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Student science achievement and the integration of indigenous knowledge in the classroom and on standardized tests

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Abstract
In science education, there has been little research focused on indigenous students' achievement on science standardized tests when indigenous knowledge is integrated into the test questions. However, there has been an increased amount of research investigating the impact of culturally relevant curriculum adaptations on indigenous students' achievement in standardized assessments (Aikenhead, 1997, 2001b; Barnhardt, 2005b).

This dissertation examines the achievement gap that is present between American Indian and White students in Montana. I use data from Montana eighth-grade standardized state science tests to determine whether incorporating indigenous material into classrooms and on state standardized science tests supported these initiatives and whether expected outcomes, such as a decrease in the achievement gap and an increase in Native student test scores, are being generated.

Using a quantitative methodology, this study focuses on how American Indian students in Montana perform on standardized state science assessments when knowledge from a cultural curriculum, "Indian Education for All," has been included on the tests. Montana is the first state in the United States to use a culturally relevant curriculum in all schools and to create standardized test items based on this curriculum. This study compares White and American Indian students' test scores on these particular test items and overall test scores to determine the effectiveness of the culturally relevant educational initiatives implemented by Montana's Office of Public Instruction in terms of student achievement on state standardized tests. Results of this study uncover the persistence of an achievement gap, with Native students still underperforming when compared to their majority counterparts. American Indian students continue to score at the "nearing proficiency" level, which is one level lower than White students are scoring, at the proficient level. When scores are investigated for items written based on cultural standards, American Indian students tend to answer these items correctly a greater percentage of the time than they do other items; yet White students are answering these culture-specific items correctly a greater percentage of the time than are American Indian students. Understanding the connections between student achievement and an adapted, culturally relevant science curriculum brings valuable insights to the fields of science education, research on student assessments, and indigenous studies.

Implications of the study are reflected in recommendations for (1) integrating culturally relevant test items in greater number on standardized science tests; (2) encouraging greater participation of community members in education; (3) encouraging greater participation of Native individuals in the test construction process; and (4) attending to the frequency of and teaching methodologies for implementing the "Indian Education for All" curriculum.

Keywords
Education, Sciences, Education, Multilingual, Native American Studies

This dissertation is available at University of New Hampshire Scholars' Repository: https://scholars.unh.edu/dissertation/684
STUDENT SCIENCE ACHIEVEMENT AND THE INTEGRATION OF INDIGENOUS KNOWLEDGE IN THE CLASSROOM AND ON STANDARDIZED TESTS

BY

JULIANN BENSON

BS, University of Vermont, 2002
MEd, University of Vermont, 2004

DISSERTATION

Submitted to the University of New Hampshire
in Partial Fulfillment of
the Requirements for the Degree of

Doctor of Philosophy

in

Education

December 2012
This dissertation has been examined and approved.

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James Vincenti, Ph.D.
DEDICATION

To my grandfather:

For always supporting and encouraging my educational pursuits and knowing that I "would make a good teacher."
ACKNOWLEDGMENTS

My dissertation would not have been possible without the help, support, and guidance of many individuals. Their ideas have contributed greatly to my growth both academically and personally. Their influences will undoubtedly have a lasting impact on my thoughts and interests as I continue my research and career.

My work with both Eleanor Abrams and Michael Middleton focusing on indigenous students and their ideas of science have been integral in helping me to formulate my interests in the vast world of science education. The experiences that I have shared with them both have been instrumental in my understandings of how science plays such a colonizing role in education for many students who are not of the majority culture. This work has sensitized me to the lens through which science is viewed for non-majority cultures and the vast amount of research and work that must be done to help create a more equitable educational system. Without the consultation provided by both Eleanor and Mike, my research would not be as rich with ideas and suggestions for future work.

Suzanne Graham provided me with invaluable guidance as I worked through all of my data in a state of confusion. She gave me a sense of focus and understanding of what it was I was investigating and setting out to accomplish. Her guidance and input were critical to the success of this study.
Cultural knowledge and sensitivity were provided by Carmelita Lamb, who was an integral part of my committee, providing insight and knowledge that was significant to my study. Being able to discuss the achievement gap with someone who works with American Indian students on a daily basis has provided me with a helpful context in which to situate my research. 

Experiencing and gaining knowledge about the world of testing and item response theory with James Vincenti was one of the major elements of the foundation for my research. Without access to individuals and data from the state standardized tests, this study would not exist. 

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ABSTRACT

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construction process; and (4) attending to the frequency of and teaching methodologies for implementing the "Indian Education for All" curriculum.
CHAPTER 1

INTRODUCTION

Since the 1800s and the time of American Indian boarding schools, there has been a history of poor academic performance on the part of indigenous students: Indigenous students historically score lower on standardized science tests (Cajete, 1988; Deyhle, 1983; Fuchs & Havighurst, 1973). The 2000 Programme for International Student Assessment (PISA) science test results, as reported by the Canadian Council on Learning (CCL, 2007) showed that Canadian Aboriginal students scored significantly lower on standardized tests than their non-Aboriginal counterparts both domestically and internationally; the mean score for Aboriginal students was 489, whereas the non-Aboriginal student mean score was 531 (CCL, 2007). In the United States, indigenous students—specifically American Indians and Alaska Natives—in a study of 2000, 2002, and 2003 reading and mathematics National Assessment of Educational Progress (NAEP) data, were more than twice as likely as their non-Native peers to score at the lowest level on the NAEP reading assessment and almost three times as likely to

---

1 Long-term trend (LTT) assessments were administered every four years and a variation of the National Assessment of Educational Progress (NAEP) was administered every two years (National Center for Education Statistics, 2010).

2 PISA is an internationally standardized assessment that was jointly developed by participating governments and administered to 15-year-olds in schools. Four assessments have been carried out to date (in 2000, 2003, 2006, and 2009).
score at the lowest level on the NAEP assessment for mathematics (Freeman & Fox, 2005). This poor performance is now reflected also in test scores from recently implemented state standardized science tests and in NAEP science scores (National Center for Education Statistics, 2011a). For example, in the 2005 NAEP science section, 4th-grade American Indians/Alaska Natives scored 138 out of 300, whereas their White counterparts scored 162 out of 300, with similar trends exhibited in both the 8th and 12th grades.

Schools, administrators, and teachers are important variables in the perpetuation of failing test scores owing to the act of "teaching to the test," a test that includes items of an entitled nature. Educators play integral roles in diminishing the achievement gap that is present between White students and American Indian students in the United States. The gap in achievement between majority and indigenous students across the globe is substantial when scores of national and international tests are examined (CCL, 2007; National Center for Education Statistics, 2010b). The increased focus on instruction aimed at preparing students for standardized tests in their current state (with no attention paid to addressing Native understandings) may work to increase this gap rather than providing for more equitable education for all students (Au, 2007; Hursh, 2001). Indigenous students' inability to perform as well as their White counterparts may be a contributing factor in their higher dropout rate. An article written by the National Conference of State Legislatures (2008) that focused on helping Native American students to succeed reported a much higher dropout rate for American Indian students than for their White peers. American Indians
were 117% more likely to drop out of school, a rate that has increased from the approximately 77% national dropout rate in the late 1960s.

That tests are being developed using state and national science standards based on the majority ideas of Western modern science (WMS) that do not include Native American knowledge introduces an inherent disadvantage for indigenous students who may have been brought up to understand science and scientific reasoning in a very different way (Barnhardt & Kawagley, 2005; CCL, 2007). WMS differs from Native traditional ecological knowledge in that WMS focuses on producing knowledge through making observations of phenomena and inventing theories to make sense of the observations (American Association for the Advancement of Science [AAAS], 1990), while Native knowledge is focused more on producing knowledge for cultural outcomes to maintain civilization (International Council for Science [ICSU], 2002).

To increase test scores, such researchers of Native knowledge and practices as Aikenhead (2001b) and Barnhardt, Kawagley, and Hill (2000) have been working to modify the curriculum to align indigenous knowledge with state and national science standards. With the incorporation of indigenous knowledge in the state standards, teachers must be held accountable to actually teach these standards. Furthermore, the incorporation of Native knowledge in test items is vital to the success of indigenous students. The inclusion of this knowledge in standardized test items is the keystone to ensuring that the Native ways of thinking and knowing are taught to all students rather than being ignored because such material is not on the test and there is no time to teach it. In
including indigenous knowledge in test items, great care must be taken by the item developers to ensure fairness and decrease bias that may be exhibited in any portion of the test item.

Though Alaska, Montana, and Canada have worked to include indigenous knowledge in the curriculum (Aikenhead, 1997, 2001b; Barnhardt, 2005b), currently only Montana has made changes in the content of standardized state science exams. Examination of the studies available in the realm of indigenous science and standardized testing reveals that, although gains have been made in standardized science test scores on the part of indigenous students (Barnhardt, Kawagley & Hill, 2000), the gap between these Native students and their non-Native majority counterparts still exists (CCL, 2007). This dissertation seeks to investigate the degree of success, specifically the performance of American Indians on Native-based test items, that implementation of standardized tests items involving indigenous knowledge in science has had on standardized test scores. While this investigation may result in findings that indigenous students are reportedly scoring higher on these tests, this may not indicate that there is a difference in the achievement gap due to the possibility of White students continuing to achieve higher performance levels than Indigenous students.

A single new initiative has recently been put forth in the state of Montana incorporating an indigenous-based curriculum that teaches all students across the state about the history and contributions of the American Indian nations in the state. The incorporation of Native knowledge in the classroom is currently being combined with the inclusion of items on the state standardized tests that are
drawn from Montana's Native curriculum. This new initiative is changing the face of the Montana testing world and may help to level the playing field for both indigenous and non-indigenous students.

In addition, Montana has initiated a new approach to Native knowledge learning and understanding for K–12 students. Montana's educators have created an American Indian curriculum that incorporates information about all 12 of their American Indian nations\(^3\) and is matched to the state standards and the *Essential Understandings Regarding Montana Indians* (see Appendix B). The intention is to teach this curriculum, entitled “Indian Education for All” (Montana Office of Public Instruction [Montana OPI], 2006a), to every student in the state of Montana to create a state of enculturation.

According to Grusec and Hastings (2007), *enculturation* is the process by which a person learns the requirements of the culture that surrounds him or her and acquires values and behaviors that are appropriate or necessary in surrounding culture(s). Both White and American Indian students in Montana are responsible for learning about the 12 Montana nations. Usually, it is the minority culture that has to assimilate the majority's understanding of a given topic (Kawagley & Barnhardt, 1998). With enculturation, everyone is on the same level, having to learn the same information at the same time. The only possible advantage to some students would be when tribal members learn specifically about their home tribe.

\(^3\) Montana's 12 American Indian nations are the Salish, Kootenai, Pend d' Oreille, Blackfeet, Chippewa-Cree, Gros Ventre, Assiniboine-Fort Belknap, Sioux, Assiniboine-Fort Peck, Northern Cheyenne, Crow, and the Little Shell Chippewa.
K–12 students learn Native knowledge as established by the "Indian Education for All" curriculum (Montana OPI, 2006a) and apply what they have learned on the state standardized assessments. The philosophy of the curriculum is to "promote the use of Indian literature as an instructional tool" (p. 1). Pieces of literature that have been written or reviewed by American Indians can be used to supplement regular textbooks and help teach state standards as well as provide knowledge about American Indian people and their views in regard to academic content. The Montana OPI believes that "every Montanan, whether Indian or non-Indian, [should] be encouraged to learn about the distinct and unique heritage of American Indians in a culturally responsive manner" (Montana OPI, 2006a).

It is important to understand the effect that the inclusion of items based on Native knowledge has had on indigenous and non-indigenous student populations because, if indigenous students perform better on the specific items addressing Native ways of knowing, then it may be in the states' and students' best interests to increase the number of these test items to improve American Indians' overall test scores and work toward closing the achievement gap. This may help the U.S. educational system achieve more equitable education for all students, regardless of cultural heritage.

**Statement and Significance of the Research**

While the achievement gap is not exclusive to the area of science alone but is sustained across all disciplines, it is a widely researched fact that science is the gateway to higher-level courses in all other subject areas, therefore leading to what is deemed "success" by majority individuals (Carter & Brickhouse, 1989;
Science, while evolving to meet the needs of the times, has remained relatively unchanged since its conception by White majority male figures (Aikenhead & Ogawa, 2007; Orange, 1981), thus being dominated by the majority knowledge and maintaining a sort of elite status whereby only those who can learn science in the standard way will be allowed access to higher education (Aikenhead, 2006). Owing to the stark difference in the conceptualization of science for majority and indigenous learners, it became apparent that this study would provide insight into the workings of the current educational system since the incorporation of Native knowledge into the curriculum and standardized tests.

Knowing whether the implementation of culture-specific test items increases test scores is important to Montana's education providers but also to other states' educational agencies, such as test item developers, helping to create more equitable items. Using the data related to these indigenous test items, I intend to examine the educational initiatives of Montana's OPI to determine whether incorporating indigenous material into classrooms and on state standardized tests was worthwhile and whether these initiatives are functioning as intended. Gaining this type of insight will be valuable to the fields of science education, assessment, and indigenous studies, and will make it possible for other states inhabited by large populations of indigenous students to replicate these initiatives. I hope that the findings of this research study will provide valuable information to the state of Montana, thus contributing to the
process of changing state standardized tests and creating a model for other
states with large American Indian populations.

The purpose of this study is to uncover possible correlations between
using a curriculum that incorporates the Native perspective of scientific
knowledge in conjunction with Westernized science and perceptible student and
district achievement gains in standardized assessment in science education. In
relation to these goals, the overarching question that this research is designed to
address is: Does adjusting the standardized test to incorporate indigenous
knowledge correlate positively with increased indigenous student test scores,
ultimately leading to a leveling of the educational playing field for Native
American children? The guiding research questions for this proposed study are
as follows:

1. Are there differences in eighth-grade students' standardized science test
   scores based on non-Native standards for American Indian versus White
   students? Is the relationship between science achievement and race
different when achievement test items based on Native standards are
   used?

