Science fair mentor*

Long before I knew what *blood quantum* meant, I was indirectly a part of defining who was an American Indian by encouraging those identified to participate in the American Indian science fairs. The American Indian Science and Engineering Society has criteria to determine if a student is *Native enough* to participate in their fair. At the beginning of the year I showed a short video of last year's science fair events, including the American Indian fair. I told John, Rita and all of my students that if they were American Indian they could participate in both the American Indian fair and non-American Indian fair.

Currently, I continue to talk about John's and Rita's success and all of the opportunities they have had because of science fair. Rita has taken time from her busy college schedule to return to my middle school classroom to talk about her experiences and how they have impacted her success in college. Rita also judges at the regional non-American Indian Science fair. I encourage all past American Indian and non-Indian students to talk to my classes about their past experiences.

To participate in the American Indian fair, I explained that the students have to be at least an eighth American Indian or one of their grandparents must have a tribal enrollment number. Every year, I have at least one student who had never identified themselves as American Indian, realize they were, according to AISES and our school district. Last year, after my American Indian science fair talk, two students became

enrolled in our school as American Indians for the first time. They were able to receive services they did not know were available to them and they participated in the National American Indian Science and Engineering Society fair in New Mexico.

In order to promote John’s and Rita’s participation in the American Indian and non-Indian science fairs I became a *border crosser* between my non-Indian white world and my students’ American Indian one. Unintentionally, John and Rita were provided with an example of how to navigate a successful crossing.

Table 2

*Identity Formation Interview Summary*

Identity formation/  
Participants

Description

Enculturation

John Appearance indicates his American Indian heritage. He lives on the reservation where he participates in many family cultural events.

Rita Appearance does not indicate her American Indian heritage. Grew up on the reservation where she participated in many family cultural events.

Bicultural Identity

John John feels very comfortable with his American Indian identity. Yet, he finds it very difficult to be “Indian one time and white the other time.”

Rita Initially, Rita felt comfortable with her American Indian identity. Around

sixth grade she noticed her appearance was different than her American Indian friends. She feels like she *fits-in* in a non-Indian setting.

#### Defining a “real” Indian

John Has a tribal number for membership. He is very concerned about his future off-springs’ tribal membership.

Rita She has contested tribal blood quantum. She is considered the offspring of an enrollee and very concerned about membership determination.

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In order to encourage American Indian student participation in all science fairs, I informed John, Rita and my American Indian students regarding the criteria for participation in both non-American Indian and American Indian science fairs. I tried to lead by example, while crossing back and forth between the American Indian and non-American Indian science fairs, while promoting American Indian participation.

#### *Best Practice in Science Class—American Indian Teaching and Learning*

At John’s and Rita’s middle and high school there is an American Indian room where students have access to computers, opportunities for group learning, and one-on-one tutoring assistance. John used the Indian Education room while he was in school, but Rita did not. While examining what educational practice works best for American Indians, this study can only tell the story of how John and Rita perceived they learn best, and how the teacher, the learning style used, and the learning environment (classroom and school) informed their learning. These truths can only be ascribed to each of them and not generalized for all American Indian students.

During the interviews, John and Rita had little to say about what helped them learn new information. Even when specifically asked about their learning style, they both had a difficult time pin-pointing any one style. They both focused on what did and did not work for them now, while attending college; each having difficulty thinking back to what worked for them during high school.

*Learning—John.*

During the interview, John expressed that he is predominantly a visual learner, who finds he learns best while working on the computer. He likes a relaxed, less structured classroom environment where he can access individual help from a teacher at any time. In his own words:

I am more of a visual learner. I get bored with listening. I like a relaxed classroom, I do not work well when things are so structured with definite due dates. I liked science fair because I could work at my own pace. There was always someone there, you, to ask questions of every step along the way. You did not nag us about getting done, well you did remind us, but you gave us some space to get the work done.

I like working with computers, doing research. In the classroom I like working in smaller groups. When I am learning, I like things broken down into little pieces. If [teachers] try and tell me the whole thing I get overwhelmed. Sitting down one-on-one with a teacher is the best way for me to learn. When I work by myself I wander off and get off task.

*Learning—Rita.*

When an oral lesson was presented without visual demonstrations, John and Rita are similar in that they both seemed to find learning was difficult. Rita had more to say about what did not work for her while learning. A text book with visual illustrations and content information helped her learn best while at college. Rita also stressed the importance of having access to a teacher for one-on-one assistance. In her own words:

I do not like when I am just lectured to. I feel like I have no idea what they are talking about. In college I feel like I am never caught up, so basically I feel like I do not know any of the stuff until after I leave the classroom and I study by myself, in a quiet space. I do not feel like group or lab activities help me a lot.

I usually can not get prepared for them before they happen, even though the college professor thinks you are. I read and then I reread and then I write and rewrite. I first learn from my text and notes then when I finally have that understood, I go back to my professors and ask for help.

When they [teachers] stand up in front of the class and are going blah...blah...blah I never know what they are talking about. It seems not until right before the test, when I am really studying, do I understand what is going on in the class. In high school I did not feel so confused. I did not feel so lost all the time. In high school there was not so much lecturing.

*Best practice in the science classroom—Science fair mentor.*

John and Rita both reported that one-on-one attention from their teacher and the opportunity to work at their own pace improved learning. Both students felt they learn the least when a teacher lectures on content. My science classroom had very little teacher lecture time. Science fair research activities were structured so students worked independently and in small groups, on projects of their choice. I worked to be a facilitator of learning, not a deliverer of information.

One day a week, John, Rita and all of the science students would go to the computer lab. The students generated questions for their scientific inquiry investigations using the structure of the scientific method; providing a model for the organization of their topics. These opportunities in the computer lab were enhanced by increased one-on-one assistance because of the presence of additional teachers (i.e., Indian Educators and University Science Graduate Fellows).

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Table 3

*Best Practice Interview Summary*


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Participants	Description
John	Predominately a visual learner, who learns best on the computer in a relaxed less structured classroom. Learns best with one-on-one help from a teacher.
Rita	Learns best from a text book with visual illustrations. Also stresses the

importance of one-on-one teacher assistance.

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In order to promote academic success for John, Rita and all of my students I worked to be a facilitator of learning not a deliverer of information, thus increasing student access to one-on-one instruction while working with students on their individualized research projects. These practices may have increased John's and Rita's academic success in the high school classroom, but I considered myself a successful educator when John and Rita were motivated to continue their education after graduating from high school.

#### *Motivation in Science*

The American Indian Science and Engineering Society (AISES) encourages students to do hands-on science, apply their knowledge of math and science, conduct research and collect data while interacting with professional role models (Silas, 2007). Annually, AISES holds the National American Indian Science and Engineering Science Fair (NAISEF). At this national fair, over four hundred students from all over the United States present their projects to professional scientists. Eight high school students at this national fair move on to participate in the Intel International Science and Engineering Fair (Intel ISEF). At Intel ISEF, over 1500 students from up to fifty countries come together to compete for over seven million dollars in prizes and scholarships ([www.societyforscience.org/ISEF](http://www.societyforscience.org/ISEF)).



*Intrinsic motivation to do science fair—Rita.*

Rita participated in science fair four years in a row. Only during the first year of competition did she *have* to do a project, but even that first year, she never had to participate in science fair events. When I asked Rita why she was motivated to do science fair projects all four years, and how that compared to the work she has to do in college, she said:

Well, you feel like you have accomplished something after you are finished [with your science fair project]. I knew that I did it myself and I felt proud of the work I had done. It did not feel like busy work, as many high school assignments do. I was not just doing worksheets. I was actually doing something that in the end was this huge product that you could be proud of and show off to other people.

I cannot even compare science fair learning and college. All you do at college is read, listen to lectures and take tests. Most of the work you do you do not turn in for credit or anything; you just have to do it. There is no meaning/reason besides doing well on a test.

*Intrinsic motivation to do science fair—John.*

John was in the high school research class because he needed a science credit to graduate. But as John was contemplating the topic in which he would do his project, all of that changed. For John, his science fair experience traversed through an intrinsic wonderland. John described the day he came up with his science fair topic and what that meant to him:

Oh yah, I remember [I was spending time looking online for a topic], it showed a college project online and we printed it. When I read the article I found the guy they [the college students] got the Mars soil from. We *Googled* his name, Chris McKay, he was from the Johnson Space Center. He sent us to Carlton Allen. He was the head planetary geologist at Johnson Space Center. We *Googled* him, found his website.

On Carlton Allen's website, there was a generic email that said if we (John and I) emailed the website it might take a month to get an answer. We both knew that a month would be too long. John and I spied a phone number. I took out my cell phone dialed the number and handed it to John. After it started ringing, he nervously handed it back to me and said he "could not talk." We never in our wildest dreams thought Carlton Allen, a NASA planetary geologist, would answer the phone. We were both so surprised. I talked to him, John talked to him, and within a week Dr. Allen had shipped us some Mars simulate soil. John was amazed at how if you tried, things could just *happen*. John explained how having a real audience while doing a project that mattered motivated him to do *good work*:

I [John] was amazed how the guy answered the phone and then sent us the soil. I never knew it could be so easy, that things can happen. This was serious. Well, after talking to the guy, he sent us some dirt and then both John McKay and Carlton Allen asked me to send them my paper when I was done. I did not want to let them down after all they did for me.

I also felt excited to do my project because well, it had not really been done before. People have done a lot on the moon, but not on Mars. I found all those articles on colonizing Mars. NASA was just thinking about figuring out a way to provide food once Mars was colonized. The space shuttle would be too small to carry many of the supplies. People living on Mars will have to grow their own food. Yah, my project was a future real life problem.

*Extrinsic motivation to do science fair—Rita.*

Rita commented on how grades were not a motivational factor in the pursuit of finishing a science fair project:

Grades did not impact whether I wanted to do a science fair project. It was more the amount of effort you put into it, or how much time you put into it--if you are really trying. If you wanted to do well on it, or if you had a desire to do well in the class, you could do that just by trying hard, no one is going to tell you your idea was horrible and then you would get bad grade. The project was yours.

*Extrinsic motivation to do science fair—John.*

John explained that even though his parents were unhappy with him for earning *bad* grades, he did not change his ways until there was the threat that he may not graduate from high school. Even though John had begun a second science fair project his senior

year, the intrinsic rewards he received the year before could not outweigh the threat of not graduating from high school. John explained:

I got an *F* and I heard about it for a week. I have good role models in my family, but while I was in school; I kept thinking “I’ll get it done next year.” I pretty much messed myself doing that. Finally, during my twelfth grade year I was getting in a real sticky spot with my grades. During my senior year while I was doing my science fair project sometimes I would miss three days of measuring my plants. I was trying to get caught up on other school work. I don’t know. I felt I needed to focus on my graduation; I did not want to put it in jeopardy. It would have been cool to go to the science fair again, but I would rather graduate.

*Multi-goal perspectives intrinsic/extrinsic motivation—Rita.*

Rita explained how she was motivated to work hard because the effort was meaningful, yet she was also motivated by the prospect of winning a trip and having fun:

[Science fair] was challenging the entire time. It helped me learn more about myself. How I liked to keep going and do well even though it was difficult, hard work. I was constantly learning new things from [my research]; because I had to do background research, sift through information, like primary sources. This gave me so much experience. Researching background information prepared me for what I would need to do in college. I never had to do this in any other high school classes except maybe some literature ones.

Because we worked hard on our project and did quality work, we were able to go to ISEF [International Science and Engineering Fair]. ISEF was like a payoff along with all the fun experiences we had there. Everything that is hosted at ISEF is like a celebration. They give off that type of atmosphere and I think a majority of the people there are taking it as a celebration and are having fun with it. Maybe for one night or afternoon you might study for your presentation, but a majority of the time you're just having fun. Your work is done; you are enjoying not being in school as well as spending time with people from all over the world, being at dinners, shows and stuff. I think when you are able to go to the state fair, and Nationals this [American Indian Fair and ISEF] is the big payoff in the end, the celebration, the fun.

*Multi-goal perspectives intrinsic/extrinsic motivation—John.*

John professed that the extrinsic reward of a possible trip to the National American Indian Fair in Albuquerque, New Mexico played a big part in his initial enthusiasm to do a good project, but eventually there was more to it than the possibility of a fun trip. John's story:

I thought it would be cool. I really just wanted to go on that trip, to the National fair. I knew other Indian kids had gone, but as I worked on my project I began to feel I had some ownership in it. I wanted to do well because it was a *good* project, it mattered. For other assignments [in school], you are doing the same things over and over again. All you do is

look in a book for stuff. I felt my project was more than that. Especially during my junior year, when I was working on my project, I liked what was going on then. My grades went up and I had science fair. My whole attitude changed. If I had not decided to go to science fair, I would have done just another dumb project like I did in 9<sup>th</sup> grade just to get by. Things changed.

*Science Motivation—Science fair mentor.*

The very first week of school, John and Rita started working on their science research projects. They had the freedom to choose a topic they were interested in and the time to work on it. The classroom schedule was structured around a schedule used by a successful company based in Minnesota. The leaders in this company told their scientists and engineers they had four days out of a five-day work-week to work on what the company wanted them to work on, and they had one-day to work on what they were interested in.

In John's and Rita's science classroom, students worked four days on content and one day on a topic of their interest. With my assistance, they accessed professional scientists and engineers from the surrounding community to support their research. John and Rita corresponded with professionals via email or phone, often meeting at the professionals' work place. Rita worked with a forest ecologist who was studying the deforestation of northern hardwood forests by exotic earthworms. Earthworms are not native to northern Minnesota because of glacial removal of topsoil. Her work was, and still is, *cutting edge* science.

Many of the evaluators that judged Rita at the national and international fairs had never heard that earthworms negatively impact northern Minnesota forests. Once when Rita, the forest ecologist, and I were in the woods collecting earth worms, a reporter from Los Angeles was in our area to interview the ecologist about her study. He went along with us on our worm collection and told us many interesting stories.

John worked with NASA scientists via email. The NASA judge at the National American Indian fair was so impressed with John and his project that he continued to email John about his work, and he and I still email each other about student projects. I sent multiple press releases to local newspapers and TV stations, so that the community knew and was informed about John's and Rita's work and accomplishments. Our local paper always featured everything that was sent to them. Participating in science is extra work for students, but both John and Rita were motivated to do the work required to produce successful science fair projects. The hope always was that this high level of motivation to do quality work would carry over into life long learning.

Table 4

*Motivation for Science Interview Summary*

Participants

Description

Intrinsic

Rita	Science Fair projects were challenging, huge projects with student ownership. Felt proud of the projects because they had meaning. Grades
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did not impact participation, it was the desire to do a good project and learn more about the project. The process of preparing for and presenting science fair projects provided experiences that helped prepare for college successes.

John There was a *real* NASA professional scientific audience for his projects. His project had not been done before. He did not want to let the NASA scientists that helped him, down.

#### Extrinsic

John Wanted to graduate from high school and win the trip to NAISEF.

Rita Wanted to advance to the state, national and international science fairs while meeting people from all over the world, having fun and celebrating.

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In order to extrinsically motivate John, Rita and all of my students, I worked to provide students with opportunities to participate in many science fair events. I generated initial excitement by showing videos of students participating and winning awards. In order to intrinsically motivate students, I always gave John, Rita and all of my students the freedom to choose their project topic and the time to work in class. Connecting students with community members and professional mentors, while modeling a passion for learning, helped prepare John and Rita for their *big* transition into college.

#### *Transition to College*

The trends identified in the interviews of John and Rita: (a) racism and oppression, b) identity formation, c) the lack of cultural inclusion in the classroom, and



d) the lack of motivation, can make it difficult for students to succeed in middle and high school. These barriers make it exceptionally hard to get American Indian students to even consider college. While participating in science fairs, students gained skills in doing research, making graphs, using statistics, as well as writing and communicating what they learned and discovered. These skills often are needed in the post-secondary setting. The transition to college can be a difficult time for many American Indian students. John and Rita spoke of what helped them make the transition to college and why this transition was difficult.

*College life—John.*

John is attending the local tribal college and living at home. He is not affected by feelings of loneliness and isolation, but anxiety, regarding how ill prepared he is for college level work. He noticed that the one-on-one help he received from high school teachers was not forthcoming in college:

I am going to the local tribal college and then will go to the local university for criminology. I could be a parole officer, or I could be a DNR officer, or possibly a head of security at a company. I guess I have just always wanted to be a police officer. One of the biggest differences I noticed right away between college and high school was the lack of help. At high school I had your [science mentor] help with my science project; there was Indian Ed. [Education]. If you went down to Indian Ed., there would always be someone to help you, you know, one on one. In college

there is an Indian Ed., but when you go down there, there are like 50 students for one teacher.

John noticed that what he learned in high school has not always prepared him for college:

High school did not really prepare me for college. I wish I would have learned more about doing work independently in all subjects not just science fair. There is no one at college to help you.

*College life—Rita.*

Rita is attending a private college three hours drive from her home. Without a car, and with a heavy college schedule, she described her feelings of isolation and loneliness, as well as explained how her science fair experiences helped prepare her for college and for her future career choices:

My family is close, I live in the cities and I do not have a car. I have to depend on other people to give me rides home. I miss a lot of family things that I used to be able to go to and take part in. I miss my family a lot.

Science fair helped prepare me for college. It shows you what you can achieve. It helps you see the *World*. More than just the little microcosm of a school you go to. You are just stuck in this little space and you do not know what is out there. Science Fair is so eye opening, especially when you get to the international or national fairs. You get to see so much more than any high school or middle school can show you.

You do not know what is out there and you can finally see the rest of the world in a safe way once you get out there at science fair events.

[In college and in the future] I want to get to the point in my life where I can be proud of what I am doing. That is what science fair was for me in my life. I looked at what others were doing [in science fair] and the opportunities they were having and thought I could be doing that in my life. I saw what the possibilities were. I worked and did do something [in science fair] that I was proud of doing. My first year of science fair is what the pharmacists I work with are for me now. I tell myself, if I try hard enough in college, I know from my past science fair success, positive things happen.

Because positive things have happened for me with the AISES science fairs, and the National Youth Council, basically, all the experiences I have had, trips that I have been on, people I have met. I feel indebted. I want to stay connected to my Ojibwe heritage. I do not know how to say it; it is hard to explain in a way. Because it is like I have two identities in a way. I have the huge community that everyone belongs to and then I have this more inclusive community group where I feel special, like I have this special connection. I feel I can give back to this specific group of people who have given to me in different ways. They have given me scholarship

Working with you and doing my project was a big part of my life, helping me learn a lot and challenging me. Just the fact that I have done research in the past has helped me. I find myself able to help other students in college do things like write a good hypothesis and stuff. I know about statistics, just getting that experience in high school has been so important. There are not many classes in high school that prepare you for college like doing a science fair project does. They do not offer students the experience of such an advanced level of research.

In the summer, I work at the Native rural pharmacy. I hope to work at this pharmacy or one like it once I graduate. Like I said, I get free health care and medication through my tribe. I would like to be a part of giving back to that community.

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Table 5

*Transition to College Interview Summary*

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Participants	Description
John	Felt he was ready to take learning seriously and doing a science fair project helped him do that. He gained the confidence he needed to believe he could be successful in college because of the success he had with this project. He took more science classes in college than he would have otherwise. He is currently a criminology/natural resources major and

attending the local Tribal college. He wishes more classes in high school would have prepared him for independent work as science fair did.

Rita A biochemistry major in an urban private college. She had the confidence needed to attend college; science fair gave her global experiences that prepared her to go away to college. She learned to appreciate that her work was good enough and took with her research skills that many other students in college did not have.

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*College life—Teacher relationships.*

For both John and Rita, high school teacher mentorship did not end once they graduated from high school. After working on science research projects with John and Rita for multiple years, I was able to write informed letters of academic support for scholarships, undergraduate and graduate school college entrance. Through email and summer visits, I have been able to make John and Rita aware of continued opportunities available through the American Indian Science and Engineering Society. Strong professional student/teacher relationships were built on the bedrock of teacher leadership; a leadership that began during high school, flourished well into John and Rita's post-secondary academic life.

*Leadership in Schools*

Leadership is a process whereby an individual influences a group of individuals to achieve a common goal (Elliot & McGreagor, 2001; York-Barr, 2006). Schools are filled with highly educated, informed individuals, but does this always lead the students they

serve down the road to academic achievement? In the following sections Rita and John will discuss how the leadership of their science fair mentor affected their high school experience and continued to affect them while in a post-secondary educational setting.

*Teacher leadership and student achievement.*

The following section will assess how John's and Rita's science fair mentor's teacher leadership impacted their success, even though the road to success was cluttered with many obstacles. I asked John, having experienced very little academic success throughout his public school career, how I helped him produce a project he was proud of:

You really pushed me to do [a science fair project] and it seemed like a pretty cool thing to do. At first I was worried I was copying other people's projects, but then we made it more complex and it was more my project. It was cool. You kept on me. You kept me focused, made me sit in the back away from my friends. You kept me focused so I would not get side tracked.

Yah, I remember when you used to sit by me helping me to stay on track. Sometimes I would still start talking to my friends and you would say "whatever," walk away, and not help me. Then I would realize I wanted your help and I wanted to work. You took me in the hall a bunch of times and reminded me I was doing a great project, but that I would have to get back to work to get it done.