2. Using students' standardized science achievement test scores based on
   non-Native and Native standards, are there differences in achievement for
   boys versus girls, for students of different socioeconomic backgrounds, or
   for students attending schools in different locations (rural vs. urban,
   reservation vs. non-reservation)?
3. Using students' standardized science achievement test scores based on non-Native standards, and then science achievement test scores based on Native standards, is the relationship between science achievement and race attenuated when controlling for gender, student socioeconomic status (SES), and school location (rural vs. urban, reservation vs. nonreservation)? Is the relationship between science achievement and race different for boys versus girls, for students of different socioeconomic backgrounds, or for students attending schools in different locations (rural vs. urban, reservation vs. non-reservation)?
CHAPTER 2

CONCEPTUAL FRAMEWORK

The following literature review presents an overview of U.S. educational policy developments, including the colonization of American Indians through education and the implementation of educational testing as a means of measuring individual student and school system performance. Examination of the history of assessment in the United States provides a picture of the stakeholders responsible for initiating standardized testing and the effects this testing has on the individuals associated with schooling, from administrators to students. Beginning with the assessment of two subject areas, math and reading, at the state level (National Center for Education Statistics, 2010), the testing revolution has evolved into a way to measure student growth and comprehension in multiple subject areas, including science.

Since the implementation of science standardized tests, researchers and educators have witnessed the underachievement of indigenous students on these tests as compared to the majority of non-indigenous students, who are scoring at the proficient or advanced levels (National Center for Educational Statistics, 2010). The presence of colonization in the way that schools are designed lends itself to perpetuating underperformance of Native students. Standardized testing as part of schooling has been a catalyst in reinforcing the concept of colonization, thus contributing to the continued presence of the
achievement gap (Eakins, Green & Bushell, 1976; Fuchs & Havighurst, 1973; Ogbu, 1995). Implementation of the No Child Left Behind Act (NCLB) of 2002 has incited efforts to close the achievement gap between White and minority students. Failure to acknowledge cultural perspectives in the classroom and on tests has emerged as an important reason why indigenous students are underperforming in science (Barnhardt et al., 2000; CCL, 2007;).

Therefore, this next chapter briefly describes the colonization\(^4\) of American Indian students through education and the history of assessment in the United States, including the development and implementation of science assessment, leading into an examination of the achievement gap in science that exists between indigenous and non-indigenous students. Following the description of the achievement differences between the two groups of students, the topic of testing is explored in two sections, the first laying out the role of Western modern science in standardized testing and the second reporting on how indigenous students are performing on these standardized tests. Finally, this study extends our understanding of how certain educators are moving toward closing the achievement gap between White and American Indian students by exploring how the state of Montana has been at the educational forefront with the development and implementation of its Native American curriculum and standardized test items. The current study provides insight into the positive effects that the

\(^4\) In this case, colonization refers to the control that majority White government officials have on how schools should be run and the ways in which they exert curricular control. The majority culture also controls testing as a means of accountability and maintaining the status quo. "Colonialism is a practice of domination, which involves the subjugation of one people to another" (Kohn, 2011).
incorporation of items based on culturally relevant standards can have on Native student achievement.

**Educational Colonization of American Indians**

The idea that Western European, White ways of thinking and living were superior arose in the 1800s when settlers pushed west to claim Native American lands. Manifest Destiny, or the right of the White to civilize the wilderness and its inhabitants, was considered a national and Christian duty. As part of that destiny, U.S. citizens and their government believed that to civilize the American Indian there was a need to erase the American Indian culture (U.S. Commission on Civil Rights, 2003). The U.S. government used schools as one way to assimilate American Indian children into White culture and to erase any trace of their “Indian-ness.” By educating the American Indian into a Christian way of life, eventually American Indian culture would be wiped out (Fuchs & Havighurst, 1973).

This type of educational colonization was not a new or novel idea. Since earliest times, majority powers had worked to create educational systems in the countries they colonized (Rizvi, 2008). Schools were built around a set of core values and interests that worked to propagate colonial ideas and to educate the larger population. For example, Aboriginal children in Australia and Canada were forcibly removed from their communities to attend government- or missionary-run boarding schools with the express purpose of “making them productive citizens.” Said (1979) describes colonialism as a way of thinking and a system by which
power is exercised over colonized people. The ideas of the colonizers were disseminated throughout the population via their educational system, in order to provide legitimacy to their efforts (Rizvi, 2008; Said, 1979). The United States was responsible for the colonization of American Indians in several ways, including taking control of their land, forcing them into boarding schools, and impressing on them the majority way of thinking. The main contributors to this colonization and the effects that ensued are discussed in the following paragraphs.

**U.S. Dominion Over American Indians: A Cultural Mismatch**

When the Supreme Court ruled in 1823 that the United States would have dominion over the land and people that European explorers had discovered (U.S. Commission on Civil Rights, 2003), Native Americans were stripped of their lands and culture and given a new way of life that suited the majority culture. The U.S. government placed American Indians on parcels of land in remote areas, usually unsuited for any type of agriculture (U.S. Commission on Civil Rights, 2003). By confining American Indians to reservations, the U.S. government forced a state of welfare dependency until some arbitrarily selected time at which the government determined the Native Americans could take care of themselves. Even after deeding land to the American Indians, the United States continued to dominate the indigenous peoples' lives and culture. The government provided all the necessary goods for survival, including food, shelter, clothes, and protection, which they believed would work toward "humanizing, Christianizing, and educating the Indians" (Fuchs & Havighurst, 1973, p. 5). Both money and land
were provided to indigenous nations, but the American Indians were instructed on how to use it. Students were educated by Euro-American schooling standards. Assimilation via control of the American Indians' autonomy and sources of self-determination was the government's way of ensuring that eradication of Indian culture was progressing (Davis, 2001).

From the outset of colonization of American Indians, schooling became a focus for the United States; the federal government saw education as a way to provide students with knowledge that was deemed valuable by the majority population. The U.S. government reinforced the idea that education was the way to achieve success and attain necessities. American Indians knew that education was a way for their children to survive, even if they would not thrive. A former war leader of the Navajo people told his grandson:

My grandchild, the whites have many things which we Navajos need. But we cannot get them. It is as though the whites were in a grassy canyon and there they have wagons, plows, and plenty of food. We Navajos are up on the dry mesa. We can hear them talking but we cannot get to them. My grandchild, education is the ladder. Tell our people to take it. (Fuchs & Havighurst, 1973, p. 39)

Amid these national sentiments, U.S. education activists were able to remove students from reservations and place them in boarding schools, which were designed to take American Indian children away from their families and cultures and immerse them in a world of dominant White ideas and formalities. Not only were Indian students forced to attend boarding schools, but they were also given a uniform course of study that emphasized vocational career training, including agriculture and homemaking. Education was not designed to support
American Indian children’s success in life but rather to prepare them for low-level jobs in the workforce (Fuchs & Havighurst, 1973).

Fuchs and Havinghurst (1973) determined that schools were designed for educating White middle-class students, thereby making it more difficult for an American Indian student to succeed. Schools are typically set up in such a way as to instill a feeling of competition among students, pushing them to work harder and compete against their peers for better grades and recognition. For example, many U.S. schools publicly display test grades to motivate students to want to learn and do well in school. Because this belief opposes the American Indians' concept of education, the Indian student may refuse to interact with this type of educational methodology, thus becoming more estranged from the educational institution (Fuchs & Havighurst, 1973; Kawagley & Barnhardt, 1998; Woolman, 2001). Aikenhead and Michell (2011) describe how knowledge is seen much differently for majority Euro-American people than it is for indigenous individuals. They state that for non-Native individuals, “[Knowledge] is something that can be given, taken, accumulate, banked, and assessed by paper and pencil examinations. Knowledge is something that exists independently of people; it exists separately form the knower” (p. 68). In contrast to this Eurocentric view, Aikenhead and Michell describe how indigenous people are “intimately and personally interconnected with what it is they know” (p. 68). Indigenous individuals tend to have an intimate connection to knowledge and not just a superficial acquaintance with it. Fuchs and Havighurst (1973) provide evidence
that features of education of American Indians in the past are similar to those seen in the present-day school:

The institution of the school is one that was imposed by and controlled by the non-Indian society, its pedagogy and curriculum little changed for the Indian children, its goals primarily aimed at removing the child from his aboriginal culture and assimilating him into the dominant White culture. Whether coercive or persuasive, this assimilationist goal of schooling has been minimally effective with Indian children, as indicated by their record of absenteeism, retardation, and high dropout rates. (p. 19)

Because of the way that the U.S. educational system is designed—in a way that fits the majority view of success—it is no wonder that such issues as dissociation from curriculum and testing practices arise for American Indian students, leading to a decrease in their attendance and association with schooling and, in turn, achievement scores.

Although the goal of U.S. colonization efforts was to eradicate Indian language, culture, and history and to spread Christian and Western culture and civilization (Fuchs & Havighurst, 1973), in some instances teachers rebelled and taught a curriculum that included Native American knowledge. The removal of children from their Native families and placement into boarding schools essentially made them noncontributing members of their own tribe, which might prove problematic if they chose to return after finishing school (Bear, 2008). Teachers at Shonto boarding schools in the 1960s indicated that they felt strongly about the incorporation of courses in which local Indian history and culture were taught (Fuchs & Havighurst, 1973). Yet despite their beliefs, even
these teachers were unable to present culturally sensitive materials in the classroom.

The memories of boarding school experiences continue to resonate for some who experienced poor conditions, poor treatment, or other ill effects. This early history with education may be a confounding factor in American Indian student motivation and achievement in school. Typically, in tribal situations, families are very close and multigenerational and extended families often live together, passing on traditions and stories that affect thoughts and actions (Reyhner, 2006). Many elder Native Americans who were forced to live in boarding schools are grandparents of current students and may continue to harbor negative feelings about their experiences, which in turn may lead to a culture opposed to schooling in general and can translate to lower achievement levels.

Another plausible reason for lower student achievement for American Indians relates to the control that the government has over funding for schools with Native American student populations. Today, while most Indian boarding schools have been closed, schools on reservations either are run through the BIA or are tribe-operated schools. Though the curriculum is no longer designed specifically to immerse American Indian youth into the majority cultures, majority knowledge is prevalent and the schools do not support academic achievement among American Indian children. According to the U.S. Commission on Civil Rights (2003), the BIA and tribe-operated schools have been neglected by government and education officials for far too long and are in such poor condition
that most of the buildings should be replaced to provide adequate support for education. "Education programs targeting Native American students are being inadequately funded through BIA, with BIA and tribally operated schools spending roughly 50 to 60 percent of funds for instruction that public schools spend because the rest must be used for the upkeep of school buildings" (U.S. Commission on Civil Rights, 2003, p. 92). According to the General Accounting Office report (1999), American Indians claim that they are not receiving sufficient funding to keep up with the demands of the entire reservation, much less their educational needs, and that more funds must be made available for use at the discretion of the nations.

Therefore, reservation schools are dependent on U.S. funds for sustainability. Although they have the power to manage their own funds because of the Self-Determination Act, Native American nations still require help and support from the government. This lack of autonomy seems to be a residual effect of the colonization of Native Americans due to their placement on reservations and provision of goods and funds. Because of the extended control that the U.S. government had on them, Native populations are now struggling to manage their monetary resources. In 2004, it was projected that Bureau of Indian Education (BIE) schools would spend approximately $3,000 per student, less than half the amount that public schools nationally would spend (U.S. Commission on Civil Rights, 2003). According to the Commission of Civil Rights, "the federal government has sole responsibility for providing education to these students—an obligation it is failing to meet" (p. 12). Funding for the Department
of Education's Office of Indian Education has been a small portion of the total budget and has, in fact, been reduced over previous decades (U.S. Commission on Civil Rights, 2003). This lack of funding has a snowball effect, causing teachers to leave because of poor pay or resulting in the hiring of unqualified teachers.

**Accountability**

Funding has been seen as a catalyst for poor performance of students due to lack of resources and highly qualified teachers, but it is also a way in which to provide rewards to those schools who are more accountable for student learning and achievement on standardized tests (Beck & Shoffstall, 2005; Miner 1999/2000; Moe, 2003). Since even before the implementation of this system of rewards, teacher accountability was on the educational forefront.

Teacher accountability and the first form of testing for American Indians arose as a result of the uniformity instituted in boarding schools. The Commissioner of Indian Affairs wrote in 1916:

> I have directed that the teachers of the service (BIA) should hereafter be graded and judged largely by their success in passing at least 70 percent of the pupils in their class. It will be necessary, however, for the pupil to actually accomplish the work before being so promoted, and steps will be taken to guard against any promotions which are not warranted. This will be accomplished by conducting uniform examination for all Indian schools throughout the United States. (Fuchs & Havighurst, 1973, p. 9)

This type of accountability can be seen in today's school systems, where students are required to take multiple tests on various subjects to determine their achievement levels. These scores then allow educational leaders and
policymakers to see where the learning gaps occur and attend to those gaps. This type of assessment also leads to changes in the appropriation of funds and resources, providing a type of reward system for schools that achieve high scores (Beck & Schoffstall, 2005; Miner, 1999/2000).

**Current-Day Influences of Education Colonization**

U.S. schooling today still maintains a focus on majority understandings and provides instruction and assessment in English rather than offering multiple languages, owing to the time constraints perceived by teachers to teach only certain subjects and concepts (Fillerup, 2005). The discipline of science, for example, is highly oriented toward a Western majority way of thinking, so people with different ways of knowing may become alienated and other cultures' ways of viewing the world may not be acknowledged, leading to a disengaged Native American student (Aikenhead, 2006).

Today's American Indian families face difficult decisions about how and where to educate their children. Johnson (2008) in his article about Montana schools, focused on the choices that American Indian parents must make about sending their students to schools either on or off the reservation. Many of the Indian parents interviewed chose to send their children to off-reservation schools owing to the lack of resources available to reservation students (U.S. Commission on Civil Rights, 2003). Even though students can choose which school to attend and where to live, a sense of colonization persists in that school is taught in a majority format and students are assessed through standardized tests, which do not attend to Native American students' different ways of knowing.
and their views of assessment but rather focus on what is important to the greater society.

The ideas that were promulgated by Native American boarding schools may seem like far-off memories. However, though not as blatantly obvious, colonization remains in the context of schooling today. Though NCLB (NCLB, 2002) was supposed to work toward creating a more equitable educational opportunity (discussed in greater detail in the following section), the achievement gap has yet to be closed and inequality still exists in the context of schooling and testing practices (Deyhle, 1983; Hartman, 2003; Johnston, 2010). The presence of colonization is evidenced by the lack of funding for schools housing mainly minority students, the structure of the school, and how subjects are taught in a majority-style format, leading to the way in which accountability is carried out and the design of standardized assessment. This difference in learning and assessment is addressed in the next section, focusing particularly on the development of tests and the outcome of the implementation of these tests in the classroom.

**History of Assessment and Its Effects in the United States**

In the years preceding the U.S. educational reform movements of the 1970s and 1980s, standardized tests were used as measures of student achievement, and the results of individual student, state, and district scores were reported to parents to show where students scored in comparison to other students in their grade (Moon, Brighton, Jarvis, and Hall, 2007). Owing to the lack of
consequences associated with these scores, teachers usually did not modify the curriculum based upon test scores (Moon et al., 2007).

A Nation at Risk: The Imperative for Educational Reform, published in 1983 by the National Commission on Excellence in Education, stated that the success and growth of the United States were being challenged by other countries. Increased production of goods and the efficiency with which they were being produced by other nations challenged the economic advantage the United States had over such other countries as Japan, Korea, and Germany. The report stated that other countries' economic success was due to a better-educated workforce. The threat of economic advancement through education by other countries provided the impetus for government officials to re-examine the foundations of the U.S. educational system, as it was determined to be "eroding" owing to "a rising tide of mediocrity that threatens our very future as a Nation and a people" (National Commission on Excellence in Education [NCEE], 1983, p. 9).

After publication of A Nation at Risk, two national educational summits were convened by IBM Chief Executive Officer (CEO) Louis Gerstner at IBM headquarters, to call for greater educational accountability through increased standardized tests nationally (Hurst, 2001). These summits were the beginning of educational reshaping by policy changes promoted by the government and large, wealthy corporations, which had a stake in students' becoming "economically productive workers" (Hurst, 2001, p. 2). A quote from a working paper, developed under the direction of IBM's Gerstner, stated:

We believe that efforts to set clear, common, and community-based academic standards for students in a given school district or state is a
necessary step in any effort to improve student performance. We are convinced that technology, if applied thoughtfully and well-integrated into the curriculum, can be used to boost student performance and ensure a competitive edge in the workforce. (Harp, 1996, p. 17)

In the fall of 1999, during the second educational summit held once again at IBM headquarters, it was determined that a set of standards should be written and adopted by each state. In addition, standardized tests would provide evidence on how well students learned those standards. Miner (1999/2000) notes that participants of the summit also called for "a system of 'rewards and consequences' for teachers, students, and schools based on those tests" (p. 1) to ensure compliance. Although states began developing state academic standards after the summit meeting, it was not until the No Child Left Behind Act was enacted in 2002 that states were required to develop and use state curriculum standards to align curriculum and teaching with standardized tests (U.S. Department of Education, 2005).

The original statement of purpose of NCLB, as put forth in 2002 by Congress, was "to ensure that all children have a fair, equal, and significant opportunity to obtain a high-quality education and reach, at a minimum, proficiency on challenging state academic achievement standards and state academic assessments" (NCLB, 2002, p. 15). This document outlined 12 standards against which education in the United States would be measured and to which it would be held. These new standards were designed to level the playing field for all students, increase accountability at the local level, and close the achievement gap between minority and nonminority students.
Moe (2003), in his book titled *No Child Left Behind? The Politics and Practice of School Accountability*, discusses how the public school system is run just like any other organization in which top-down control is exercised with respect to all areas of educational policies, programs, and directives. With accountability being the goal of educational policymakers, the focus is on continued student achievement. Moe (2003) describes the rationale behind the systems recently put into place regarding high-stakes assessment:

The movement for school accountability is essentially a movement for more effective top-down control of the schools. The idea is that, if public authorities want to promote student achievement, they need to adopt organizational control mechanisms—tests, school report cards, rewards and sanctions, and the like—designed to get district officials, principals, teachers, and students to change their behavior. . . . Virtually all organizations need to engage in top-down control, because the people at the top have goals they want the people at the bottom to pursue, and something has to be done to bring about the desired behaviors. The public school system is just like other organizations in this respect. (p. 81)

Moe's statements reveal that measures of accountability are brought about usually by high-level personnel who determine what is important and how their desired goals will be met by methods of teaching and assessing.

It is clear from research (Miner 1999/2000; Moe, 2003) that testing has put an immense strain on teachers and a pressure on how they should address the issue of preparing for the test. The stress surrounding preparing for and taking a test and then awaiting the results to determine whether you have met or exceeded standards and will be rewarded or have failed to meet standards and will be liable for sanctions against you until you show improvement is an incredible burden and brings to light the negativity that arises out of testing. At a
time when assessment is the norm for determining whether students and schools are meeting predetermined standards, the question of why we are testing and what we are really getting out of it must be addressed. Is testing providing positive, informing data that we could not obtain from simply asking our students in the classroom to display the knowledge they have acquired? The next section provides rationale for why the United States has turned to standardized testing as a means of accountability.

**Reasons for Testing**

Since NCLB became law in 2002, the amount of testing that takes place at the state and district levels in the United States has increased tremendously (U.S. Department of Education, 2010). Standardized testing has become the main form of assessment to test the knowledge of students (U.S. Department of Education, 2010). Advocates of this type of testing method state that standardized tests can help educators on multiple levels measure student and school performance in relation to other students who take the same test. This type of data provides valuable information to administrators who make decisions regarding the instructional program (Bagin & Lawrence, 1994).

One of the most widely used assessments that measures students' progress across states and years is the National Assessment of Educational Progress (NAEP). The Commissioner of Education Statistics, who directs the National Center for Education Statistics for the U.S. Department of Education, is responsible for administering NAEP, the largest ongoing national assessment that measures student knowledge of mathematics, reading, science, writing, the
arts, civics, economics, geography, and U.S. history (National Center for Education Statistics [NCES], 2010, 2011a). All states participate in the mathematics and reading test, while 46 states participate in the science test (Alaska, Vermont, Oklahoma, and Kansas excluded). NAEP "provides results on subject-matter achievement, instructional experiences, and school environment for populations of students (e.g., all fourth graders) and groups within those populations (e.g., female students, Hispanic students)." Students at grades 4, 8, and 12 take the state, district, or national long-term trend assessments. These grade levels are selected because of the critical junctures in academic achievement that they represent, as they occur during different transitional phases in a student's educational career (advancing to middle school, high school, or post–high school) (NCES, 2010). The data collected from the NAEP provide valuable insight into the achievement of districts, states, regions, and the entire country through the Nation's Report Card, which allows all Americans to view student performance in various academic subject areas. The NAEP provides national data comparisons across state school systems, and the results allow the officials at the state level to determine which area(s) of the state are performing well or are underperforming.

Both the U.S. Department of Education and state-level departments of education use testing data, whether from high-stakes tests or general testing practices such as NAEP, to determine which schools are in need of improvement and which ones meet adequate yearly progress (AYP) criteria. However, each state differs as to the degree to which testing is a focus and priority. Each state
places a different emphasis on testing, from monitoring school progress to high-stakes testing, in which successful completion of the test is a prerequisite to graduating or moving on to the next grade (Miner, 1999/2000). One example of high-stakes state testing is the Massachusetts Comprehensive Assessment System (MCAS), which requires students to pass grade 10 tests in multiple subject areas, including science, before they can obtain a diploma (Massachusetts Department of Education, 2010).

Though standardized testing may be viewed as an efficient and economical means for measurement and monitoring of our educational system (Babin & Lawrence, 1994; Moe, 2003), it can have both positive and negative effects on school systems that may not be realized by educational reformers. While the testing reform movements were designed with the best interests of our students and our country at the forefront, many educators have felt pressured by this movement. Some schools and students may have benefited from this type of accountability, while others have felt the unnecessary pressures of measuring up to others and cutting corners to get there. The next section addresses some of the implications of the implementation of standardized testing on schooling in the United States.

**Effects of Testing Reform on Schooling in the United States**

The increase and impetus to hold all states and districts accountable for student learning and achievement has produced mixed outcomes, both positive and negative. The increased accountability of schools and teachers to create meaningful learning experiences based on state standards and a well-rounded
curriculum has produced some positive results, including teaching across the curriculum and student exposure to multiple subject-area topics (U.S. Department of Education, 2010). The negative aspect of testing is evident in outcomes related to the pressure to consistently produce high test scores (Moon et al., 2007).

Based on her in-depth case studies with three Texas Magnet schools during the reforms of the 1980s, McNeil (2000) determined that standardization has negative effects on schooling, specifically in what and how students are taught. In Contradictions of School Reform: Educational Costs of Standardized Testing, McNeil concludes, “Standardization reduces the quality and quantity of what is taught and learned in schools.” Furthermore, “over the long term, standardization creates inequities, widening the gap between the quality of education for poor and minority youth and that of more privileged students” (McNeil, 2000, p. 3). Since the advent of standardization, many pressures have been exerted on the school system (McNeil, 2000). To uphold the new standards and to meet the goals, certain consequences for underperformance have been implemented by various states. For example, Michigan relies in part on outside consultation and reduced funding, among other measures that may be determined by specific school districts, as a means of castigating schools that are underperforming (Michigan Department of Education, 2001–2009).

The next three sections address multiple implications attributable to the implementation of standardized tests.
Top-Down Pressures. Many teachers find themselves pressured by the administration to provide an education for their students that will elicit positive test results, thus making their school compare well with other school’s test scores. With yearly rewards and sanctions attached to of the results of state testing, administrators are motivated to pressure teachers to produce positive results.

Findings from a study by Moon et al. (2007) focused on the effects that state standardized tests have on teachers and students. Data were collected from a national survey, given to 2,097 teachers and specifically developed and piloted for this study, that examined the perceived influence of state testing on curriculum and instruction, the pressure that teachers felt to improve test scores, the amount of time and attention given to test preparation, the perceived positive and negative effects of standardized testing, the teachers’ perceptions of the consequences of testing, and teacher background data, including geographic and poverty indicators. School data combined with the survey indicated that there was perceived top-down filtering of test-related pressure on the entire school (Moon et al., 2007). This study shed light on the origins of the pressures that affect teachers, beginning with central office administrators, who transfer it to school principals, who in turn exert pressure on teachers and students. This study provides insight into where the pressure to do well originates and where supports can be put in place to decrease this pressure.

Burch (2007) provides an example of how control is exerted not only by policymakers but by the teachers as well. Burch (2007) examined a case study
focusing on a reading and mathematics reform program in one California school district. Throughout her study, she had contact with individuals at all school levels, including the district office, school administration, faculty, and staff. She formally and informally interviewed members of the school district, to investigate the school personnel’s thoughts on the changes occurring in the district. From data related to school changes and teachers’ professional development, Burch was able to determine how bottom-up rather than top-down pressure changes play a role in establishing policy and practice. Burch (2007) reported that the curricular control found in the school being studied suggested that high-stakes testing may be one means by which schools can structure how they help their students become successful on the tests while maintaining a hold on how subjects are taught. In this way, the school can make the required curricular changes but still be in control of their own classrooms and delivery of material. For example, the school hired literacy coaches to help increase reading levels and achievement, which supports the idea that outside sources or businesses can be brought in to assist with teaching and test-taking strategies. This example demonstrates how schools are being proactive in finding ways to increase learning on their own before top-down control is put in place. However, many teachers are not as supported by the school as was the case in Burch’s study.

Teaching to the Test. Because of high-stakes testing associated with NCLB, many teachers find themselves “teaching to the test,” where they are more concerned with covering material on which students are going to be tested than with teaching for understanding across each content area (Hursh, 2001). In
my experience working in the Florida school system, I found the pressure to have one’s students perform well on tests to be extremely high. The Florida Comprehensive Achievement Test (FCAT) dictates the grade a school receives, ultimately affecting a school’s reputation and whether it maintains control over its own initiatives or whether the district or state assumes control from the school and dictates interventions (Florida Department of Education, 2010). The curriculum was controlled so that teachers read only prescribed paragraphs, complete certain workbook pages, and perform only designated activities within the classroom, rather than having guidelines to follow and being allowed to teach the subjects in a manner that meets the needs and multiple learning styles of the students. As a science teacher teaching in this type of environment, I encountered multiple challenges. First, the time available to “cover” the material necessary for a student to be successful on the FCAT was limited. Second, a district curriculum coordinator continually traveled around the district to ensure that all teachers were working at the same pace and teaching the same concepts, making it very difficult for educators to teach with constructivist methods or hands-on investigative labs, which are generally considered effective and often superior teaching methods (Rowe, 2006). Third, I was hampered by a lack of cultural content displayed in the curriculum. Florida’s student population is highly diverse, yet the students’ cultural needs and differences were not addressed in this type of educational structure. Like Hursh, Colt (2005) found that some teachers in such states as Washington and North Carolina also feel constrained in their delivery: As one of the interviewed teachers explained, “At
the very beginning I felt very programmed, very much a clock watcher, very much 'do not stray from this path'” (p. 2).

In a qualitative meta-synthesis of high-stakes testing and curricular control, Au (2007) investigated the ways that high-stakes testing affects the cohesiveness of the curriculum. The results suggested that "as teachers negotiate a high-stakes testing educational environment, the tests have the predominant effect of narrowing curricular content to those subjects included in the tests, resulting in the increased fragmentation of knowledge forms into bits and pieces learned for the sake of the tests themselves, and compelling teachers to use more lecture-based, teacher-centered pedagogies" (p. 264). Au's study encompassed 49 qualitative studies selected because they were composed of either high-stakes testing or state-mandated testing. According to Au (2007), many studies were conducted in such fields as English language arts, social studies, and general education but very few in science and math. Of the 49 studies that Au included, only 3 were either science or math related, indicating that science needs to be more closely examined for tendencies to become too focused on the test material at the expense of other integral pieces that students should learn.

The pressures of high-stakes testing has diminished curricular autonomy and cohesiveness for the teacher and replaced it with a more streamlined, efficient set of pieces of knowledge to be learned and assessed. However, if test “cutoff scores” are not met in the schools, funding can be lost.
Impacts on School Funding. Educational accountability affects the manner in which evaluation resources, such as jobs and monetary funds, are allocated, generally on the basis of outcomes on standardized testing (Beck & Shoffstall, 2005; Miner 1999/2000). The main focus of standardized testing in the United States is on school results rather than individual student scores, and test results can have a major impact on school funding and future student success, either bolstering or reducing future funding.

In their study comparing test scores of 1,342 Illinois rural and non-rural junior high schools, Beck and Shoffstall (2005) found that standardized testing can have detrimental effects on schools, such as revoking funding for supplemental classes in schools that are not financially as well off as others.\(^5\) However, the performance of schools was found to be strongly associated with schools' socioeconomic characteristics, indicating that students who may be attending poorly funded schools may not have access to resources that higher-performing and therefore more well-funded schools may have (Beck & Shoffstall, 2005; Darling-Hammond, 2000).