Rita had experienced high levels of academic success, but never felt like it was enough. I asked her how working with me and doing a science fair project helped her overcome this. In Rita's words:

That is probably what it is-I need someone to push me-or I mean I push my self-hard enough, but I do it in a negative way. If I am not getting positive feedback I would even be more of a negative person than I am right now. I am never happy with my grades, and with what I do. If others are proud or happy about what I do, then I can be more accepting of what I did. So having you as a positive mentor or teacher that is there for me helps me push myself. You helped me see that I could do good work and be happy about it.

Rita also talked about how participating in science fair and having her science fair mentor as a role model helped prepare her to deal with future challenges on her own. Recently, she had to write an essay in order to study abroad. In the essay, she wrote about how she faced a challenge in her life with positive outcomes. In Rita's words:

Well at ISEF [other big science fair events], we had you to fall back on; you would be able to fix things if there were problems-help us through everything. At the National Native American Science Fair [NAISEF], I did not have that support; you were not allowed to attend. The teachers I was with did not even know me, so they did not have any compassion or did not want to help me out. I had to learn how to work independently when dealing with new situations.

Recently, I applied to study abroad. On the application it asked a question about-How did you cope with and handle an unexpected situation, how did you deal with this? I thought back to my second year at the American Indian National Fair, when I was by myself. When my board arrived, it was all in pieces and I had no idea what to do. I had never been without you or my parents. I was completely alone and I had to fix it. This was a moment in my life, when I looked back over my science fair experiences, and realized how you and science fair helped me to learn to deal with difficult situations independently.

I had to decide if I was going to give up and say, "Oh well, my board is broken, so everything is down the drain now." Instead, I was able to cope with the situation. What I had learned from you helped me, "Don't panic, we'll figure it out." I learned I had the ability to cope in a crisis situation. So I used that as part of my admissions paper and I was accepted (laugh).

*Communication and leadership.*

Rita and John talked about how open communication with their science fair mentor helped them continue working on their long term science fair project, so that in the end, they were able to produce quality work. Rita and John discussed how important the feedback from their science fair mentor was and how they have already used the skills they gained from doing their project, in college. In Rita's words:



The feedback was the most important. When you thought my project was going well and gave me feedback, then I would believe that it was good enough to go to science fair. [As I have said before] I need someone to push me-or I mean I push my self-hard enough, but I do it in a negative way.

Recently, I worked at a health fair and we did a project board and gave a presentation similar to science fair. I work for the Tribal pharmacy. The pharmacy had a booth set up and I was one of the main speakers. It was another girl and I. I could tell my people skills and my ability to present were better than most of the students there. I feel that you and science fair helped me develop my people skills. I am not a super outgoing person, but when it came to judges, I was good at talking to them.

I always felt confident in what I was saying. I knew what I was talking about instead of memorizing it. Working with you and having you question me, you would bring up random questions that you thought a judge might ask, and had me practice answering them. The years I did the project by myself at the National American Indian Fair forced me to present the whole project by myself. Therefore, I understood everything and could answer questions to all parts of the project.

In John's words:

Science fair opened a lot of doors for me. Because I did science fair, I thought about taking classes in science that I would not have

thought about before. Because of your help and feedback, I am a better researcher of information, much better people person. I am more willing to talk to adults at the college, especially teachers. Even in the classroom in smaller groups.

*Teacher leadership and the value of relationships.*

John and his mentor worked together for one and a half years. As John has stated before, because his mentor never gave up and kept trying to help him focus on his work, he was able to finish his project and be proud. He traveled to the National American Indian Science Fair in Albuquerque, New Mexico. He was awarded the top project in the botany category and was honored by receiving the top high school NASA, space related project award. John and his science fair teacher developed a strong mentor/student relationship centered on collaborative learning.

Rita worked with her science fair mentor for four years. She traveled with the science fair teacher to the International Science Fair three times to: Portland, Oregon, Phoenix, Arizona; and Cleveland, Ohio. At the International fair, she and her partner were awarded a fourth place grand award all three years. A fourth place grand award is awarded to the top 20 percent of the 1500 projects from 50 countries, or the top 300 projects in the *World*. She traveled to the Minnesota Academy of Science State Science Fair and the Junior Science and Humanities Science research symposium (JSHS) three years in a row. Relationships are important, but just as anything really worth while; they take a long time to form. Because Rita and her mentor worked together three years longer

than John, Rita had a lot more to say about what their relationship has meant to her and her academic successes. In Rita's words:

Well, I spent a lot of time from my life working on science fair: doing the research, and the project, preparing to present it, making my board. To begin with, in 9<sup>th</sup> grade you were just one of my teachers, but after a while we became connected through science fair and it gave me more of a mentor than just a teacher. Teachers and mentors are different things. You were more of a mentor to me. You were someone who gave of yourself and encouraged me to try new things; you did not just teach me science out of a book.

I think science fair is a unique experience, especially when it came to my senior year and I needed letters of recommendation. Other students had to just go to teachers they had classes with. I had someone who was basically a teacher, someone I could look up to, but at the same time someone who was my friend. We had experienced so many things together, like losses, wins, victories in science fair. Basically, we experienced doing well together and at the same time being disappointed together. This kind of made us feel more like a team and this gave me someone who I knew was willing to support me, because you were always there. You made special connections to help us/and other students out. You really kept encouraging me to learn and continue science fair.

This is what you still are today. That is why I can feel comfortable hanging out with you and your family. As we went through high school together, science fair together, we traveled and spent a lot of time out of school together. It was a really positive experience. You are willing to put that extra effort into forming relationships, you reach out to people and encourage them. I gained a mentor and a friend, someone who is always supportive of me.

*Teacher leadership—Science fair mentor.*

I encouraged students through modeling, though my commitment to continued participation in higher education. Through this exchange, Rita and John witnessed my passion for life long learning. For John and Rita, the size and amount of work associated with their projects often was overwhelming. I tried to help them stay on-task by encouraging them to stay focused on the next step that *had* to get done, instead of panicking about *all* that still *had not* been done. I am not American Indian; I hope by attending many of the American Indian Science fairs I modeled how to be a cultural border crosser. Possibly, when John and Rita saw me cross over into the American Indian Science fair experience, they were prompted to take a risk and participate in the non-American Indian science fair.

Table 6

*Teacher Leadership Interview Summary*

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Participants	Description
John	His mentor kept him focused on his science fair project so he would not get side tracked by friends. Reminded him he was doing a great project and helped him find NASA scientists to assist with his project.
Rita	Her mentor gave positive feedback about her project so that she could feel happy about the work she did. By example, showed her how to deal with difficult situations. Her mentor supported and encouraged her to try new things. She felt that she and her mentor were a team.

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By working on a doctorate degree in education, I was a concrete example of what it means to be a life long learner. With any luck, while modeling cultural border crossing, the barriers of racism and oppression for John and Rita were, in a small way, easier to bear.

## Chapter 5

*Conclusion/Discussion**Introduction*

This ethnographical/auto-ethnographic study used the stories told by two high school American Indian students (John and Rita) to determine the impact of science fair participation and the relationship developed with their science fair educator on their future academic goals. In hopes of realizing this mission, while reading background literature and transcribing these interviews, two themes emerged as barriers to science learning and the American Indian educational experience: (a) racism and continued oppression, and (b) difficulties in identity formation. Four themes emerged that inform educators and American Indian students how science fair participation and teacher mentorship/relationship building, combined with educational best practice, can *motivate* students to span these barriers, working towards academic success and bridge the way towards a *transition to college* and the likelihood of life long learning. The four themes in educational best practice that came into view were: (a) curricular cultural integration, (b) teacher student one-on-one instruction, (c) the use of multiple and varied learning styles, and (d) increased community/parent/teacher leadership and involvement.

In chapter 5, the conclusion section of this qualitative study, a brief summary of the data is presented with discussion of the identified themes in relation to the literature review in chapter 2. I will explore how my mentoring has affected their success as science fair participants and as adults. I will discuss and interpret the results of this study specifically in terms of the research question. Finally, I will suggest recommendation for

further studies and my specific recommendations for administrators and teachers in school with American Native populations.

### *Barriers to Academic Success*

In order to determine to what extent the original research question had been answered, a discussion of the interview data and autoethnographical introspection was done according to the themes that emerged. The original question was: To what extent does two American Indian students' participation in science fairs, the leadership exhibited and relationship formed with their mentor during the teaching and learning process, affect academic achievement and the students' drive to continue learning beyond high school? In order to answer this question, the two barriers to academic success that emerged from the interview data will be discussed: (a) racism and continued oppression, and (b) difficulties in identity formation.

#### *Racism and oppression.*

The first educational barrier as summarized in table one is the constant struggle with the effects of racism and oppression in John's and Rita's lives. John and Rita are Ojibwe American Indians. Visually, John has many of the characteristics of an American Indian and is often identified as one. Rita, on the other hand, has blond hair and blue eyes, and in a crowd is never identified as an American Indian. They both have lived all their lives on the reservation, participated in cultural events, family celebrations, and spiritual gatherings, but their experiences with racism and oppression, though apparent in both of their lives, were quite different.

John felt that if he went to the non-American Indian science fair his project would be perceived as unremarkable. Racism and continued oppression lead to imbalances in power; resulting in unequal opportunities and a lack of positive educational outcomes for all students. Not only does the dominant culture often blame the oppressed culture for their misfortune, but a legacy of unresolved grief can cause the oppressed to internalize this blame and expect less of themselves (Wilder et al., 2001). Often, this leads to a true fear of success because of a "...world that will let them down again" (Cleary & Peacock, 1998, p. 88).

John's and Rita's experiences with racism and oppression were not limited to the experiences of their everyday lives, but compounded by the legacy of oppression that they and their parents were forced to endure. John's father was removed from his home, separated from his mother and siblings. During the time of parental isolation he was not instructed in his culture and lost his ability to speak Ojibwe. He was able to return to his home reservation and his family, relearning what it meant to be an American Indian. Because of John's father's past experiences with racism, he was able to support John when he experienced many of the same things.

Rita's grandfather, whose appearance indicates he is an American Indian, had to work hard to prove himself in the non-American Indian public school. Rita's and her mother's appearance limited their experiences with overt acts of racism outside of the American Indian community, but increased sub-oppressive events while interacting with other American Indians.



Alan Siebert's (1996) description of resilient people sounds as though it could have been written about both John's and Rita's families.

Some of life's best survivors grew up in horrible situations....They have been strengthened in the school of life. They have been abused, lied to, deceived, robbed, raped, mistreated, and hit by the worst life can throw at them; their reaction is to pick themselves up, learn important lessons, set positive goals, and rebuild their lives. (Siebert, 1996, p. 387)

John's father professed no bitterness when telling his son his story, he traveled back to his home of origin and was able to go to a University, earn a degree in psychology, and raise a family while living with a failing kidney. Rita's grandfather raised his family while supporting and passing on his Ojibwe ways to his family, particularly his granddaughter.