Poor performance, and therefore lack of funding, has been evidenced in the Illinois study by Beck and Shoffstall (2005) in which school-level data obtained from the demographic information portion of the state standardized assessment revealed that the most well-funded schools in the state were suburban and had a nearly all-White student enrollment, as compared to lower-

\(^5\) Data were obtained from the Illinois Goals Assessment Program (IGAP), which is the state standardized test measuring student performance in the subjects of reading, writing, mathematics, science, and social studies.
funded schools with a more diverse student population. The findings from Beck and Shoffstall provide evidence of inequality with regard to funding allocations. If schools with a majority White student population are performing at higher levels than schools with a non-White student majority, then the funding will go to the former and the latter will be left with little financial assistance.

Whereas the Beck and Shoffstall (2005) study takes into account only a certain snapshot of funding issues, the larger issue that must be addressed is that of the unique needs of schools that serve students from families of low socioeconomic status (SES) and its effects on funding and achievement for all students attending poorly funded schools. The Northwest Evaluation Association (NWEA) conducted a study in 2006 that examined differences in students' math and reading achievement scores across grades, races, and school poverty levels as indicated by funding for students in grades three through eight who completed the Northwest Evaluation Achievement tests during 2004 and 2005. The results that emerged were that an achievement gap existed "between students in low-poverty schools and those in high-poverty schools for all grades and subjects studied. This achievement gap was relatively consistent across all grades, indicating that the groups of students in schools with high levels of poverty are no closer to students in low-poverty schools in the eighth grade than they were in the third grade" (McCall et al., 2006, p. 13). These findings indicate that no matter what their race, if a school is more poorly funded than other schools, students tend to perform at lower achievement levels.
Data from the NWEA6 (McCall, et al., 2006) that focused on student academic growth over the summer break suggest that while students in all groups continue their cognitive growth, African American and Hispanic students and students enrolled in poorly funded schools tend to grow less than White students enrolled in well-funded schools. Even when all high-performing students' growth is compared, data show that African American and Hispanic students' knowledge tends to deteriorate more over the summer than does that of their White counterparts. No matter what the students' race, the knowledge gained by high-performing students who attend poorly funded schools atrophies over the course of the summer more than does that of high-performing students who attend well-funded schools. In this particular study, most minority students attended poorly funded schools, whereas most students attending well-funded schools were White. The authors noted that "for every score level, students enrolled in low-income schools grow less than students in wealthier schools. This means that for two students who start the school year with the same score, the student who attends the high-poverty school is more likely to end the year behind the student who attends the low-poverty school" (McCall et al., p. 39).

This study makes evident that no matter a student's race; if the school is poorly funded, then achievement will suffer. The study also makes apparent that minority students attending well-funded schools still tend to perform at a lower achievement rate than their fellow White students. Presumably, by increasing the

6 NWEA provides a "formative testing system that responds dynamically to the child and gives educators detailed insight into kids' learning" (http://www.nwea.org/about-nwea-1).
levels of funding for schools, minority and poor White students would have a greater chance of increasing their academic performance.

Okoye (2009) explored the relationship among gender, SES, location of school, and performance in an integrated science class in a study of 600 secondary-school students in Nigeria. The author found the interaction of gender and SES to produce no significant differences in student performance, whereas the interaction of location and gender did have an effect on student performance. In this case, male students attending urban schools tended to perform better in their integrated science classes than did their female counterparts who attended rural schools. Okoye attributes this greater success to the fact that urban schools tended to have greater resources, such as access to well-equipped libraries and teachers who were better educated. This study appears to be in agreement with the previous research conducted by Beck and Shoffstall (2005), who also found that schools located in more rural areas tended to have fewer resources available to them, which might negatively influence student achievement.

In light of the findings of these studies many schools still tend to be underfunded and therefore perpetuate low student achievement. As part of combating and working to close the achievement gap, issues of school funding and access to equal resources and quality of education must be further addressed to ensure equality of education for all students and to aid in an increase of student achievement scores, particularly if standardized tests are going to continue to be a measure of student and school success.
The following section addresses studies that make clear that the people and groups located in both business and educational settings who promote high-stakes educational testing may also have a role in policy-making processes. Individuals involved in the promotion of high-stakes testing have the power and ability to determine what should be tested, how these subjects should be tested, and what consequences await those who do not achieve certain standards (Hursh, 2001; Miner 2009/2010). Currently, policy designs appear to be constructed so as to align classroom practice with the policy goals of those holding political and bureaucratic power.

Though standardized testing may be an efficient and economical means for measurement and monitoring of our educational system, it may not be the most culturally sensitive tool (Johnston, 2010). Most standardized tests are written with the majority student population in mind and, even when testing material purports to reflect the cultural ideas of the minority, the tests do not always perform as intended. It is important and necessary to call attention to the construction of standardized tests and make note of the bias that often is found within the items contained in the test. Issues surrounding the achievement gap, including the construction of standardized tests, will be further explored in the following section.

**Cultural Test Bias**

A review of the literature focusing on international discussions which relate to culturally appropriate or inappropriate assessments through the lens of overarching themes and practices, as well as inclusion of cultural content and the
appropriateness of that content is provided by Johnston (2010). This review (which includes Christensen and Lilley, 1997; Cockburn, Musgrave, Matheson, Mitchell, Reid, and Stewart, 2007; Craven, 2003; Gopaul-McNichol and Armour-Thomas, 2002; Philpott, Nesbit, Cahill, and Jeffery, 2004; Sakrzewski, 1997; and Verjee, 2003) supports the "provision of changing environments and assessment practices to account for the uniqueness of specific cultural groups" (p. 237). The article also focuses on the struggle that occurs between majority powers and minority interests when assessments are developed in New Zealand. For Maori students, assessments used to check for student understanding and achievement may be culturally inappropriate (Johnston, 2010). The cultural inappropriateness of most tests is a contributing factor in the failure of indigenous students, because these students lack the "cultural capital" of the dominant group after whom the tests are modeled. In this sense, the tests have been developed with the dominant group in mind rather than taking into account what is deemed valuable from the indigenous perspective, making majority knowledge more valued and therefore less attainable for indigenous students (Johnston, 2010). Johnston finds that the problem with the transmission of information and knowledge in schools and on assessments associated with differences in language is only one issue linked to the challenges for Native students with regard to testing. Assessing knowledge through a pencil-and-paper test adds to the cultural incongruencies witnessed in standardized assessment as it "serves, just like knowledge, the interests of specific groups over others" (Johnston, 2010, p. 233).
Johnston (2010) states that “tests developed and validated with dominant groups include culturally inappropriate test-item content and rely on first-language skills and meta-cognitive test strategies that further exacerbate existing social, educational, and vocational inequities for culturally diverse participants” (p. 233). She reports that current assessment systems marginalize all indigenous students. In this study, Johnson suggests that assessment practices be modified to include collaborative or cooperative approaches for assessment or group work.

Critics of standardized assessment believe that standardized tests may discriminate against certain individuals owing to their cultural bias (Eakins et al., 1976). Murphy (2007), in her literature review of test validation and construction, states that “even the most culturally knowledgeable item writers and reviewers may write items that students misconstrue, so gathering information about test-takers' perspectives seems critical to the development of valid assessments” (pp. 235–236). The focus of her review is based on her concerns that “test scores provide the basis for long-term decisions about students concerning placement, selection, certification, and promotion” (p. 228). She concludes that assessments need to be written and administered in a way that is fair and unbiased toward students of cultures and backgrounds other than upper-middle-class White students.

Koelsch, Estrin, and Farr (1995) suggest that low test scores for minority students may be the result of test developers’ failure to consider these students' cultural experiences when designing their assessments. Koelsch et al. state:
If the student's experiences in a cultural group are not taken into account when assessment tasks are developed and scored, the evaluation process of how well a student has learned with the school's culture will be flawed. A failing performance may indicate the degree of disconnection between the task and the student's frame of reference, rather than the degree of mastery of the knowledge and skills being assessed. (p. 21)

The authors highlight the fact that many test developers may not take non-majority students' knowledge, beliefs, or values into consideration when creating standardized tests, thus perpetuating the disconnection between the students' perspective and what the item is actually asking the students. The authors suggest ensuring that cultural experiences should be included in testing material to ensure equal opportunities for non-majority students.

Helms (1995) also addresses the issue of cultural bias in test construction through her literature review focusing on cognitive ability tests, as she explores environmental impediments to student achievement for Black Americans. She notes that much of the time when tests are constructed, the “quantity and quality of educational material present in one's home environment, parental education, or income (i.e., socioeconomic status [SES]), or personality characteristics (anxiety, lack of motivation) elicited by submersion in an unfamiliar (testing) environment” (p. 685) are not taken into account, thus providing an unequal testing experience for many students. All these factors have an influence on student achievement, with minority and low-SES students tending to feel the greatest effects.

Cultural bias in the construction of standardized tests has been deemed a major area of concern by many researchers. This concern is completely
warranted given the fact that indigenous students are struggling to achieve the same academic standards as their non-indigenous counterparts. Bias on standardized tests has been an ongoing issue that is compounded when the subject of science is assessed, given the differences that arise not only in language but also in how science itself is understood by indigenous students—in a holistic way—as compared to the dominant way that science is understood by majority individuals—categorizing and breaking down information.

Science assessment is the newest and fastest-growing area now being implemented in most states owing to the push for increased achievement in the areas of science education (Dorph, Shields, Tiffany-Morales, Hartry, & McCaffrey, 2011). The next section explores the implementation of science assessment as it has been developed and applied in the United States.

**Science Assessment in the United States**

Joining reading and mathematics, science testing is now required under NCLB (NCLB, 2002). Starting in the 2007–2008 school year, public schools began to administer annual science assessments at three academic-year levels: grades 3–5, 6–9, and 10–12 (U.S. Department of Education, 2009). Previously, many elementary-school teachers disregarded science and focused more on mathematics and language arts; however, they now must teach the subject matter to prepare students for standardized assessments (Dorph et al., 2011). Although not every state has mandated science testing as part of the state standardized assessment, international tests have been administered during elementary- and middle-school years to track student achievement.
Since 1995, the Trends in International Mathematics and Science Study (TIMSS) has provided comparison data on fourth- and eighth-grade students across the globe for mathematics and science achievement (NCES, 2010b). This test instills a sense of international competition among developed countries. Recent TIMSS data show that there is room for improvement on U.S. student test scores as compared with their counterparts' scores in various other countries (Committee on Science Education K–12 and Mathematical Sciences Education Board, National Research Council, 1999). TIMSS data from the mid-'90s show that U.S. fourth-grade students' average score (565) was higher than the international average score (524) on the science portion of the test; only two countries scored higher than 565. In contrast, U.S. eighth-grade students scored significantly higher (534) on the science portion of the test than did fourth graders but much closer to the international average of 516. At least 16 other countries scored higher than U.S. eighth graders on the science portion of the test (Committee on Science Education K-12 and Mathematical Sciences Education Board, National Research Council, 1999).

The perceived need for improvement on math and science test scores has increased the U.S. Education Department's awareness of both local and national performance. With an increase in globalization and competition for jobs in the workforce, the need for students to do well on these international tests seems imperative if a nation is to keep pace with other countries and vie for top positions within the global workforce. With an increase of testing in these areas
comes a greater demand for teaching to the test as a way to increase test scores (Moon et al., 2007).

The Committee on Science Education K-12 and Mathematical Sciences Education Board (1999) points out that, though differences in scores among world nations do exist, differences between school cultures that could lead to differences in scores also exist. "Just as curriculum and instruction affect student performance, the broader culture of a school and a society matters as well. Aspects of this culture include the preparation and support of teachers; attitudes toward the profession of teaching; the attitudes of teachers, students, and parents toward learning; and the lives of teachers and students, both inside and outside school" (p. 4). The section that follows provides insight into the areas in need of improvement in order to close the achievement gap and increase the achievement scores of American Indian students.

**Achievement Gap**

Today's schools, like the societies they reflect, are defined by multiple groups with varying agendas. Science, mathematics, and technology have been defined as a gatekeeper in the process of defining whether schools fall into the category of advanced (Hammond & Brandt, 2004). Hence, science education has become linked to a variety of interconnected political and economic forces that are ever-changing and evolving (Hammond & Brandt, 2004). Within the achievement gap, race is another key variable that has been researched in relation to student achievement (NCSL, 2008; Fuchs & Havighurst, 1973). However, SES has traditionally been a major variable contributing to performance levels of students.
Little research on the student achievement gap in science is available; however, trends in such other disciplines as reading and mathematics, which have been the original subjects tested, show that Native students are performing at lower achievement rates than non-Native students.

The intent of NCLB, the 2002 educational act of Congress, was to make learning equal for everyone and to help close the gap in learning for all minority students. Findings from past research and reported test scores indicate that indigenous people's rate of participation in science classes and science-related jobs is about a third that of White students (CCL, 2007). In 2007, the U.S. Department of Education released their report *Status and Trends in the Education of Racial and Ethnic Minorities*, which examines the educational progress and challenges that racial and ethnic minorities experience in the United States. Findings from this report illustrate that, although the number of minority students who completed high school and have gone on to college has increased, a disparity in overall progress remains. The NCES states, "Despite these gains, progress has varied, and differences persist among Hispanic, Black, American Indian/Alaska Native, Asian, Native Hawaiian or Other Pacific Islander, and White students on key indicators of educational performance" (U.S. Department of Education, 2007).

Research conducted by the Regional Educational Laboratory (REL), entitled the National Education Research Study, also shows how education is not yet equal in a four-year study (from the 2003–2004 school year through the 2006–2007 school year) examining standardized reading and math test scores.
for fourth- and eighth-grade students from 26 states having large American
Indian and Alaska Native populations (4,000 or more individuals). The research
showed that the majority of states with large American Indian student populations
had substantially lower state standardized test scores in reading and math for
2005 and 2007 when compared with non-indigenous student scores. The authors
showed that, "[I]n reading, the achievement gap in grade 8 was 14 percentage
points in 2005 and 18 percentage points in 2007—an increase of 4 percentage
points" (Nelson, Greenough & Sage, 2009, p. 4).