Parents are the guiding forces that create a safety net of support, while their children traverse between the wider community and dominant culture. The importance of parental support can not be overstated. They "...are instrumental in setting the tone for their children's behavior, attitude, and successful functioning in both cultural worlds (Farver et al., 2007, p. 185). In his meta-analysis, Burk (2007) stated that, "Community and parental involvement and support emerged in the literature as crucial factors contributing to student persistence" (Burk, 2007, p. 7). The racist events that occurred in John's life (hunting, fishing, and harassment at school) understandably made it difficult for John to comfortably move between his Native and non-Native worlds. John's experiences help explain how positive (hunting, fishing, and ricing) family experiences

that were grounded in one's culture can alleviate worldview conflicts; allowing children to successfully navigate across the *cultural border* into collateral learning.

Currently, John and Rita are successfully pursuing undergraduate degrees, John criminology, and Rita biochemistry; she is also in the process of applying to pharmacy school. Racist barriers to learning and success occurred at John's and Rita's high school, as well as during their science fair experiences. The listening ears of the students' family members, and their science fair mentor helped them persevere and have successful academic science fair experiences. These successes directly changed their personal perspectives of themselves and improved their outlook on life, ultimately minimizing the effects of racism and oppression.

*Identity development.*

The second barrier to American Indian academic achievement that was unexpectedly and continuously reported was John's and Rita's struggle with identity formation. Enculturation is part of the identity formation process where one is learning and adapting to an individual's home culture (Garrett, 1996). Bicultural identity forms when a person maintains aspects of their native culture, but is working to acquire some of the dominant culture (Farver et al., 2007; Garrett, 1996; Jackson, 2004; LaFromboise, Coleman, & Gerton, 1993).

A summary description of how and why identity formation difficulties were barriers to John's and Rita's academic success will be presented, followed by a discussion of how science fair participation and the relationship formed with their science fair mentor helped reduced these effects. John and Rita, both, grew up on the reservation,

participated in many cultural family events, while attending the local public school.

Sadly, as time went on, John's and Rita's outward appearance was shown to have the greatest impact on their bicultural identity formation.

As John and Rita grew older, John, who outwardly appeared to be American Indian, closely identified with his Native culture and less with the dominant culture at his public school. Rita, on the other hand, whose appearance does not indicate an American Indian heritage, began to question how well she fit in around sixth grade. Even though John and Rita struggled to form a bicultural identity for different reasons, they both were concerned about how and who would determine tribal membership in the future.

Both John and Rita expressed that the longer blood quantum issues are debated and continue to be uncertain, the more difficult it will become to navigate back and forth across their cultural borders. These worldview conflicts, understandably, appeared to have an influence on their academic success. Allen & Crawley (1998) reported that these identity conflicts can be minimized when all students have a better understanding of themselves and each other. Parents, teachers, tribal leaders and the dominant surrounding community must work together to nurture and exemplify the formation of a strong bicultural American Indian identity, especially for those children of mixed blood. When this happens, American Indian students are given a bridge, which allows them to safely make the cultural border crossings into collateral learning (Jegede & Aikenhead, 1999).

For many American Indian children, a central cultural value, no matter the tribal affiliation, is the importance of their family and tribal community in the development of who they are. Many children "...view family as an extension of themselves providing a

sense of identity, confidence, and security: and interdependence among all Native people” (Burk, 2007, p. 7). When the community and family foster the successful incorporation of the American Indian child’s home culture into their lives, enculturation occurs (Garrett, 1996).

If identity development issues are a barrier to academic achievement and life long learning, then what effect did participation in science fair and the relationship developed with their science fair mentor have on John and Rita? John identifies more with his American Indian heritage than his non-Indian one. After examining the interview data, maturity, parental support, teacher mentorship/leadership levels, science fair participation appeared to give John the opportunity for the academic success. This success never led to an academic self-confidence that allowed him to cross into the non-American Indian fair, but may have been the first step of many that will lead to more successful crossings in the future.

Rita, before the discovery of the AISES science fair, successfully took part in the non-American Indian science fair. Later, she successfully participated in the AISES fairs, but because of her appearance, she always felt she was an outsider or did not belong. After examining the interview data, parental support, teacher mentorship/leadership, and science fair participation provided Rita with an alternate academic cultural experience from which she gained much success. Even though Rita did feel isolated at the AISES fairs, she participated and continues, even in college, to stay active within this academic group. She applied for and did received a small college scholarship from AISES, and in

the summer of 2007, she was awarded an AISES grant to do pharmaceutical science research.

*Identity summary.*

John's and Rita's story about racism, oppression and identity development in their lives answers the original research question. The support and relationships developed with their family, community and science fair mentor, as well as the confidence gained from producing and presenting successful science fair projects, appeared to help them minimize the barriers of racism and oppression in their lives, allowing for increased levels of academic achievement in high school and currently in college.

*Educational Best Practice, Motivation, Academic Success and College Life*

The relationship developed with John's and Rita's science fair mentor, along with their participation in science fair, appeared to minimize identity development struggles, and the effects of racism and oppression; thus answering the original question regarding how the participation and mentorship, along with educational best practices lead to increased motivation, academic achievement, and continued learning beyond high school. After analyzing the interview data, the following themes in educational best practice came into view: (a) curricular cultural integration, (b) teacher student one-on-one instruction, (c) the use of multiple and varied learning styles, and (d) increased community/parent/teacher leadership and involvement. The following sections will analyze the effects of these best practice initiatives and their impact on John's and Rita's (a) learning motivation, (b) academic achievement and (c) transition to college.

*Best practice in education.*

Many educational techniques can be considered *best practice*, which ones work is often dependent on the individual engaged in learning. Thus, educators and students must remember that what John and Rita report are educational best practices may not be true for all students or American Indian students. Both John and Rita feel they learn best when they receive one-on-one instruction from a teacher. They both do not like teacher centered lectures, have increased motivation to do work when assigned activities/projects that have meaning, and enjoy visual illustrations, while being allowed to work at their own pace. They differ in some aspects of best practice and learning. John feels he learns best on the computer in a relaxed, less structured classroom. Rita learns best when reading a text book with visual illustrations.

The original question this qualitative research project asked was how does science fair participation and the relationship developed with a science fair mentor affect academic achievement and continued learning past high school? When the interview data was considered, the process of scientific inquiry in the classroom appeared to enhance Rita's and John's learning. Not only does an individualized science inquiry research project in the classroom meet the National Science Standards, but multiple learning techniques are employed by students in the process. Students chose the topic, so the project has more meaning than the commonly assigned activity. They work at their own pace, while teacher lecturing is minimal. Teachers act as facilitators of learning, not producers of learning. Students work one-on-one with their science fair mentor, who

individually advises them on their unique project, which can be culture and/or interest centered.

When taking a quick look at research-based best practice for American Indian learners, similar patterns emerge. A few research studies indicate that American Indian students learn best when educators blend an oral delivery with a visual demonstration. American Indian students' learning can be enhanced when experiential teaching and learning is used, along with hands-on activities in a collaborative setting. The classroom that promotes learning has an informal *culturally friendly* atmosphere where teachers act as facilitators in a relaxed democratic environment. Interviewees John and Rita mention some of these processes and situations, but not all of them. In some cases, they even contradict them, thus further promoting the importance of instructing in multiple ways in order to reach *all* children (Cleary & Peacock, 1998; Finkel, 2005; Starnes, 2006b).

*Motivation to learn science.*

As stated, educators evaluating what will motivate their students must remember that John's and Rita's motivational revelations may not be true for all students. After examining the interview data, Rita reported she was intrinsically motivated to do well in science (science fair) because her science fair projects were always challenging and she felt strong student ownership. When she was done with this year-long project, she felt it had meaning and she was proud of the outcome.

John was very intrinsically motivated to participate in science fair because his project was *real*. He talked to an actual NASA scientist on the phone and the scientist sent John Mars simulate soil. Because of the help NASA scientists gave him, he did not

want to let them down, so he had to do work to ensure a project in which they could all be proud. Rita reported that she was motivated to do a science fair project because she used many of the techniques that best practices in science have shown to work.

Both John and Rita were extrinsically motivated to do high quality academic work because they wanted to go on the trips that successful science fair projects can provide. Both had learned that participation in science fairs was *fun*. While participating they were able to travel, eat good food, and meet people from all over the world. In the interview John and Rita were both intrinsically and extrinsically motivated to do high quality science projects resulting in a high level of academic achievement in science. Barron and Harackiewicz (2001) confirmed the benefit of using a combination of mastery and performance goals, or extrinsic and intrinsic motivational factors, when it came to mastery learning.

Marzano et al. (2005) reminds educators that there is more depth to students doing inquiry based science research projects and the participation in science fairs than the accolades received. Using *self-system* theory Marzano explained how long-term projects, such as science fair projects, can enhance internal motivation. Students are internally motivated to do the *right work* while working on long term [science fair] projects, because they are given the freedom to select the topics and specific goals of their projects, and are given the necessary time and resources to complete them. The question is whether John and Rita were motivated by their science fair success enough to continue their education beyond high school.



*Motivation summary.*

The original question this study hoped to answer was, did John's and Rita's participation in science fair and the relationships developed with their science fair mentor increase academic achievement and promote life-long learning. Family, community and science fair mentor academic support, as well as the confidence gained from producing and presenting successful science fair projects, appeared to help John and Rita minimize the barriers of racism and oppression in their lives. With these barriers reduced, a science fair mentor in their corner, and a successful project produced, John and Rita were motivated to initiate and make the transition to college.

*Transition to college.*

Ultimately, since this study looked at the effect of science fair participation and teacher mentorship on academic achievement and the likelihood of life long learning, examining John's and Rita's transition to college is important. Up until eleventh grade, John's focus was not about learning or his grades. He was more concerned about making his friends laugh than being on the honor roll. Things changed when he started eleventh grade. He was ready to take his grades seriously; his science fair project helped him do that. The high level of success he had because of his science fair project helped him gain the confidence he needed to believe he could be successful in college. He is currently a criminology/natural resources major and attending the local Tribal college. John felt that, even though the skills he attained while doing science fair were helping him in college, he wished he had learned to work more independently in other content areas while in high school.

Rita is a biochemistry major at an urban private college. She did not lack in the confidence needed to attend college, she always knew she wanted to go away to college. She professed in the interviews that science fair gave her global experiences that helped prepared her to leave the security and familiarity of her home. In high school, Rita always felt her work was never good enough. With the success of her projects and the help of her science fair mentor she learned to appreciate that her work was good enough, and took with her to college research skills that many other students in college did not have.