Hall and Kennedy (2006) reported similar findings from their study of test
score results in reading and math from 2003 through 2005 nationally at all school
levels. At the elementary level, 31 states were included for reading and 32 for
math. Middle-level data included 31 state scores for both reading and math and,
at the high school level, 24 states for reading and 23 for math (Hall & Kennedy,
2006). Among the acknowledged findings was the fact that, although American
Indian students were making positive gains in their test scores, their White
counterparts' test scores were also increasing. Though the achievement gap was
being addressed in the form of increasing test scores, scores were increasing for
all students, thus maintaining the gap.

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7 The difference in achievement scores in math in grade 8 increased 3 percentage points, with a
16–percentage point difference in 2005 and a 19–percentage point difference in 2007" (Nelson et
al., 2009, p. 4). An increase in percentage points for American Indians was observed in most
states; however, non-indigenous students still maintained a solid lead in test scores over their
indigenous counterparts. Although this study provided valuable data concerning Native students' 
reading and mathematics standardized tests scores, the study was limited because there was no
common assessment across states: The data used for comparison were from a variety of state
assessments.
One limitation of this study, as was true of the Nelson et al. (2009) study, is that state assessments were used to compile the data and results. Because these state assessments are dissimilar, the standards they address and the levels of proficiency they exemplify differ from one another. NAEP scores may be a better choice of data to examine because the same test is administered across states. While the NAEP is administered in most states, not every state uses the NAEP, making the comparison of data difficult. However, this is the most practical and standard form of testing that can be compared across states and therefore different racial groups. This test also provides demographic data that is helpful in identifying groups with low SES, which may contribute to low academic achievement.

Data from the 2005 NAEP\(^8\) show consistent differences between White students and their minority counterparts. In grades 4, 8, and 12, similar results emerged in the area of reading. At all grade levels, White and Asian/Pacific Islanders scored higher than Hispanic, American Indian/Alaska Native, and Black students, with more students scoring in the "at or above proficient" category. In grades 4 and 8, both Hispanic and American Indian/Alaska Native students outscored their Black counterparts. Not until 12\(^{th}\) grade did White students dominate the highest achievement level, with 43% of students scoring at or above proficient, whereas 36% of Asian/Pacific Islanders, 20% of Hispanics, and 16% of Black students scored at or above proficient. It was noted that at this

\(^8\) The National Assessment of Educational Progress (NAEP) is a nationally representative assessment of what U.S. students know and can do in various subject areas. This indicator focuses on the 2005 results of 4\(^{th}\), 8\(^{th}\), and 12\(^{th}\)-grade students in the subjects of reading and mathematics (National Center for Education Statistics, 2007).
level, American Indian/Alaska Native students “were not measurably different from the percentages of other racial/ethnic groups, which may be due in part to a large standard error” (U.S. Department of Education, 2007).

Results similar to those for reading achievement were found in the area of mathematics when all groups were analyzed. In all three grades, Asian/Pacific Islanders outscored their peers, with a greater number of students scoring in the “at or above proficient” category (4th grade, 55%; 8th grade, 47%; 12th grade, 36%), whereas White students remained in second place throughout the three grades (4th grade, 47%; 8th grade, 39%; 12th grade, 29%). American Indian/Alaska Natives followed behind White students in grades 4 (21%) and 8 (14%), but joined their fellow Black students in last place in grade 12 (6%). Hispanic students outperformed Black students in all grades, and fewer Black students than students of all other races scored in the “at or above proficient” category (4th grade, 13%; 8th grade, 9%; 12th grade, 6%).

The results of a 2006 NWEA (McCall, Hauser, Cronin, Kingsbury & Houser, 2006) study that focused on student achievement in reading (N = 569,564) and math (N = 542,057) provided valuable insight into the role that race and poverty play in student academic achievement and growth over the course of a year and into the challenges faced by minority and high-poverty students. A major finding of the study was that an achievement gap exists among White, African-American, and Hispanic students in each of the grades (three through eight) and subjects (math and reading) studied. Furthermore, differences in achievement levels were noted between low-poverty and high-poverty schools. In
schools where White students' level of poverty was similar to that of both Hispanic and African American students, White students still performed higher than their minority counterparts. As regards the difference in academic growth over the course of a school year, African American students tend to demonstrate less growth than students in other groups, especially in the area of mathematics.

Data collected in 2005 indicated that Black students had the highest reported percentage of poverty (30.1%) as compared with other groups\(^9\) (U.S. Department of Education, 2007). This high poverty level may play a role in the lower achievement levels of Black students. With a greater number of Black students (71%) living in households where only one parent is present and the family is considered to be at the poverty level (U.S. Department of Education, 2007), concerns arise as to how much support is available for students to succeed academically. Clearly, a number of issues related to student achievement warrant investigation, especially in the realm of minority students' achievement. Results from the NWEA and NAEP studies suggest that both minority students and students at the poverty level, which in many cases coincide, are scoring at lower achievement levels than their White counterparts. This is apparently the case for American Indian students, who tend to receive some of the lowest amounts of school funding (U.S. Commission on Civil Rights, 2003) and lack important resources; the results of standardized tests indicate that these students have some of the lowest achievement levels of all the defined

\(^9\) Other groups included White 10.0%, Hispanic 25.6%, Asian 10.4%, Native Hawaiian/Pacific Islander 20.0%, and American Indian/Alaska Native 26.8% percent (U.S. Department of Education, 2007).
racial groups (U.S. Department of Education, 2007). Even in schools where poverty is low, findings are that minority students still seem to achieve at lower levels than do White students afforded the same resources and education. Greater research must be conducted in the area of equitable funding and its effects on student achievement to account for the continued gap in racial achievement.

On the journey for educational equality, state funding is an important factor. The Education Trust, an organization that "promotes high academic achievement for all students at all levels—pre-kindergarten through college" (Education Trust, 2009, p. 1), has as one of its goals closing the gaps in student achievement, especially minority achievement. The Education Trust's 2008 report provides valuable insight into the spending gap that currently exists in the U.S. school system. The Trust's report on school funding, which examines data from 1999 to 2005 and was drawn from U.S. Census Bureau and the U.S. Department of Education information, compares spending in school districts with both high and low numbers of low-income students, English language learners (ELLs), and minority students (Arroyo, 2008). Although the Education Trust works on behalf of minority students and looks to find differences and gaps in achievement between minority and majority students, their data is drawn from U.S. government information and their findings are based on those data. From the most recent data (provided in the 2004–2005 school year), Arroyo reported that most states spend less to fund students in districts with high ELL and minority populations than to fund students who reside in districts with low ELL
and minority populations. In addition, the data revealed an almost even split between the number of states that spend more per student in high-poverty districts (18 states) and those that spend less per student in high-poverty districts (16 states). Arroyo (2008) points out that "these data challenge Americans' deeply held belief that we provide equal educational opportunity, because they make clear that in too many communities students who are poor, minority, or English learners do not get their fair share of education funds" (p. 2). On the basis of reported numbers from Arroyo's 2008 publication, as of 2005 the United States was reported to have spent $938 per pupil less in the highest-poverty districts as compared to those districts at the lowest poverty level. In fact, Montana, the state of interest for this dissertation, exhibited similar funding discrepancies. The state spent $505 per pupil less in the high-poverty districts than it spent in the lowest-poverty districts (Arroyo, 2008). This lack of spending on the part of Montana schools may be cause for concern for American Indian families, owing to the high poverty levels associated with reservation living (NCSL, 2010).

Jensen (2009), in his book *Teaching with Poverty in Mind: What Being Poor Does to Kids' Brains and What Schools Can Do About It*, focuses on the relationship between academic achievement and low SES. Jensen claims that individual student's SES has been reported to play a role in student academic achievement, evidenced by scores on IQ tests, standardized tests, and the rate and frequency at which students are retained. Students, no matter what their race, who come from a background where parents have limited academic
exposure and who feel the stress of supporting their families with limited resources—as is common with low-SES individuals—tend also to have issues that inhibit their ability to learn, therefore decreasing their academic achievement. In this way, poverty may play a role in students' motivation to learn in school, owing to the overwhelming challenges and competing demands these students face on a daily basis that more affluent students do not need to acknowledge (Jensen, 2009). Poverty also contributes to the behaviors that low-SES students exhibit, thus hindering their abilities to interact in a meaningful and fulfilling way with their peers and with the content being taught in the classroom (Jensen, 2009).

The National Caucus of Native American State Legislators (NCNASL), established in 1992, is an organization composed of members of Native American nations throughout the country who act as advisors for the National Conference of State Legislatures (NCSL) to address Native American issues. In response to the findings of the National Indian Education Study (2008), the NCNASL and the NCSL (2008) have addressed these issues in a call to action, "to work to ensure that opportunities are equitably distributed to all American Indian, Alaska Native, and Native Hawaiian students" (p. 17). The NCSL (2008) reported that "state test results indicate that American Indian/Alaska Native student achievement decreases as the concentration of American Indian/Alaska Native students in the school increases" (p. 19). This decrease in achievement

10 The NCSL is "a bipartisan organization that serves the legislators and staffs of the nation's 50 states, its commonwealths, and territories. NCSL provides research, technical assistance, and opportunities for policymakers to exchange ideas on the most pressing state issues" (NCSL, 2010).
could be attributed to the fact that areas with high concentrations of Native individuals have been found to have high poverty levels, which has been associated with low achievement (Arroyo, 2008; NCSL, 2008). The more Native American students in a given state, the greater the likelihood for Native students to attend the same schools, thus creating a higher density of Native students per school. When there are fewer Native American students in a state, as in Oklahoma, students tend to be more dispersed throughout the state schools and throughout the majority population. Results from the 2005 NAEP show a negative correlation between Native American population density and test scores. Oklahoma achieved higher scores (scaled score of 213) than did those states with higher-density American Indian populations, such as Montana (scaled score of 204) (NCSL, 2008).

The NCSL makes note of the fact that poverty can play a major role in student achievement: “[I]n many cases, when there is a [high] concentration of American Indian/Alaska Native students in a school, there generally is more poverty in the community” (NCSL, 2008, p. 19). The NCSL report also addresses the issue of poor health care and takes the stance that better health care—specifically vision and hearing care—may help lessen the achievement gaps.

Though the achievement gap between indigenous and non-indigenous students persists, much research in this area has been conducted on indigenous student achievement in the areas of reading and mathematics. As science quickly becomes a focus of standardized testing in the United States, the need to raise student achievement in this subject area also increases. However, other
countries such as Canada also struggle with differences in achievement on science assessments between indigenous and non-indigenous groups. Aboriginal students in Canada achieved lower scores when compared to both the average score for non-Aboriginal Canadian students and the international average score for the Program for International Student Assessment (CCL, 2007). Testing results have been reported in which Aboriginal students do not start to do poorly in science until they are closer to middle-school age. Results of this study found that in fourth grade, indigenous students start to achieve lower scores than their White classmates on standardized science tests and score only slightly higher than their Black and Hispanic counterparts. These data indicate that Aboriginal students' scores are continuing to decrease over time (CCL, 2007).

Despite work on the part of the U.S. government toward the creation of a more equal opportunity for schooling through NCLB, achievement differences persist. Several possibilities ought to be considered when attempting to learn why such differences exist in indigenous and non-indigenous student achievement. Many variables in addition to state spending and poverty have helped to create the achievement gap; additional topics will be explored in this section, including teacher preparation and teaching techniques, lack of a culturally responsive curriculum, and gender-related differences in achievement (NCSL, 2008).

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11 The Program for International Student Assessment aims at testing literacy in three competency fields: reading, mathematics, and science.
Teacher Preparation

Teachers are another important variable in the achievement gap. Quality, preparation and cultural sensitivity are all factors that have been found to contribute to the difference in achievement for Native students as compared to non-Native students (Callingham & Griffin, 2001; Mead, Grigg, Moran & Kuang, 2010). The NCSL hypothesized that the lack of quality teachers in schools with high populations of Native American students contributes to poor Native student achievement (NCSL, 2008).

Compounding the lack of quality teachers is the lack of Native American teachers in the school system. Using data from the 2005 school year included in the National Indian Study, Part II (Mead, et al., 2010), 73% of all fourth-grade teachers were White and 76% of all eighth-grade mathematics teachers and 75% of eighth-grade reading teachers were White. Although more American Indian teachers are present in schools with a higher population density of American Indian students, White teachers clearly dominate in numbers (NCSL, 2008).

The Role of Culturally Relevant Curriculum in Teacher Preparation.

Though the ability of non-indigenous teachers to teach students of indigenous backgrounds may be a factor in the lack of indigenous achievement, other issues such as cultural relevance of the test and the curriculum being taught in the classroom need also to be taken into account. Gloria Ladson-Billings (2012) explores issues of "paradigmatic and epistemologic challenges" in her article, Through a Glass Darkly: The Persistence of Race in Education Research & Scholarship. In her paper, she focuses on the "paradigmatic and epistemologic
challenges" research focused on race must address, such as how race is seen by the world as unequal and set up in a hierarchical system perpetuating inequality. She finds that successful teachers of minority students, particularly African American students, are most successful when three propositions are used as a focal point for classroom instruction: "focus on student learning, development of cultural competence, and promotion of sociopolitical consciousness" (p. 118). Ladson-Billings draws on her research to claim that the success of minority students goes deeper than simply developing and implementing a more culturally relevant curriculum but rather rests heavily on the teacher and whether the teacher believes deeply and fully in the intellectual capability of his or her students.

Other studies such as that of Callingham and Griffin (2001) focus on the effects incorporation of culturally relevant curriculum or teaching methodologies have on student achievement. Their study reveals that as a result of this incorporation, positive results emerge as an increase in student achievement. Callingham and Griffin (2001) recruited 40 teachers and Aboriginal education workers in 19 project schools located in Australia to participate in professional development that aimed to develop teachers' skills in teaching numeracy in ways to support indigenous students' learning. Students were assessed on how well they did on various tasks at the beginning of the school year and again at the end of the school year. Approximately 6 months into the study, students and teachers were also given a questionnaire in which teachers answered questions about various teaching and assessment styles and students discussed their attitudes
toward mathematics and school. Students concluded in their responses that they enjoyed learning math when it was fun and enjoyed the way in which it was being taught (after the teachers had attended workshops). Teachers who changed their teaching style based on workshops saw a greater gain in student achievement.

In previous studies conducted by Aikenhead (2001a, 2001b, 2006), indigenous students' achievement levels were found to increase when the students had greater exposure to a curriculum that integrated Native knowledge into the science curriculum. These findings indicate that cultural exposure can have a positive effect on student outcomes. Continued focus and study of this issue is valuable in understanding how students are learning and respond to exposure to cultural curriculum and teaching methodologies.