Even with all of the success she had throughout her science fair career, Rita reported that while at college, the biggest hurdle she faced was loneliness. She missed her family a lot and wished she could see them more. Bronwynne (2005) reported that many Native students carry with them to college a commitment and obligation to their family. When Native students are many miles from home attending college, their family “...support drastically diminishes and cannot be replaced, even with surrogates such as friends” (p. 221).

Both John and Rita felt that they could be more successful in college if they knew more of their teachers and were able to get one-on-one assistance from them. In his study of American Indian students and the obstacles they face in college, Burke (2007) had a message for John’s and Rita’s college professors. “Faculty members or advisors who work with American Indian students should move beyond their traditional activities, taking a proactive, intrusive role, and seek students out to establish personal relationships and offer help” (p. 224).

*Teacher/mentor leadership and relationship development.*

Teacher leaders are often thought of as *caught in the middle*, yet the middle can be an exciting place where fusion level energy occurs. This high voltage radiation is capable of transforming learning for every student who intersects its path, while radiating a truth that penetrates the soul of every learner (Sparks, 2006; York-Barr & Duke, 2004). The research documenting the impact of teacher leadership on student achievement is limited (York-Barr & Duke, 2004). Most of the research on educational leadership focuses on administrative leadership. This study provides missing meaningful feedback, and embraces students and teachers as a productive community of learning.

John felt that the close relationship we formed while working on his science fair research kept him focused on his project. Without my constant reminders to stay on task, reminding him he was doing important work, he would have reverted back to making his friends laugh instead of doing his school project. John felt it was essential that I believed his project was important, and that he was capable of doing good work. Many educators believe that some groups of students will never be able to learn at the same level as other students. Marzano (2003) reminded us that teachers and schools "... that are highly effective produce results that almost entirely overcome the effects of student background" (p. chapter 1).

Rita had experienced high levels of academic success, but never felt like it was enough. While working together on Rita's research project, we developed a close caring relationship. Rita trusted me when I told her that her project was good. Rita also talked about how participating in science fair and having me as a role model helped prepare her

to deal with future challenges on her own. Bryk and Schneider (2002) reported on the importance of professional learning as a change agent, stating that this same type of learning that can occur between teachers and their colleagues can occur between teachers and their students. They said schools with high degrees of “relational-trust” are better able to implement change (p. 2).

Ellinor & Gerard (1998) remind us that in order to help teachers to understand the impact they are having on students, they need to start with good student/teacher communication, and that “dialog as a communication practice bridges communication, leadership, and culture” (p. 13). For long-lasting change to occur, teachers must focus on these behaviors in order to initiate renewal and whole school change:

The behaviors that will make a difference are ones such as how leaders listen and develop the trust of others, and how they challenge team members to think productively together and surface problems before they become a crisis....This creates a culture of collaboration and partnership. (Ellinor & Gerard, 1998, p. 12)

Teachers can help create a productive classroom culture by opening up good avenues of communication, but ultimately this is not just about dispersing information to students, communication is a “two-way street” (Richardson, 2002, p. 2). To be a good communicator, it is also important to be an effective listener. Good listeners focus on what the student is saying without concentrating on what they are going to say next. Two-way communication leads to stronger relationships and trust in the classroom (Richardson, 2002). In addition, “A high-performing culture is ultimately about quality

relationships” (p. 2). *Relationships* are the corner stone of a classroom learning community and *trust* is the mortar that connects those relationships and allows transformational learning to occur (Meier, 2002; Tschannen-Moran, 2005).

*Discussion summary.*

Overall, both John and Rita acknowledged that their science fair participation and the relationship they developed with their science fair mentor influenced them in a positive academic way. Both students graduated from high school and are currently enrolled in post-secondary institutions. Rita will graduate with a four year science degree in the field of biochemistry. She is in the process of applying to pharmacy schools across the United States. I continue to maintain a mentor/mentee relationship with both students.

*Educational Recommendations*

As I was sorting individual statements from the interviews, two themes emerged that were barriers to learning, while four themes were centered around successful learning. The barriers to successful learning including racism and oppression, as well as by the importance of culture and family on identity formation, the student statements easily blended with the research into these sections. However, this same ease was not realized when analyzing transcript sections titled: (a) best practice in science education, (b) community and family support, (c) teacher leadership, and (d) motivation to learn. I found myself putting the same passages into each of these sections over and over again.

After contemplating the participants’ interviews, I found that for successful science learning to occur, meaningful relationships with teachers, parents and the community must all be woven into a tapestry of support for any *best practice* to have an

impact on successful learning, now and in the future. Science fair participation alone, without student choice and meaningful parental, community and teacher leadership will not have the impact it could have on life's learning opportunities.

After transcription of the interviews, background research, and an analysis of the data, the following themes emerged as having an effect on American Indian learning and academic achievement in high school and beyond:

1. The effects of racism and oppression result in creating incredible obstacles to successful learning
2. Positive identity formation and the importance of family and community are essential in student learning.
3. The use of best practice in science education, including the use of curricular cultural integration for American Indian learners, supports student success.
4. The motivational need for student-directed educational opportunities (science fair/inquiry based research) is evident.
5. Supportive teacher-student relationships in high school positively influence successful transitions into higher education

An overarching theme became apparent: the importance of understanding the continued resiliency of the American Indian culture as it relates to success.

Even though John and Rita were/are burdened with the reality of racism, on-going oppression and the struggle for a strong American Indian identity, their resiliency overcame many obstacles and allowed them to continue to be motivated to do science fair

projects. They both received public accolades for their science fair projects, while their school and tribal community celebrated, together, their successes. During their science fair experiences, as their mentor I developed close relationships with them. They both graduated from high school and were faced with the decisions all high school seniors face, “Will I go to college, where and for what?” For John, Rita and other American Indian students, making these difficult decisions can be even more difficult. Going *away* to college means “depriving Native students of the necessary and dependable support systems on which they rely” (Burk, 2007, p. 10).

I am a *white* teacher who continually works to help *all* students learn. Possibly, through community and administrative support, as well as teacher leadership, we can build the bridges that securely span the barriers of racism and identity confusion, allowing for a triumphant crossing into post-secondary success.

### *Conclusion*

After the first interview sessions I had with John and Rita, I was reading a section from *Ethics and the Foundations of Education* by Slattery and Rapp. Slattery and Rapp’s (2003) words impelled me to reflect on all the hardships racism and continued oppression have inflicted on John and Rita. Slattery and Rapp profess that “Bicultural people have to learn to make it in many different worlds. As they juggle with culture they become more complex and interesting people. The border lands offer many possibilities to remake themselves in ways that are preferable” (p. 79).

John and Rita lived on the reservation, but went to a public school. They had to cross these cultural borders every day. When I read this, I thought about how John and

Rita described the students who live and go to school on the reservation, not always in flattering ways. Most students attending the Tribal School are bicultural like John and Rita, but they do not often leave the reservation. Maybe John and Rita feel differently, and are *seen* as different because of all of the borders they had to cross. Maybe as Slattery and Rapp foretell, as they had to cross these borders they are "...becoming more complex and interesting people" (p. 79).

In order to understand how the hardships of racism and oppression can be turned inward leading to self transformations, I am going to use Rapp's analysis of life's *opportunities* by inserting John's and Rita's situation into his analysis. Whenever Rita and John have a sense an American Indian is oppressed, "it deeply rattles their soul." Perhaps being an American Indian man or woman who has experienced identity confusion, racism and oppression in their lives has less to do with the "grave reality of oppression and abuse" and more to do with "unleashing the hidden and mysterious intuitive fortitude that resides in each of us....It also has to do with helping others escape feelings of isolated entrapment and hopelessness by working to remove the psychic and social conditions in which they are bound" (Slattery & Rapp, 2003, p. 79). A past American Indian science fair participant spoke of this hope for the future, and how he saw change could occur and racism can end:

I want to figure out if there is a way to show people that what they say matters. Just as you should not call someone *white trash*, you should not be able to go up to an American Indian and call them a savage. It is like putting Native people in a separate classroom and bringing them down;



because they are not what you can be, they are different. When this happens we cannot be brothers or friends.

I want to work with the reservation; I know it is not just non-native kids saying this stuff. Native kids are saying it too. Even among Natives “you live on this part of the reservation; therefore I am better than you.” Because one person has a little bit more money, they are better than the other person is. That is not the way it should be. (Welsh, 2004, p. 30)

I found a prayer that helped an American Indian woman survive the racism she experienced as a professor in a mid-western college. When I read the words, they spoke to me of John’s and Rita’s anguish and hope for the future rooted in the harmony and balance we all seek: “Grandfather Great Mystery. On this day, have pity on me and help me. Make strong my heart and strengthen my mind and will” (Nunpa, 2003, p. 363).

I have come to realize the best educational motivational force to end racism and promote life long learning for all American Indian children comes from deep within our souls; where constant reflection is needed to propel us down the path we are on and have taken. It is a type of feedback that speaks a language free of bias. In order to choose a self-determined path, we must first know where the path originated and what we encountered along the way.

Telling John’s and Rita’s stories has given me an understanding of what it means to be an American Indian student trying to learn, while faced with identity confusion, a legacy of oppression and a lack of harmony and balance in life, an eschatological

foundation, where senseless oppression and hope for the future are irrevocably linked. A former science fair student commented on this struggle:

I want to see everyone on the same level; no one is different, even the mentally challenged. They may take longer to do the same thing you can do, but it is not different. You should not put them down by saying, “you were born with this therefore you cannot do this.” American Indians are just people and material things are not everything. If you give everyone enough time, everyone can do something. (Welsh, 2006, p. 32)

I have been a science teacher for 13 years. Every year, my students have done individualized science research projects, and if they chose, participated in science fair events. Originally, I wanted to understand the effects of science fair participation and the relationship I developed with my students on life-long learning, specifically for my American Indian students, but I have learned so much more from their inspiring stories. Stories have often been shown to be one of the most effective ways for many American Indian people to learn, “...it is through learning that we come to an understanding of ourselves, the world around us, and our relationship to everything in that world. Soliciting a person's story involves creating an opportunity to understand that person's life-experience as he or she understands it” (Garrett, 1996, p. 7).

Meyer (2003) reinforced the importance of telling one's story and then listening when she says, “If we sit still and listen, we will hear the truth in your own life. We will improve education by understanding that words are indeed part of the life force, and they

ordinate in thought. And thought is a process of education” (p. 8). John expressed his truth about his science fair experience, stating:

During my junior year, when I was working on my project with you, I liked what was going on then. I was ready to be more than the class clown; you pushed me to do that. You helped me stay focused. My grades went up and I had science fair. My whole attitude changed. If I had not decided to go to science fair I would have done just another dumb project like I did in 9<sup>th</sup> grade just to get by. Things changed for me and I was ready.

Rita expressed her truth about her science fair experience, stating:

I think students should do science fair because it is fun, a good experience, you learn a lot. It looks good if you plan on going to college. It helps you learn so much and helps you become prepared in different ways instead of just regular school. It keeps you focused on school and it gives you that positive feedback and rewards. Participating in science fair makes you feel special. Like if you were to go to the American Indian National Fair you would be really proud and happy when you get there because of what you have accomplished.

I mean science fair helped me so much. It is like, you cannot even say it. I have talked to you for three hours about it and that does not even say enough about what it has actually done for me, really. It was just such a positive experience, you taught me so much and gave me so much, my experiences, and memories I have of science fair. Now that I am going to

college, it helped me get into the college I am in. I wrote about science fair on my admissions stuff. So, all I can say is *that it is like a big part of everything*.

I hope that the relationships I formed with John, Rita and all of my students in the classroom, and the time allowed for science fair participation will help them *do something* that will make them proud of their efforts. I can never assume, but I can hope. I hope the science fair experience and the relationship developed will give them some important gifts to take on their life's journey. I hope that science fair participation has prepared them to always seek the *truth* in their lives, while understanding they may never truly find it. I hope my legacy as a teacher is that I am a small seed in their hearts, a seed placed in a garden from which a deep love of learning grows. I hope they reach for the stars, but are humble enough to remember they are a part of a community; a community that has always loved and supported them. I hope that when life seems the most difficult, they have a quiet place where *harmony and balance* can again surround them with enough comfort to face their daily lives. Initially through my eyes, and finally through their own, I hope they are able to unwrap and realize all of the amazing possibilities that reside within.

## Appendix A

### Consent Form

#### Making science education meaningful for American Indian students: The effect of science fair participation

You are invited to be in a research study of how American Indian student participation in American Indian Science and Engineering Society (AISES) science fairs and the relationship formed with their teacher/mentor affects the likelihood of continued education beyond high school. You were selected as a possible participant because this study is looking at past American Indian students that were mentored by the principal investigator of this study. You need to be in the final planning stages for a post high school experience and or have graduated from high school with post graduation plans or are already enrolled in a post high school educational setting. I ask that you read this form and ask any questions you may have before agreeing to be in the study.

This study is being conducted by: Cynthia Welsh, a doctoral candidate at the University of Minnesota Duluth, in Educational Policy and Administration.

#### Background Information

The purpose of this study is: to determine to what extent an American Indian student's participation in science fairs and the relationship formed with their teacher during the teaching and learning process affects the student's drive to continue learning beyond high school.

#### Procedures:

If you agree to be in this study, I will ask you to do the following things: You will be asked by the primary investigator if are willing to participate in this study. Participants will be asked to participate in three interviews approximately 2-3 hours long. You can refuse to participate and/or answer any interview questions and can stop at any time. All interview material will be locked in a cabinet at the primary investigators residence and will be kept confidential.

The primary investigator will also do a "search for artifacts" by collecting written or graphic materials available on your past science fair involvement. While all of the above methods are taking place, researcher introspective data will be collected. "In this manner, the ethnographer tries to account for sources of emergent interpretations, insights, feelings, and the reactive effects that occur as the work proceeds" (Eisenhart, 1988). An examination of interview transcripts, photos documenting past science fair participation and researcher field notes, will be used to "analyze events, find patterns, and create models from data" (Ellis, 2006, p. 27). These materials will also be locked in a cabinet at

the primary investigators residence and will be kept confidential. Research participants will be given a copy of interview transcripts, artifacts and researcher field notes upon request.

#### Risks and Benefits of being in the Study:

The study has several risks: First, during the open ended interview, participants may disclose personal or sensitive information. You will be reminded you can stop answering a question and can stop the interview at any time. Also, the participants can change their names if they choose.

The benefits to participation are: American Indian subjects will benefit from understanding how the relationship developed during the teaching and learning process of high school science fair research has impacted their current educational choices and may affect future educational choices. Participants will be given the transcript of their interviews upon request. These understandings or meaning makings may also benefit future American Indian Science Fair participants.

#### Confidentiality:

The records of this study will be kept private, and all participant materials will be kept in a locked cabinet at the researcher's home. In any sort of report we might publish, upon request, we will not include any information that will make it possible to identify a subject. Research records will be stored securely and only the primary investigator will have access to the records. Only the primary investigator will have access to tape recordings or videotapes. The tapes will be erased after three years.

#### Voluntary Nature of the Study:

Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with the University of Minnesota. If you decide to participate, you are free to not answer any question or withdraw at any time with out affecting those relationships.

#### Contacts and Questions:

The researcher conducting this study is Cynthia Welsh. You may ask any questions you have now. If you have questions later, you are encouraged to contact her at 4134 Jeffrey Road, Duluth, MN 55810, 218-729-7411, for the researcher's advisor, Dr. Mary Hermes at 11217 Blue Heron Lane, Hayward, WI 54843, 715-462-4230, mhermes@d.umn.edu

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher(s), you are encouraged to contact the Research

Subjects' Advocate Line, D528 Mayo, 420 Delaware St. Southeast, Minneapolis, Minnesota 55455; (612) 625-1650.

*You will be given a copy of this information to keep for your records.*

Statement of Consent:

I have read the above information. I have asked questions and have received answers. I consent to participate in the study.

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

Signature of Investigator: \_\_\_\_\_ Date: \_\_\_\_\_

Appendix B

Internal Review Board Approval Form

The IRB: Human Subjects Committee determined that the referenced study is exempt from review under federal guidelines 45 CFR Part 46.101(b) category #2 SURVEYS/INTERVIEWS; STANDARDIZED EDUCATIONAL TESTS; OBSERVATION OF PUBLIC BEHAVIOR.

Study Number: 0706E09561

Principal Investigator: Cynthia Welsh

Title(s): Making science education meaningful for American Indian students: The affect of science fair participation

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This e-mail confirmation is your official University of Minnesota RSPP notification of exemption from full committee review. You will not receive a hard copy or letter. This secure electronic notification between password protected authentications has been deemed by the University of Minnesota to constitute a legal signature.

The study number above is assigned to your research. That number and the title of your study must be used in all communication with the IRB office. Research that involves observation can be approved under this category without obtaining consent.

**SURVEY OR INTERVIEW RESEARCH APPROVED AS EXEMPT UNDER THIS CATEGORY IS LIMITED TO ADULT SUBJECTS.**

This exemption is valid for three years from the date of this correspondence. You will receive a notification requesting an update after three years, at which time you will have the opportunity to renew your study.

Upon receipt of this email, you may begin your research. If you have questions, please call the IRB office at (612) 626-5654.

You may go to the View Completed section of eResearch Central at <http://eresearch.umn.edu/> to view further details on your study.

The IRB wishes you success with this research.  
Stacia Madsen, Doctoral Degree Coordinator (612)625-0168; [gsdoc@umn.edu](mailto:gsdoc@umn.edu)



Appendix C

Interview Protocol

Interview 1-Centered around early science fair experiences

1. What influenced your decision to participate in science fair events?
4. Why did you originally chose the research topic of study?
5. What/who influenced the path your research took over the years?
6. In the community and professional scientific world, who assisted/influenced your continued participation in science fair?
7. What part did your science fair teacher play in your initial and continued participation in science fair events and research?

Interview 2-Centered around specific details regarding the teaching and learning process of scientific research and past science fair events.

1. During the first year you did a science inquiry, science fair project, what is your earliest significant memory?
2. What or who influenced your continued participation in conducting scientific research for science fair events?
3. How did your science fair teacher/mentor influence the progression of your science fair projects?
4. How did community/professional mentors influence your science fair research?
5. Thinking back on each year of science fair participation tell me a stories that stands out in your mind.

Interview 3- Centered around looking back and reflecting on the meaning of science fair participation in the participant's life tying this to the participants career goals.

1. Tell me about your career goals.
2. Think back to the stories you told me in the last interview. How has what happened in those stories, influenced your life?
3. What did you like the most about science fair participation and why?
4. What did you like the least and why?
5. In what ways has your relationship with your science fair mentor influenced your life?
6. What academic endeavors have you been participating in since you graduated from high school?
7. What are your future educational plans?
8. What part did science fair participation have in your past, current and future educational plans.
9. What role has your science fair mentor played in your past, current and future educational plans.

*References*

- Alexander, G. E. (2008, May). *How does participation in science fair affect student performance in a science classroom?* Paper presented at the Intel International Science and Engineering Fair, Atlanta, GA.
- Allen, N. (1999). Native American schools move into the new millennium. *Educational Leadership, 56*(7), 71-74.
- Allen, N., & Crawley, F. (1998). Voices from the bridge: Worldview conflicts of Kickapoo students of science. *Journal of Research in Science Teaching, 35*(2), 111-132.
- Ambler, M. (1991). Indian energies devoted to self-sufficiency. *National Forum, 71*(2), ¶1. Retrieved December 10, 2006, from Academic Search Premier database.
- American Indian Science and Engineering Society (2005). *Mission*. Retrieved October 22, 2005, from [www.aises.org/](http://www.aises.org/)
- American Association for the Advancement to Science. (1989). *Science for all Americans*. Washington, DC.
- Argon, S. (2002). An investigation of factors influencing classroom motivation for postsecondary American Indian/Alaska Native students. *International Journal of Instructional Media, 41*(1), 1-18.
- Argon, S. (2004). Learning and study practices of postsecondary American Indian/Alaskan Native students. *Journal of American Indian Education, 43*(2), 1-18.
- Aune, B., & Weber, M. (2007). *Systemic STEM school redesign: Grant application*

*materials*. Retrieved November 20, 2007, from MN Department of Education

Web site: <http://www.education.state.mn.us/>

- Barlow, A., & Villarejo, M. (2004). Making a difference for minorities: Evaluation of an educational enrichment program. *Journal of Research in Science Teaching*, 1-21.
- Barron, K. E., & Harackiewicz, J. M. (2001). Achievement goals and optimal motivation testing multiple goal models. *Journal of Personality and Social Psychology*, 80(5), 706-722.
- Barth, L. (2007). A revamped science expo. *Science and Children*, 45(4), 36-37.
- Bartholomew, B. (2007). Why we can't always get what we want. *Phi Delta Kappan*, 88(8), 593-598.
- Bayer Facts of Science Education (1997). *Female scientists face more career difficulties, more negative influences than men*. Retrieved October 2, 2002, from <http://www.bayerus.com/msms/news/index>
- Bayer Facts of Science Education (1998). *Key questions from the Bayer facts of science surveys*. Retrieved October 2, 2002, from <http://www.bayerus.com/msms/news/index>
- Beaulieu, D. (2000). Comprehensive reform and American Indian education. *Journal of American Indian Education*, 39(2), 29-38.
- Bergstrom, A., Cleary, L. M., & Peacock, T. (2003). The seventh generation: Native students speak about finding the good path. Charleston, WV: Clearinghouse on Rural Education and Small Schools (ERIC).
- Bizzaro, R. C. (2004). Shooting our last arrow: Developing a rhetoric of identity for

unenrolled American Indians. *College English*, 67(1), 61-75.