Building on data from previous studies by Aikenhead (2001a, 2001b, 2006), findings from the second part of the National Indian Education Study (Mead et al., 2010) focus on survey responses from approximately 22,000 fourth- and eighth-grade American Indian and Alaska Native students that addressed their family, community, and educational experiences. Additionally, approximately 8,400 fourth- and eighth-grade teachers were also surveyed to discover their teaching techniques and the covered content in the classroom. The study found that nearly half of the students reported having exposure to Native American knowledge in their classrooms. When the results were broken down by school, a greater percentage of students who reported learning about Native knowledge were found in BIE schools as compared to public schools with high or low concentrations of Native students. Mead speculated that it was much more
probable, given school-level observations, that students in schools with high densities of Native American students had more exposure to elders or tribal members who participated in school activities and visited schools on a more frequent basis, thus providing for a more authentic and memorable experience with the curriculum (Mead et al., 2010). More than half of the students reported that someone in their home participated in helping them with schoolwork at least one to two times per week. Mead et al. (2010) believe that "[t]he inter-actions among home, school, and community influences are complex and potentially provide avenues for promoting AI/AN [American Indian/Alaskan Native] student achievement" (p. 12).

Findings from the teacher surveys indicated that students in BIE schools were more likely to be exposed to cultural information and activities in the classroom (Mead et al., 2010). Although Native American students reported that they greatly preferred a curriculum in which cultural knowledge was an inherent feature, 95% of fourth- and eighth-grade students had teachers who reported that they rely solely on state content standards when preparing lessons, and most teachers provided instruction completely in English. American Indian/Alaska Native culture was rarely honored (Mead et al., 2010). When examining the difference between BIE schools and public schools with high/low densities of Native students, higher numbers of students in BIE schools had teachers who relied on American Indian/Alaskan Native content or cultural standards as well as state standards when providing instruction. Clearly, this study illustrates the
differences in instruction and utilization of Native standards in the classroom and the effects it can have on Native students.

It is hoped that having greater access to prepared quality teachers, culturally relevant curriculum, and family and tribal elders who can teach Native science concepts through authentic experiences would lend itself to increasing indigenous student achievement and decreasing the gap between White and American Indian students. However, most science curriculum is not culturally relevant and therefore lacks cultural sensitivity. This lack of sensitivity can be addressed by educators by providing an integrated, multi-science perspective for all students (Ogawa, 1995).

**Culturally Responsive Curriculum in Science Education**

The majority of science curriculum lacks cultural sensitivity and fails to acknowledge that there are other ways of viewing science. McKinley (2007), in a literature review entitled *Postcolonialism, Indigenous Students, and Science Education*, discusses the struggles that Native students must face when learning science in today’s classrooms. In this review, she elaborates on how indigenous knowledge may not be found in school curricula because it is not considered “scholarly, because of the way in which it is developed and transmitted” (p. 207).

Ogawa (1995) believes that science needs to be reconceptualized in a relativistic perspective. Based on his claim that “science for all” equates to Western science for all, he proposes to remedy this situation with an approach that he calls “multiscience,” a rational explanation of the physical world that is “relative to the community of scientists who produced its knowledge” (Ogawa,
Indigenous science is an alternate approach that "is held by a specific cultural group, not by a specific individual" (1995, p. 585). Ogawa (1995) argues that each culture's approach to science carries with it not only a body of information but a particular process or definition of rationalism. At the same time, individuals experience 'personal science,' which is their own particular worldview that is affected by their indigenous background, religion, level of development, and other factors. These three types of science—Western, indigenous, and personal—together constitute a "multiscience perspective" (Ogawa, 1995). The incorporation of a multiscience perspective could prove useful when developing both curriculum and standardized assessments for schools with indigenous populations.

With a similar lens, Aikenhead and Michell (2011), in their book, *Bridging Cultures: Indigenous and Scientific Ways of Knowing Nature*, describe how indigenous students find Eurocentric science irrelevant to their worlds, which are constructed as a series of relationships rather than categorically, as WMS situates them. The authors suggest that learning for Native students must become personal and attached to who they are as individuals and what they do. Students' self-identity should therefore play a major role in how the curriculum is designed and taught. Native students do not perform at their best when memorizing of facts is expected, as it is so frequently in WMS; rather, "learning is ideally about becoming whole, complete, and balanced in mental, spiritual, emotional, and physical ways. A balanced person can fulfill her or his responsibilities within the interdependent context of family, community,
ceremonies, and nature relationships" (Aikenhead & Michell, 2011, p. 69). By combining the ideas of both WMS and Native science into a curriculum that addresses the learning styles of both White and American Indian students, the concept of multisciences as proposed by Ogawa will be enacted, allowing for both perspectives to be explored.

Turnbull (1997) believes that there should be a “third space” in which multiple perspectives can be negotiated, “an interstitial space, a space in which local knowledge traditions can be reframed, decentered and the social organization of trust can be negotiated” (Hammond & Brandt, 2004, p. 560). She believes that knowledge as it is currently portrayed “as essentially a form of representation, will tend towards universal homogenous information at the expense of local knowledge traditions” (p. 560). If both Western knowledge and indigenous knowledge are able to work together, then gaps may be filled where modern science has failed (e.g., the “green” revolution). Turnbull uses this example to examine the failure of Western knowledge in the instance of Indonesian rice farmers and the development of high-yield rice. She concludes that “there is a future for other knowledge traditions because, as the myth of science and progress collapses, so we become more aware that diversity is the key to survival” (p. 561).

In relation to concerns raised by Aikenhead (1997, 2001) and Barnhardt (2005a, 2005b) with regard to developing an indigenous science curriculum that incorporates both Western and indigenous worldviews, the state of Montana has gone a step further by developing an extensive curriculum, “Indian Education for
All," using the standards to incorporate indigenous knowledge and providing
Native items on the state standardized science tests, all mechanisms put in place
to decrease the achievement gap and all seemingly to align with the suggestions
of researchers such as Aikenhead and Barnhardt.

The incorporation of a culturally responsive curriculum in science
education seems to be at the forefront of indigenous education today as we work
toward diminishing the achievement gap and leveling the playing field for Native
students. While incorporation of cultural knowledge into the curriculum may help
to increase Native students' knowledge and understanding of a subject as well as
overall achievement, there remains the issue of gender equity in science
education. Many data have been collected on the differences in achievement for
White male and female students, but few have been gathered on the differences
between male and female Native students. The next section investigates the
differences between gender and racial groups.

**Gender Differences in Science Achievement**

Historically gender differences in science achievement have been well
documented in White students (Wigfield, Battle, Keller & Eccles, 2002), while
gender differences among races need attention. Gonzales, Williams, Jocelyn,
Roey, Kastberg and Brenwald (2008) used data collected from the TIMSS\(^{12} \) to
determine that at the eighth-grade level, boys were found to achieve significantly
higher average scores than girls in many countries. In the United States, boys

\(^{12}\) TIMSS is the largest international comparative standardized study of educational achievement.
scored 541, whereas girls scored 536 on the 2007 science portion of TIMSS. The data showed that boys scored at least 20 points higher than their female counterparts in 12 different countries. When the science scores were broken down into specific science fields, boys typically excelled in earth science, physics, and chemistry, and girls tended to do equally as well as their male counterparts in the areas of life and environmental sciences (Mullis, Martin, Fierros, Goldberg & Stemler, 2000). Therefore, though female achievement in certain areas of science may differ from that of male students, boys and girls score similarly when it comes to life sciences.

In the 2009 NAEP, which is administered every 2 years in the United States, male students in the eighth grade scored higher on the science portion of the test than did their female counterparts (NCES, 2011b). Boys had an average scaled score of 152, whereas girls' average scaled score was 148, the mean being 150. This scaled score also translates into levels of proficiency, landing more male than female students in the categories of "at or above basic," "at or above proficient," and "at advanced." One type of data that is lacking from the results section of the NAEP but could be of great use is a comparison between genders and different races. Though the test results do show differences in achievement scores between races and between genders separately, knowing

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13 The levels of proficiency as determined by the NAEP are defined as follows: Basic denotes partial mastery of prerequisite knowledge and skills that are fundamental for proficient work at each grade. Proficient represents solid academic performance. Students reaching this level have demonstrated competency over challenging subject matter. Advanced represents superior performance (National Center for Education Statistics, 2011).
how students in each of the categories do in comparison to their counterparts of the same race would be informative as well.

Large-scale data sets can provide overall achievement scores in certain academic areas for multiple groups of students, allowing for comparison between racial groups. These data are valuable when looking at different subject areas and over large groups of students because they provide insight into how groups compare to one another in multiple areas.

Data collected by Dimitrov (1999), from the Ohio state standardized test, was examined to "determine patterns of gender differences in science achievement across response formats and strands of learning outcomes, taking into account the role of ethnicity and ability" (p. 2). Data included science scores based on both multiple-choice and open-response items from 2,551 fifth graders from 40 schools in a large urban area in northeast Ohio. Analysis of the data concluded that while scores between low- and medium-achieving male and female students differed little, the mean scores being equal or differing by only 1 or 2 points, high-achieving male students tended to score higher on open-response items than their high-achieving female counterparts, especially on items involving physical science. These results illustrate that though there may not be a great difference in test scores at the fifth-grade level for this population of students regardless of gender, a difference does still exist when it comes to standardized assessment in science. Another outcome in Dimitrov's study (1999) supports the previously stated data from TIMSS, where higher achievement is exhibited by male students in the physical science realm. Though the findings
suggest that there is a difference in various aspects of science achievement between genders, Dimitrov does not suggest an explanation for the existence of this difference, and therefore more investigation is needed into the reasons behind the difference among higher-achieving students and the much less notable difference among lower- and middle-achieving students.

Many quantitative studies provide evidence of a disparity between male and female students' science achievement, but few qualitative studies investigate the reasons for female students' poor performance on achievement-oriented tasks. The qualitative study of Brickhouse, Lowery, and Schultz (2000) investigates female students' identities in science classes and how they engage in the class. During an investigation of 12 African American–mixed race female eighth-grade students, it was uncovered through interviews and journals that even though girls may believe they are good at science, they may not be completely successful at it. One of the students interviewed believed that she was good at science, had a strong interest in science, and did moderately well; however, as she matured and went on to high school, she enrolled in the lowest-level science courses. Brickhouse et al. (2000) suggest that this type of change in attitude and beliefs can be attributed to the way the subject matter is taught: As depicted in the study, several different teachers used different methodologies that may not have allowed for flexibility in learning and thus may have alienated female students. Whereas 12 students were followed in this study, only 4 were included in the final write-up. The cases in the Brickhouse et al. study illustrate how female students can engage with science in ways that are not stereotypical.
The authors suggest that the girls in this study might have benefited from a differentiated curriculum that would allow for greater diversity of methods by which students could engage with the material.

In a literature review focusing on feminist scholars in science education, Brickhouse (2001) discusses the importance of theories of learning and the role that feminist perspectives play in adding and substantiating these theories rather than simply categorizing a person by “thinking/feeling, mind/body,” as many people believe feminist perspectives do. These theories of learning that suggest that women just think and do not do often disregard issues associated with feminism and thus perpetuate the very problems and inequalities that girls and women have continually had to overcome. It has been reported on the TIMSS 1997 report that differences in achievement scores between boys and girls are almost nonexistent; yet the small difference in scores that does exist does not account for the disproportionately low numbers of women in the scientific workplace (Brickhouse, 2001; Martin, Mullis, Beaton, Gonzalez, Smith & Kelly, 1997). Brickhouse’s review uses many articles from such authors as Baker and Leary (1995), Harding (1991), and Kirschner and Whitson (1998) to illustrate how learning environments can shape student identities; however, Brickhouse points out that gender differences, such as feminist epistemologies, are absent in much of the literature. This review provides an important timeline of the evolution of science education research with regard to student success and learning based on gender. Although the review provides important information in the form of a
compilation, more in-depth studies must be conducted to determine the reasons for a gender difference in student performance on standardized tests.

Many of the available studies make clear that female perspectives on science standardized testing are lacking, which may play a key role in understanding why there is a gender difference in science achievement at the standardized test level. It is important that the current study continue to investigate whether gender plays a role in achievement on standardized science tests, including an indigenous aspect. Another facet of the investigation into gender differences is a comparison of race and gender and the effect of both these variables with relation to minority student achievement and the gaps elucidated when compared to fellow White students.

It is important to bear in mind the similarities and differences of how majority and minority students view science specifically during standardized examinations. As has been established, Western science has played a major role in the development of standardized science tests in the United States. With the exception of Montana, every state uses state standards drawn from Western concepts and ideals based on the scientific method and other linear scientific methodologies. This study explores the role that Western science plays in the creation of these exams and the work of the state of Montana toward creating a tool that measures the knowledge of all students, not only those who are of the majority race.
The Prevalence of Western Perception in Today's Testing

Until recently, each state administering science assessments has included only information that was found in its state standards. With the exception of Alaska and Montana, these standards did not include multicultural or indigenous standards. Though these two states included indigenous standards in their curriculum, Montana is the first state to consult these standards when developing standardized test items. Without the inclusion of cultural standards on standardized tests, it seems that teachers do not voluntarily integrate them into their curriculum. In the second part of the National Indian Education Study of 2009, based on student and teacher responses to survey questions, results revealed alarming differences in how cultural standards were used in the classroom as compared to the use of district and state standards. The study examined the percentage of time teachers used district and state curricula as well as American Indian/Alaskan Native content or cultural standards to design their language arts and mathematics lessons. A large majority of students (85% of fourth graders and 83% of eighth graders) had teachers who reported relying almost solely on the state content standards for language arts instruction. Only 13% of grade 4 students and 10% of grade 8 students had teachers who used indigenous standards frequently in the classroom to teach language arts. Similar results were found when survey data for usage of the curriculum in mathematics instruction were examined: 96% of fourth-grade and 97% of eighth-grade students had teachers who reported relying greatly on the state standards, with
only 10% of grade 4 and 5% of grade 8 students’ teachers using content or cultural standards to guide their mathematics instruction (Mead et al., 2010).

Given the heavy reliance on state standards to develop curriculum, it is important to include Native knowledge in the standards. Since it has been reported in the National Indian Education Study that teachers rarely veer from the state standards, there is a greater likelihood that if Native standards are included, then teachers may focus more instructional time on this content.

The type of teaching and learning that takes place in U.S. classrooms to prepare students for standardized science tests conflicts with indigenous ideas and ways of knowing. The current focus of science tests is on recalling information that Department of Education officials, who help to develop test items and are usually of the majority culture, deem to be important. Rarely do these types of standardized tests provide authentic indicators of learning, such as through performance assessments or practical application of knowledge, which is the main way that American Indians have been taught science (Castagno & Brayboy, 2008).

Bamhardt and Kawagley (2005) describe a difference in ways of living in nature in terms of competencies that can be seen and measured through multiple viewpoints:

In Western terms, competency is often assessed based on predetermined ideas of what a person should know, which is then measured indirectly through various forms of "objective" tests. Such an approach does not address whether that person is actually capable of putting that knowledge into practice. In the traditional Native sense, competency has an unequivocal relationship to survival or extinction—if one fails as a caribou hunter, the entire family is in jeopardy. One
either has or does not have requisite knowledge [ways of living in nature], and it is tested in a real-world context. (p. 11)

Such an example is an indicator that standardized assessment is not a one-size-fits-all solution to understanding whether our students are learning what the content teachers are teaching them. These differing viewpoints should be indicators to educational reformers that change is necessary in the testing process to allow for success across the board and not just simply in the majority culture.

Because testing is an important societal indicator of success for most students (Moon et al., 2007), it is critical that student perceptions of testing and the curriculum used to prepare for testing be uncovered and understood for a better grasp of how students value the tasks that they are given. In this way, educators and policymakers can see the impact that testing has on a sociocognitive level and the effects on the value students place on these tasks, leading ultimately to achievement outcomes in the form of passing or failing standardized tests.

**Montana Initiatives**

During the 2006–2007 school year, the United States had nearly 600,000 American Indian and Alaskan Native students in the K–12 school system (NCSL, 2008). Of these students, the state of Montana accounted for more than 16,000 Native American individuals comprising more than 11% of the total U.S. student population (NCSL, 2008).
The state of Montana has attempted to provide a more equal learning opportunity for all students, regardless of race or American Indian nation, by developing the "Indian Education for All" curriculum. Arising from much work with Native communities in Canada and Alaska, Aikenhead (1997, 2001a, 2001b) and Bamhardt (2005a, 2005b) raised concerns about the lack of an indigenous science curriculum that integrates both Western and indigenous worldviews. Montana has addressed this concern with the "Indian Education for All" curriculum, in which Montana's 12 American Indian nations are represented. All students across the state are taught this curriculum, regardless of their race or tribal origin. The focus of this curriculum is to connect "cultures and classrooms" across the state of Montana, making each group feel valued in the information that they have to offer. Although many Montana teachers are not of American Indian heritage, these teachers do have a stake in their students' learning and overall achievement and may benefit greatly from such a unified curriculum being incorporated into the state standards (Lugones & Spelman, 1983).

Although the state of Montana sees great value in a multicultural curriculum, challenges remain concerning cultural activity-related legitimacy. Most activities related to multicultural education involve holidays, celebrations, and food rather than deeper understandings of the American Indian way of life and contributions to science and society. Through the "Indian Education for All" curriculum, teachers are able to integrate material that is specific and genuine to all nations locally, in school districts, and across the state, and to provide deeper understandings of the subject matter. Rather than creating additional standards,
the state has aligned the curriculum with state standards to ensure that students are meeting the state educational requirements. As part of the curriculum developed for science, several of the state standards were addressed, including the following:

**Standard 1:** Students design, conduct, evaluate, and communicate scientific investigations.

**Standard 3:** Students demonstrate knowledge of characteristics, structures, and function of living things, the process and diversity of life, and how living organisms interact with each other and their environment.

**Standard 4:** Students demonstrate knowledge of the composition, structures, processes, and interactions of Earth's systems and other objects in space.

**Standard 6:** Students understand historical developments in science and technology. (Montana OPI, 2006a)

Although standard 5, how scientific knowledge and technological developments affect society, is not specifically addressed in this curriculum, the state does make the following recommendation: "Science Standard 5 can be addressed by including information on how more recent scientific knowledge and technological developments affected the Indian world in Montana, e.g., the coming of the railroad, electricity, computers, etc." (Montana OPI, 2006a, p. 37).

Montana believes that all students would benefit in learning that by exploring Native cultures through a holistic perspective and through the contributions of Native people, American Indians can truly be presented as multidimensional human beings—as complex, specialized, and knowledgeable individuals and acknowledging Indians as serious students of the world in which they live. (Montana OPI, 2006a, p. 38)
This use of culturally relevant pedagogy is progressive in the world of education and provides for a multicultural perspective that is commonly lacking in the traditional Western science curriculum.

In addition to developing a culturally responsive curriculum to be used in the classroom, the state of Montana developed standardized test items using American Indian standards, to assess the teachings and understandings of this curriculum. As part of an amendment to an article of the Constitution of the state of Montana and statutes in 2006, the implementation of the state science standards must include the “distinct and unique cultural heritage of Montana American Indians” (Montana OPI, 2006b). Items were developed according to usual procedure, by developers at Measured Progress, the contracting company for the state test, and the items then were reviewed by committees in the Office of Public Instruction and Indian Education division. These items reflected the knowledge that students should have acquired from the teachings of the “Indian Education for All” curriculum in their classrooms, based on state science standards.

Montana seems to be in alignment with researchers who associate themselves with indigenous science, whether it be in the realm of teaching, curriculum, or testing. With regard to all of the combined perspectives on how the discipline of science should be taught to students of all cultures, Montana appears to be making positive gains in accounting for individual learning and

14 “The Montana Office of Public Instruction provides vision, advocacy, support and leadership for schools and communities to ensure that all students meet today’s challenges and tomorrow’s opportunities” (Montana OPI 2012).
cultural needs. Montana's efforts to create standardized test questions from an integrated, culturally relevant curriculum may be paving the way for positive growth and relevant research in indigenous student achievement. Such efforts begin to integrate and account for all the challenges, including educational colonization, curricular control, lack of cultural relevance, content, and standards.

There is a clear issue of inequitable educational opportunities for minority students that perpetuates the issue of lower levels of achievement. The achievement gap is a complicated issue that will not simply go away with the implementation of greater funding or resources. While the amount of money spent and poverty levels of schools and individuals need to be addressed, other areas including lack of culturally relevant curriculum, test items, and teacher preparation also need further exploration as to their role in the achievement gap. These themes provide the foundation for my investigation of American Indian student achievement on standardized science tests: My study advances what all the cited studies have investigated—lack of culturally relevant curriculum, Native standards, and indigenous test items—bringing all these considerations together to determine whether they actually make a difference in indigenous student science achievement. The preceding sections form the basis from which to address my research questions, focusing specifically on the difference in achievement between American Indian and White students when their race, gender, SES, and school locale are taken into account and comparing both groups of students on overall test scores and on responses to individual items that are specifically derived from the Native standards. While the foregoing
sections offer insight into the past and current status of the achievement gap between American Indian and White students, the intention of this study is to focus on what might be done in the future to combat widening of the achievement gap.
CHAPTER 3

METHODOLOGY

Rationale and Research Questions

The views that Native and non-Native students have toward mandatory state science assessments have become increasingly more important as a greater number of states prioritize inclusive science testing. For a clear understanding of student achievement, an appropriate science assessment must be used. Montana has developed a state science assessment that has incorporated test items that assess White modern science (WMS) and a few test items that assess students' understanding of indigenous science. Within my study, I examine Montana's eighth grade students achievement on the state science assessment exploring indigenous and White student performance on both WMS and American Indian items on the Montana State science test. The research questions in play were as follows:

1. Are there differences in eighth-grade students' standardized science test scores based on non-Native standards for American Indian versus White students? Is the relationship between science achievement and race different when achievement test items based on Native standards are used?
2. Using students' standardized science achievement test scores based on non-Native and Native standards, are there differences in achievement for boys versus girls, for students of different socioeconomic backgrounds, or for students attending schools in different locations (rural vs. urban, reservation vs. non-reservation)?

3. Using students' standardized science achievement test scores based on non-Native standards, and then science achievement test scores based on Native standards; is the relationship between science achievement and race attenuated when controlling for gender, student socioeconomic status (SES), and school location (rural vs. urban, reservation vs. non-reservation)? Is the relationship between science achievement and race different for boys versus girls, for students of different socioeconomic backgrounds, or for students attending schools in different locations (rural vs. urban, reservation vs. non-reservation)?

Data Collection

Site Selection

Research conducted previously by Kawgley and Barnhardt (2007), Aikenhead (1997, 2001), and Barnhardt (2005a, 2005b) has shown that there is a new emphasis on the utilization of local knowledge and people in the K-12 schools. Examples of indigenous science curriculum has already been implemented into science curriculum across Alaska and Canada. Although it has been incorporated into the curriculum in these geographical areas, indigenous knowledge has never been included on the standardized tests to measure
whether, in fact, the teaching of indigenous knowledge in science classrooms play a role in indigenous student achievement. Montana was selected as the research site for my research because it is the first state in the United States to have developed state standards focused on American Indian knowledge and to incorporate indigenous knowledge on their state assessments. The inclusion of indigenous test items makes Montana an exclusive case and study site.

Participants

Although the state standardized science assessment is given in grades 4, 8, and 10, I chose to work with the grade 8 science assessment data. I considered the 10th grade assessment, however the dropout age for Montana is 16 years, which is the age of the majority of 10th graders. Recent data from the Montana American Indian Student Achievement Data Report from fall of 2010 reported American Indians in Montana had a dropout rate of 8.8% while White students had a 2.9% dropout rate for the 2008–2009 school year (Montana OPI, 2010). The 10th grade science assessment scores would be missing some of the students that I was interested in studying. In addition, I felt the 4th grade assessment might not be as optimal because the 4th grade students were not as experience as the 8th graders in taking the science assessments and they would also have less opportunity to learn the indigenous curriculum in the classroom.

Montana began their statewide testing 2001 with the Iowa Tests of Basic Skills (ITBS) in grades four and eight and Iowa Tests of Educational Development (ITED) in grade 11. Each of these tests measured progress in reading, communication arts, Math, Social Studies and Science. In the Spring of
2004 and 2005 Criterion-Referenced Test (CRT) and Criterion-Referenced Test-Alternative were introduced by Measured progress to assess reading and math skills in grades four, eight and ten. This was expanded to grades three through eight and ten in the Spring of 2006 and continues currently (Montana OPI, 2012).

In 2007 Measured Progress implemented the CRT and CRT-Alt in science for grades four, eight and ten (Montana, OPI, 2012). During this year the Office of Public Instruction included test items based on Native standards as a pilot test to determine how well students would score on these items since the implementation of "Indian Education For All" in 2006. After careful review the items were not included on the test in 2007 but in 2008 a single item was included and in 2009 eight items were included.

Currently, Montana utilizes a standardized assessment known as The Montana Comprehensive Assessment System (MontCAS), where Criterion-Referenced Tests (MT CRT) are used to measure the progress of students from third to eighth grades, as well as tenth grade in reading and math. Science assessments are administered in fourth, eighth and tenth grades. The data provided by the CRT helps parents, teachers, and students improve academic performance in reading, math, and science. Montana also uses the Iowa Norm-Referenced Tests to assess students in fourth, eighth, and eleventh grade on basic skills in reading, language arts, math, science and social studies (Montana OPI, 2012). MontCAS test results play a pivotal role in the evaluation of school's for Adequate Yearly Progress (AYP) as required by the federal No Child Left Behind Act (NCLB).
Approximately 200 middle schools and approximately 11,000 eighth-grade White and American Indian students each year who take the state science test in the state of Montana were used. As determined by the Montana OPI, all students in accredited schools are required to participate in either the criterion-referenced test (CRT) or an alternative assessment if they meet special specific accommodation requirements. These alternative assessments are not included in this study. The scores of students in the following categories were excluded from the calculation of averages by the state: students with limited English proficiency enrolled for the first time in a U.S. school; foreign exchange students; students not enrolled (i.e., home-schooled students); students enrolled for fewer than 180 hours and taking a reading, mathematics, or science course; students enrolled in a private accredited school; students enrolled in a private non-accredited school; and students enrolled in a private non-accredited Title 1 school.

Participants' overall assessment scores from Montana 8th grade science state assessments from the first 3 years the test was administered—2007–2008, 2008–2009 and 2009–2010—were used to investigate differences in average overall achievement between White and American Indian students. The analytic data set included only those students who have identified their race as either White or American Indian. The final sample included a total of 31,436 students for all 3 years, with 27,752 White students and 3,684 American Indian students.
Sources of Data

The eighth-grade assessments from the first 3 years the test was administered—2007–2008, 2008–2009 and 2009–2010—were obtained from Measured Progress, the testing company used by the state of Montana. Measured Progress, founded in 1983 is a non-profit assessment company which has grown into a national company serving over 2.5 million students nationwide. Products and services are offered to school districts and at the state level to help educators to be more informed on using standards based lessons as a basis for instruction. Products and services range from performance and standardized assessment to professional development for educators at all levels. (Measured Progress, 2012). Measured Progress initially began creating and administering Montana’s state standardized tests in 2004 beginning with reading and math followed by science in 2007. Measured Progress constructs the Montana CRT test, which provides results regarding individual student data where the students are only competing against him or herself instead of being compared to other students in the same grade as norm-referenced tests do.

The science assessment data obtained from Measured Progress was modified to eliminate extraneous data that did not apply to the study, such as reading and math scores. Data provided by Measured Progress also included demographic information for students including gender, race, SES, date of birth, the name of the school attended, and whether students are on an individualized
education plan (IEP) or 504 plan. Additional information such as whether the school was located on a reservation or in an urban area was provided by the Montana OPI.

Individual item scores from the testing years 2008-2009 and 2009-2010 were obtained through Measured Progress during the fall of 2010. The data obtained included:

1. All eighth-grade overall science test scores
2. All eighth-grade scores on science items using Indigenous (American Indian) standards
3. Eighth-grade scores for both overall and on specific science items using American Indian standards broken down by race
4. Copies of all eighth-grade science items and, more specifically, items that were written from American Indian standards
5. Demographic data for the eighth graders and their schools (i.e., gender, race, student SES, whether the school is located in an urban or not urban area, location of school either on or off a reservation)

Science achievement (outcome):

1. Overall score on science test: Eighth-grade students' overall scores attained on the science test. The range of possible scaled scores is 200–300. Because this outcome is continuous, linear regression was conducted for each of the seven models described.