Bloom, J. (1996). "Show what an Indian can do": Sports, memory, and ethnic identity at Federal Indian boarding schools. *Journal of American Indian Education*, 35, 33-48.

Boss, S. (2003). Journey to understanding: Lessons from a canoe curriculum. *Northwest Teacher: A Publication of the Northwest Eisenhower Regional Consortium for Mathematics and Science*, 4(2), 6-10.

Bracey, G. W. (2008). Research—Assessing NCLB. *Phi Delta Kappan*, 89(10), 781-782.

Brainwashing and boarding schools: Undoing the shameful legacy. (2004). Retrieved October 10, 2004, from

[www.kporterfield.com/aicctw/articles/boardingschool.html](http://www.kporterfield.com/aicctw/articles/boardingschool.html)

Bronwynne, E. C. (2005). Content validation of instruments: Are the perspectives of Anglo reviews different from those of Hispanic/Latino and American Indian reviewers? *Journal of Nursing Education*, 44(5), 216-224.

Brooks, J. G., Libresco, A. S., & Plonczak, I. (2007). Spaces of liberty: Battling the new soft bigotry of NCLB. *Phi Delta Kappan*, 88(10), 749-780.

Bryk, A. S., & Schneider, B. (2002). *Trust in schools: A core resource for improvement*. New York: Russell Sage Foundation.

Bull, T. (2006). Preserving our histories for those yet to be born. *Phi Delta Kappan*, 88(3), 192.

- Bureau of Indian Affairs. (2006a, April 21). *American Indian Content Standards in Science*. Retrieved December 15, 2006, from the Center for Educational Technology in Indian America Web site: <http://www.Idoe.org/cetia/science.htm/>
- Bureau of Indian Affairs. (2006b, April 21). *American Indian Content Standards in Technology*. Retrieved December 15, 2006, from the Center for Educational Technology in Indian America Web site: <http://www.Idoe.org/cetia/technology.htm/>
- Burk, N. M. (2007). Conceptualizing American Indian/Alaska Native college students' classroom experiences: Negotiation of cultural identity between faculty and students. *Journal of American Indian Education, 46*(2), 1-18.
- Burrell, G., & Morgan, G. (1979). *Sociological Paradigms and Organization Analysis*. Exeter, NH: Heinemann.
- Cajete, G. (1988). *Motivating American Indian students in science and math*. (Eric Digest Document Reproduction Service No. ED296812).
- Carlone, H. (2004). The cultural production of science in reform-based physics: Girls' access, participation, and resistance. *Journal of Research in Science Teaching, 41*(4), 392-414.
- Castagno, A. (2005). Extending the bounds of race and racism: Indigenous women and the persistence of the black—white paradigm of race. *The Urban Review, 37*(5), 447-468.
- Cavanagh, S. (2004). NCLB could alter science teaching. *Education Week, 24*(11), 1-12. Retrieved July 29, 2008, from EBSCO MegaFILE database.

- Chenoweth, K. (1999). Expanding the top tier. *Black Issues in Higher Education*, 16(19), 16-17.
- Church, M. A., Elliot, A. J., & Gable, S. L. (2001). Perceptions of classroom environment, achievement goals, and achievement outcomes. *Journal of Educational Psychology*, 93(1), 43-54.
- Cleary, L. M., & Peacock, T. (1997). Disseminating American Indian educational research through stories: A case against academic discourse. *Journal of American Indian Education*, 37(1)
- Cleary, L. M., & Peacock, T. (1998). *Collected wisdom: American Indian education*. Needham Heights, MA: Allyn & Bacon.
- Clement, D., Eisenhart, M., & Harding, J. (1979). The veneer of harmony: Social-race relations in a southern desegregated school. In R. Rist (Ed.), *Desegregated schools: Appraisals of an American experiment* (15-64). New York: Academic Press.
- Cohen, D., Raudenbush, S., & Ball, D. (2003). Resources, instruction, and research. *Educational Evaluation and Policy Analysis*, 25(2), 119-142.
- Cresswell, J. (1998). *Qualitative inquiry and research design: Choosing among five traditions*. Oaks, CA: Sage.
- Davidson, A. B., & Sterling, D. R. (1998). From science fair to interdisciplinary inquiry. *Schools in the Middle*, 8(3), 17-19.
- Davis, J. (2001). American Indian boarding school experiences: Recent studies from Native perspectives. *OAH Magazine of History*, 15(2), 20-22.

- DeBoer, G. E. (2000). Scientific literacy: Another look at its history and contemporary meanings and its relationship to science education reform. *Journal of Research and Science Teaching*, 37(6), 582-601.
- Dewey, J. (1934). *Art as experience*. New York: Perigee.
- Dewey, J. (1948). *Reconstruction in philosophy*. Boston: Beacon Press.
- Dickinson, G. K. (2006). The spirit of inquiry in information literacy. *Teacher Librarian*, 34(2), 23-27.
- Eisenhart, M. (1988). The ethnographic research tradition and mathematics education. *Journal for Research in Mathematics Education*, 19, 99-114.
- Eisenhart, M. (2001a). Changing conceptions of culture and ethnographic methodology: Recent thematic shifts and their implications for research on teaching. In V. Richardson (Ed.), *Handbook of research on teaching*, (4<sup>th</sup> ed., pp. 209-225). Washington, DC: American Educational Research Association.
- Eisenhart, M. (2001b). Educational ethnography past, present and future: Ideas to think with. *Educational Researcher*, 30(8), 16-27.
- Eisenhart, M. (2005). Hammers and saws for the improvement of educational research. *Educational Theory*, 55(3), 245-255.
- Eisenhart, M., & Edwards, L. (2004). Red-eared sliders and neighborhood dogs: Creating third spaces to support ethnic girls' interest in technology and scientific expertise. *Children, Youth and Environments*, 14(2), 156-177.
- Ellinor, L., & Gerard, G. (1998). *Dialogue: Rediscovering the transforming power of conversation*. New York: John Wiley & Sons.



- Elliot, A. J., & McGregor, H. A. (2001). A 2 x 2 achievement goal framework. *Journal of Personality & Social Psychology*, 80(3), 501-519.
- Ellis, C. (2003). *The Ethnographic I: A Methodological Novel about Auto-Ethnography*. Walnut Creek, CA: AltaMira Press.
- Farkas, G. (2003). Racial disparities and discrimination in education: What do we know, how do we know it and what do we need to know? *Teachers College Record*, 105(6), 1119-1146.
- Farver, J. A., Bakhtawar, Y. X., Bhadha, R., & Lieber, N. E. (2007). Ethnic identity, acculturation, parenting beliefs, and adolescent adjustment. *Merrill-Palmer Quarterly*, 5(2), 184-215.
- Finkel, E. (2005). Native American identity and learning. *Inquiry*, 10-13.
- First, P. (2004). NCLB & the role of the school district superintendent. *J Law Educ*, 33(3), 341-342.
- Fischman, G. E. (2001). Reflections about images, visual culture, and educational research. *Educational Researcher*, 28-33.
- Fleming, W. C. (2006). Myths and stereotypes about Native Americans. *Phi Delta Kappan*, 88(3), 213-216.
- Fox, E. (2006). A tribal college perspective. *Phi Delta Kappan*, 88(3), 208-211.
- Friere, P. (1970). *Pedagogy of the oppressed*. New York: Continuum.
- Friedman, T. (2005). *The world is flat*. New York: Douglas & McIntyre Ltd.
- Grande, S. (2004). *Red pedagogy: Native American social and political thought*. Lanham, MD: Roman & Littlefield.

Garrett, M. T. (1996). "Two People": An American Indian narrative of bicultural identity.

*Journal of American Indian Education, 36*, 1-21.

Garson, D. G. (2008). Ethnographic research. *North Carolina State University*.

Retrieved June 20, 2008 from

<http://www2.chass.ncsu.edu/garson/PA765/ethno.htm>

Glidden, M. (personal communication, 2008, July 29). *59<sup>th</sup> International Science and Engineering Fair Vital Statistics*.

Hegel, G. W. F. (1977). *Phenomenology of spirit*. (T. M. Knox, Tans.) New York: Harper Torch Books.

Hill, N. (1991) A college intervention program that works. *Change, 23*(2), 24.

Hollowell, M., & Jeffries, R. (2004). Worldviews of urban Iroquois faculty: A case study of a Native American resource program. *American Indian Quarterly, 28*(3&4), 764-785.

Hopwood, N. (2004). Research design and methods of data collection and analysis: Researching students' conceptions in a multiple-method study. *Journal of Geography in Higher Education, 28*(2), 347-353.

Horse, P. G. (2005). Native American identity. *New Directions for Student Services, 109*, 61-68.

House, J. (2001). Predictive relationships between self-beliefs and mathematics achievement of American Indian/Alaska Native students. *International Journal of Instructional Media, 28*(3), 287-297.

House, J. (2003). A longitudinal assessment of cognitive-motivational predictors of the

Grade performance of American Indian/Alaska Native students. *International Journal of Instructional media*, 30(3), 303-314.

Houston, P. D. (2007). The seven deadly sins of No Child Left Behind. *Phi Delta Kappan*, 88(10), 744-748.

Huziak-Clark, T., Van Hook, S. J., Nurnberger-Haag, J., & Ballone-Duran, L. (2007). Using inquiry to improve pedagogy through K-12/university partnerships. *School Science and Math*, 107(8), p. 311-324.

Indian Nations at Risk Task Force. (1991, October). Indian nations at risk: An educational strategy for action (Final report). *Washington, DC: U.S. Department of Education*.

Jackson, R. L. (2004). Cultural contracts theory: Toward a critical-rhetorical identity negotiation paradigm. In P. Sullivan & S. Goldzwig (Eds.), *New approaches to rhetoric* (pp. 89-108). Thousand Oaks, CA: Sage Publications, Inc.

Jegede, O. & Aikenhead, G. (1999). Transcending cultural borders: implications for science teaching. *Research in Science & Technological Education*, 17(1), 45-65.

InterAcademy Council. (2006). *Women for science: Advisory Report: Executive Summary*. (Report No. 90-6984-492-3). Amsterdam, The Netherlands.

Kelly, M. (1999, April 28). American Indian boarding schools: 'That hurt never goes away' *Associated Press*. Retrieved October 9, 2002 from [www.canoe.ca/CNEWSFeatures9904/28\\_indians.html](http://www.canoe.ca/CNEWSFeatures9904/28_indians.html)

Klein, A. (2008). Kennedy's illness raises doubts for NCLB. *Education Week*, 27(41), 17-19.

- Kopp, W. (2008). Building the movement to end educational inequity. *Phi Delta Kappan*, 89(10), 734-736.
- LaFromboise, T. D., Coleman, H. L. K., & Gerton, J. (1993). Psychological impact of biculturalism: Evidence and theory. *Psychological Bulletin*, 114(3), 395-412.
- Lee, J. (2004). How feasible is adequate yearly progress (AYP)? Simulations of school AYP “uniform averaging” and “safe harbor” under the No Child Left Behind Act. *Educational Policy Analysis Archives*. 14(12). Retrieved April 20, 2005 from <http://epaa.asu.edu/epaa/v12n14>
- Levinson, B. A., Foley, D. E., & Holland, D. C. (Eds.), (1996). *The cultural production of the educated person: Critical ethnographies of schooling and local practice*. NY: New York Press.
- Lewis, M., & Ippen, C. (2004). Rainbows of tears, souls full of hope: Cultural issues related to young children and trauma. In Osofsky, J. (Eds.), *Young children and trauma: Intervention and treatment* (pp. 11-43). New York: Guilford Publications.
- Manley, J. (2008). Let’s fight for inquiry science. *Science and Children*, 45(8), 36-38.
- Martusewicz, R. A. & Reynolds, W. M. (Eds.). (1994). *Inside out: Contemporary critical perspectives in education*. New York: St. Martin’s Press.
- Marzano, R. J. (2003). *What works in schools: Translating research into action*. Alexandria, VA: Association for Supervision and Curriculum Development.
- Marzano, R. J., Waters, T. & McNulty, B. A. (2005). *School leadership that works*. Aurora, CO: Mid-continent Research for Educational Learning (McREL).

- McNamee S. J. & Miller, R. K. (2004). The meritocracy myth. *Sociation Today*, 2(1).
- Meier, D. (2002). *In school we trust: Creating communities of learning in an era of testing and standardization*. Boston, MA: Beacon Press.
- Meyer, M. A. (2003). *Ho'oulu: Hawaiian epistemology and early writings*. Honolulu, HI: 'Ai Pohaku Press Native Books.
- Miller, R., & Osborne, J. (1998). Beyond 2000: Science education for the future. *Beyond 2000, Closed Seminar*. Retrieved October 4, 2002, from <http://www.kcl.ac.uk/education>
- Minnesota Department of Education. (2004) *K-12 Education Finance Overview—2004-2005*. St. Paul, MN: K-12 Educational Finance.
- Minnesota Department of Children, Families & Learning (2000). *Minnesota's high standards, 1*, 1-4.
- Moore, S. (1962). Science interest peaks at age 12. *Science Newsletter*, 82, 178.
- Moore, D. (2004). No child left behind: The good, the bad, and the ugly. *American Annals of the Deaf*, 148(5), 347-348.
- Mosley, C., & Ramsey, S. J. (2007). Elementary teacher progressive understanding of inquiry through the process of reflection. *School Science and Mathematic*, 108(2), p.49-57.
- National Academy of Sciences, National Academy of Engineering, & Institute of Medicine of the National Academies: Executive Summary. (2006). *Rising above the gathering storm: Energizing and employing America for a brighter economic future*.

- National Research Council. (1996). *National science education standards*. Washington, DC: National Academy Press.
- Ness, J., Bequette, J. & Olson, D. (2007, October). *Early data on Project Intersect: Improving student achievement through the integration of American Indian arts into math, science, and language arts education*. Paper presented at the meeting of Project Intersect, Cloquet, MN.
- Noel, J. (2002). Education toward cultural shame: A century of Native American education. *Educational Foundations*, 45(1), 19-32.
- Nupa, C. (2003). Native faculty, higher education, racism and survival. *American Indian Quarterly*, 27(1 & 2), 349-364.
- Osborne, J. (2003). Attitudes towards science: a review of the literature and its implications. *International Journal of Science Education*, 25(9), 1049-1079.
- Pheterson, G. (1986). Alliances between women: Overcoming internalized oppression and internalized domination. *Journal of Women in Culture and Society*, 12(1), 146-160.
- Pine, J., Aschbacher, E. R., Roth, E., Jones, M., McPhee, C. M., Martin, C. et al. (2006). Fifth graders' science inquiry abilities: A comparative study of students in hands-on and textbook curricula. *Journal of Research in Science Teaching*, 43(5), 467-484.
- Poupart, L. M. (2003). The familiar face of genocide: Internalized oppression among American Indians. *Hypatia*, 18(2), 86-102.

Richardson, J. (2002). Listen carefully: Good communication skills build relationships that foster school improvement. *National Staff Development Council: Tools for Schools*.

Richau, D. (1981). *Introduce science to students using the environment: A guide for teachers of Native American students*. Bowie, MD: Pre-college Teacher Development Programs at Northern University and University of South Dakota.

Rose, L. (2004). No child left behind. The mathematics of guaranteed failure. *Educational Horizons*, 82(2), 121-130.

Sanchez, I. (2000). Motivating and maximizing learning in minority classrooms. *New Directions for Community Colleges*, 112, 35-44.

Shelby, C. C. (2006). What makes science? A modern look at scientific inquiry. *Journal of College Science Teaching*, 35(7), 8-11.

Siebert, A. (1996). *Life is not fair and that can be very good for you*. Berkeley, CA: Perigee.

Silas, P. (2008). Mission: Success. *Albuquerque, NE 2008 National American Indian Science & Engineering Fair: Annual 21<sup>st</sup>*. (1-18). American Indian Science & Engineering Society.

Slattery & Rapp. (2003). *Ethics and the foundations of education*. Boston, MA: Allyn and Bacon.

Society for Science and the Public. (2008, May). *Intel International Science and Engineering Fair*. Retrieved July 30, 2008, from <http://www.societyforscience.org/isef>

- Sparks, D. (2006). Appear to the heart as well as the head. *Tools for Schools: National Staff Development Council*, 9(4), 1-2.
- Starnes, B. A. (2006a). Montana's Indian education for all: Toward an education worthy of American ideals. *Phi Delta Kappan*, 88(3), 184-192.
- Starnes, B. A. (2006b). What we don't know can hurt them: White teachers, Indian children. *Phi Delta Kappan*, 384-392.
- Stephans, S. (2003). *Handbook for culturally responsible science curriculum* (2<sup>nd</sup> ed.). Fairbanks, AK: Alaska Native Knowledge Network.
- Stokes, S. (1997). Curriculum of Native American students: Using Native American values. *The Reading Teacher*, 50, 576-584.
- Sunderman, G. L., & Orfield, G. (2008). Do states have the capacity to meet the NCLB mandates? *Phi Delta Kappan*, 89(2), 137-139.
- Taylor, F. (1916). The principles of scientific management. In *Classics of Organizations Theory Bulletin of the Taylor Society. Organizational Theory* (5<sup>th</sup> ed.). (pp. 61-72). USA: Wadsworth.
- Tschannen-Moran, M. (2004). *Trust matters: Leadership for successful schools*. San Francisco, CA: Jossey-Bass.
- Valentine & Cooper. (2005). Scaling the quality of causal research in education. In G. D. Phye & D. H. Robinson, & Levin (Eds.), *Empirical methods for evaluating educational interventions*. San Diego, CA: Academic Press.
- Warren, W. Z. (2006). One teacher's story: Creating a new future or living up to our own history? *Phi Delta Kappan*, 88(3), 198-203.



- Wakshul, B. (2005). A native perspective on contemporary technology—an interview with Daniel Wildcat. *Winds of Change-American Indian Education & Opportunity*, 20(3), 40-42.
- Weeks, D., & Stepanek, J. (2003). Editors' note: Beginning the conversation. *Northwest Teacher: A Publication of the Northwest Eisenhower Regional Consortium for Mathematics and Science*, 4(2), 1.
- Welsh, C. A. (2004). *An exploration of American Indian educational support: American Indian students' use of the American Indian education room*, Unpublished manuscript, University of Minnesota Northern Cohort, EdPa 5056.
- Welsh, C. A. (2006). *A Phenomenological exploration of an American Indian student's perception of Racism, oppression and the impact it has on his life—School, home and community*. Unpublished manuscript, University of Minnesota Northern Cohort, EdPa 5056.
- Wilder, L., Jackson, A., & Smith, T. (2001). Secondary transitions of multicultural learners: Lessons from the Navajo Native American experience. *Preventing School Failure*, 45(3), 119-124.
- Wilson, J. D., Cordry, S., & Uline, C. (2004). Science fairs: Promoting positive attitudes towards science from student participation. *College Street Journal*, 38(1), 112-114. Retrieved July 29, 2008, from SPORTDisc with Full Text database.

- Wolters, C. A. (2004). Advancing achievement goal theory using goal structures and goal orientations to predict student motivation, cognition, and achievement. *Journal of Educational Psychology, 96*(2), 236-250.
- Woods, B. (1999) *US workforce needs to gear up for tech future*. Retrieved October 9, 2002, from <http://www.newsbytes.com>
- Yasar, S. & Baker, D. (2003). *The impact of involvement in a science fair on seventh grade students* (NARST Poster Session). Philadelphia, PA: Annual Meeting of the National Association for Research in Science Teaching. (ERIC Document Reproduction Service No. 200495)
- Yecke, C. P. (2005a). Efficiency and effectiveness in Minnesota school districts: How do districts compare? *Center for the American Experiment*. Retrieved August 11, 2005, from <http://www.amexp.org/Publications/Archives/Yecke/Yecke071405.htm>
- Yecke, C. P. (2005b, July 14). Meet the needs of all kids. *St. Paul Pioneer Press*. Retrieved August 11, 2005, from <http://www.amexp.org/Publications/Archives/Yecke/Yecke071405.htm>.
- Yellow Bird, M. (1999). What we want to be called: Indigenous people's perspectives on racial and ethnic identity labels. *American Indian Quarterly, 23*(2), 1-21.
- York-Barr, J., & Duke, K. (2004). What do we know about teacher leadership? Findings from two decades of scholarship. *Review of Educational Research, 74*(3), 255-316.
- York-Barr, J. (2006). Class Syllabus for Educational Leadership Practice in Context.

*University of Minnesota EdPA 5364.* Mpls, MN.

Zemelman, S., Daniels, H., & Hyde, A. (1998). *Best practice: New standards for teaching and learning in America's schools (2<sup>nd</sup> ed.)*. Portsmouth, NH.

Heinemann.

Zinn, H. (1980). *The people's history of the United States*. New York: Harper & Row.