2. Item score on indigenous science item: Eighth-grade students' item score on indigenous science item. (Score is based on whether student answered the question(s) correctly.)

Student demographic variables (predictors):

1. Student race/ethnicity: White and American Indian
2. Student gender: male and female
3. SES: Low poverty/high poverty (These data are coded as either a 1 for low income or a 0 for not reported for each student.) The SES of students
within schools defining them as poverty or non-poverty schools is determined by whether students receive free and/or reduced lunch. These data are reported as individual student demographic data by Measured Progress.

Locale of school (reservation/non-reservation, urban/non-urban): information provided by the Montana OPI

**Test Forms and Individual Native Test Items**

Scores for school years 2008–2009 and 2009–2010 on items developed using indigenous standards were examined to see if there was a difference in average scores on these particular items between White and American Indian students. The data was narrowed down to specific test forms that included items containing items with Native content and those items identified as Native on these forms. For year 2008–2009 these were test forms 4 and 8; for year 2009–2010 test forms 1, 2, 3, and 4 were examined. The only data needed for this part of the statistical analysis was the demographic data (whether students are White or American Indian) and the individual test items (including indicators of whether each item reflects indigenous knowledge). For the 2008–2009 school year only one Native item was included, which was present on only test forms 4 and 8. During the 2009-2010 testing year, eight items were included across all four of the different test forms in varying numbers (Form 1 = 3 items, form 2 = 1 item, form 3 = 1 item, form 4 = 3 items), thus providing for a difference in the number of students included in the study from the first year of Native item inclusion to the second year. An example of both an item written using indigenous standard and a non-indigenous item used in 2008–2009 and 2009–2010 test booklets are provided in Figure 1 with the remaining indigenous items available in Chapter 4.
Figure 1. Indigenous/non-indigenous item samples

<table>
<thead>
<tr>
<th>Indigenous Item</th>
<th>Non-Indigenous Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which sentence describes how the Blackfeet people's knowledge of astronomy was historically important to their culture?</td>
<td>Engineers at a hydroelectric dam are using computer models to learn how the energy in falling water can be efficiently harnessed. How do computer models help the engineers increase the efficiency of the dam?</td>
</tr>
<tr>
<td>A. They predicted changes in the seasons by observing the movement of stars.</td>
<td>A. by creating simulations of the water falling.</td>
</tr>
<tr>
<td>B. They predicted changes in the migration of animals by observing the orbits of comets.</td>
<td>B. by calculating the amount of water falling.</td>
</tr>
<tr>
<td>C. They predicted changes in the daily weather by observing different shapes of the Moon.</td>
<td>C. by describing the falling water in nonmathematical Language.</td>
</tr>
<tr>
<td>D. They predicted changes in the number of buffalo born each year by observing the brightness of the Sun.</td>
<td>D. by monitoring the amount of electricity generated by the falling water.</td>
</tr>
</tbody>
</table>

All items identified as originating from "Indian Education for All" have been labeled by the test developers as field test items. Field test items are typically divided among the total number of test forms and randomly distributed to students. According to Measured Progress approximately 90% of these field test items will become the set of common items on the following year's test where all students will receive all of the common items.

Test Scoring

Measured Progress uses two types of scores to report performance on the CRT; percentages and scaled scores. Percentage refers to the percentage of questions answered correctly; the percentage correct is simply the percentage of test questions that each student answered correctly. Results are reported...
according to levels that describe student performance in relation to the state standards established by the state of Montana. These standards are as follows and have been defined by the state of Montana (2010): advanced (A), which denotes superior performance; proficient (P), which denotes solid academic performance for each benchmark (students reaching this level have demonstrated competency over challenging subject matter, including subject-matter knowledge, application of such knowledge to real-world situations, and analytical skills appropriate to the subject matter); nearing proficiency (NP), which denotes that the student has partial mastery of prerequisite knowledge and skills fundamental for proficient work at each benchmark; and novice (N), which denotes that the student is beginning to attain the prerequisite knowledge and skills that are fundamental for work at each benchmark.

Table 1 depicts how Measured Progress and the state of Montana align performance designations and scaled scores for eighth-grade students (Montana OPI, 2010b).

Table 1. Eighth-Grade CRT Scaled Score Ranges for Performance Levels

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Point Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced</td>
<td>283–300</td>
</tr>
<tr>
<td>Proficient</td>
<td>250–282</td>
</tr>
<tr>
<td>Nearing proficiency</td>
<td>225–249</td>
</tr>
<tr>
<td>Novice</td>
<td>200–224</td>
</tr>
</tbody>
</table>

Scaled scores for the overall test range from 200 to 300 points. Scaled scores supplement the performance level results by providing information about the position of a student’s results within a performance level. Scaling simply converts
raw points from one scale to another. It is important to note that converting from raw scores to scaled scores does not change the students' performance-level classifications. Scaled scores are used because they simplify the reporting of results across content areas, grade levels, and subsequent years. These scores are seen to be more easily interpretable and consistent and greatly simplify the task of understanding how a student performed. School and system level scores are calculated by computing the average of student-level scores. A student's total number of points on the test is translated into a scaled score using a data-analysis process called scaling. On each test there are multiple choice questions worth 1 point each scored by a scanning machine which assigns a score of 1 point for correct responses and a 0 for responses that are either left blank or incorrect. Other items such as constructed response where students are asked to provide longer answers which demonstrate their competency in scientific knowledge and application are scored by trained scorers and are assigned scores ranging from 0-4 with four being the highest possible score. In this research only multiple choice items contain indigenous knowledge, therefore only a 0-1 scale would be utilized indicating an incorrect or correct response.

Data Analysis

All of the necessary test scores and demographic data were obtained from Measured Progress and the Montana OPI. These data included all eighth-grade science test scores broken down per item for both indigenous and non-indigenous test items, overall test scores and demographics, school level data
such as demographics, annual yearly progress (AYP) information and overall test data, among other data. The same data used by the OPI to determine AYP for each school is the same data used to conduct this analysis. After receiving the initial data set from Measured Progress which included students overall scores for the past three school years in which the science test was administered (2007–2008, 2008–2009, 2009–2010) a preliminary analysis of overall student performance on the test was conducted.

Using SPSS, data was examined to ensure that only necessary information was included in the file (i.e. student achievement scores, race, gender, location of school and SES of student). Students who did not report a gender but who had either obvious masculine or feminine names were assigned a gender. Ethnicity was also re-coded to the two categories of interest, White and American Indian. Following initial re-coding of the data descriptive analyses were conducted. After re-coding for only White and American Indian ethnicities only 1899 students of other races not fitting the established criteria were eliminated from the initial sample of 33,335 students for all 3 years. The final sample contained a total of 31,436 students with 27,752 White students and 3,684 American Indian students.

Statistical analysis was performed, beginning with conducting simple descriptive analyses which included obtaining means of student test scores, standard deviations, and confidence levels. In addition, the distributions of all variables were reviewed which allowed for investigation into what proportion of student scores fell between the mean and other various points for specific items.
and groups of items. By using the standard normal distribution percentiles of a given distribution of scores were determined; for example, it was determined what percent of students had scores that were greater than or less than the mean scores on Indigenous and Non-Indigenous science items. The second step was to conduct bivariate analyses, such as correlation and independent samples t-tests. The t-tests allowed for the determination of any statistically significant differences between average student scores on the indigenous and non-indigenous items based on race and gender, thus addressing the first research question. Correlations provided information about whether there were significant relationships between student scores and student SES, urban vs. non-urban, ethnicity of students etc. Prior to conducting bivariate analyses a visual analysis of box plot was undertaken to examine the variability of student scores for each of the student and school level variables. Estimating correlation coefficients also provided information about the magnitude of relationships being compared.

The third step in the analysis process was to fit a series of multiple regression and logistic regression models using SPSS. The goal was to identify which variables were most predictive of both the overall achievement scores as well as scores on specific indigenous items. Examples of predictors that are included in this model are as follows:

- **Race**: Self-reported by the student on the test booklet. Used to determine if there is a difference in average test scores between White and American Indian students on both overall science test
scores and on the specific items designated as Indigenous and to determine if race is correlated with achievement.

- **Gender**: Used as a control variable and/or used in determining whether the gender effect changes when there are multiple predictors in the model.

- **SES**: Used to determine the effect of race on ethnicity and to explore if it is lessened when we consider the impact of student SES.

- **Locale of school** (reservation or not, urban or not urban): This item was investigated to determine if controlling for where the student attended school, accounted for differences in student achievement on the science tests and on specific indigenous items.

Examination of the outcome achievement variables helped in determining whether there was a relationship between the predictors and the outcome and if any relationships emerged when the predictors are controlled for.

Using the overall achievement scores as an outcome, the following series of multiple regression models were fitted:

1. **Model 1**: Simple linear regression – \[ ACHIEVEMENT = \beta_0 + \beta_1 RACE + \varepsilon \]
   This model tests the effect of race on achievement, not controlling for any other predictors.

2. **Model 2**: \[ ACHIEVEMENT = \beta_0 + \beta_1 RACE + \beta_2 GENDER + \varepsilon \]
This model tests the impact of both race and gender on achievement and addresses the questions: Are there differences in student achievement as a function of race and gender? And is there a relationship between race and achievement, controlling for gender?

3. Model 3: \( ACHIEVEMENT = \beta_0 + \beta_1 RACE + \beta_2 GENDER + \beta_3 SES + \epsilon \)

Model 3 models the effects of race, gender, and SES on achievement. In addition, it allows us to determine whether the race effect persists, controlling for gender and SES.

4. Model 4:

\[ ACHIEVEMENT = \beta_0 + \beta_1 RACE + \beta_2 GENDER + \beta_3 SES + \beta_4 LOCAL + \epsilon \]

Model 4 addresses differences in the location of the school, while taking race, gender, and SES of the student into account. In addition, it allows us to determine whether the race effect changes when LOCAL is controlled for.

Testing for interactions:

5. Model 5:

\[ ACHIEVEMENT = \beta_0 + \beta_1 RACE + \beta_2 GENDER + \beta_3 SES + \beta_4 LOCAL + \beta_5 RACE \times GENDER + \epsilon \]

Does the effect of race differ for male vs. female students, controlling for SES and LOCAL?

6. Model 6:

\[ ACHIEVEMENT = \beta_0 + \beta_1 RACE + \beta_2 GENDER + \beta_3 SES + \beta_4 LOCAL + \beta_5 RACE \times SES + \epsilon \]
Does the effect of race differ by student SES, controlling for GENDER and LOCAL?

7. Model 7:

\[ ACHIEVEMENT = \beta_0 + \beta_1 RACE + \beta_2 GENDER + \beta_3 SES + \beta_4 LOCAL + \beta_5 RACE \times LOCAL + \epsilon \]

Does the effect of race differ by school location, controlling for GENDER and SES?

A different set of analyses were undertaken using students' scores on the indigenous items as outcomes. Because each indigenous item is either coded correct or not correct, achievement outcome variables based solely on these items are dichotomous variables, and thus logistic regression analysis was necessary to model the relationships between student success on indigenous items and the predictors listed above. A set of models similar to the ones described above were fitted using logistic regression analysis.

- Model 1: Logit (probability of correct answer) = \( \beta_0 + \beta_1 RACE + \epsilon \)
- Model 2: Logit (probability of correct answer) = \( \beta_0 + \beta_1 RACE + \beta_2 GENDER + \epsilon \)
- Model 3: Logit (probability of correct answer) = \( \beta_0 + \beta_1 RACE + \beta_2 GENDER + \beta_3 SES + \epsilon \)
- Model 4: Logit (probability of correct answer) = \( \beta_0 + \beta_1 RACE + \beta_2 GENDER + \beta_3 SES + \beta_4 LOCAL + \epsilon \)
Testing for interactions

- Model 5: Logit (probability of correct answer)

\[ p_0 + \beta_1 \text{RACE} + \beta_2 \text{GENDER} + \beta_3 \text{SES} + \beta_4 \text{LOCAL} + \beta_5 \text{RACE} \times \text{GENDER} + \varepsilon \]

(Does the effect of race differ for male vs. female students?)

- Model 6: Logit (probability of correct answer)

\[ p_0 + \beta_1 \text{RACE} + \beta_2 \text{GENDER} + \beta_3 \text{SES} + \beta_4 \text{LOCAL} + \beta_5 \text{RACE} \times \text{SES} + \varepsilon \]

(Does the effect of race differ by student SES?)

- Model 7: Logit (probability of correct answer)

\[ p_0 + \beta_1 \text{RACE} + \beta_2 \text{GENDER} + \beta_3 \text{SES} + \beta_4 \text{LOCAL} + \beta_5 \text{RACE} \times \text{LOCAL} + \varepsilon \]

(Does the effect of race differ by school location?)

**Results of Initial Exploratory Analysis of Three Years of Data**

Exploratory analysis was initially conducted using data from all 3 years the Montana science standardized test was administered. The first year, 2007–2008, no indigenous items were present on the test, however this year, coupled with tests from the two years that had indigenous items provided insight into the overall achievement gap between White and American Indian students on science standardized tests. The three year sample included a total of 31,436 students.

Tables 2 and 3 provide a comparison of scores for White students and American Indian students in the eighth grade for 3 years. Each performance
level, based upon points a student earned throughout the test is also assigned a corresponding number 1-4. The score breakdowns for each performance level as established by the state of Montana (2010) are as follows: advanced (A), 283–300 points, which denotes superior performance and is also equal to a 4; proficient (P), 250–282, a 3 score, which denotes solid academic performance for each benchmark (students reaching this level have demonstrated competency over challenging subject matter, including subject-matter knowledge, application of such knowledge to real-world situations, and analytical skills appropriate to the subject matter); nearing proficiency (NP), 225–249, a score of 2, which denotes that the student has partial mastery of prerequisite knowledge and skills fundamental for proficient work at each benchmark; and novice (N), 200–224, a score of 1, which denotes that the student is beginning to attain the prerequisite knowledge and skills that are fundamental for work at each benchmark.

Table 2. Students' Mean Scaled Score per Year Based on Race

<table>
<thead>
<tr>
<th>Race</th>
<th>Mean Scaled Score per Year</th>
<th>Total (all 3 years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Indian</td>
<td>235</td>
<td>236</td>
</tr>
<tr>
<td>n = 1,223</td>
<td>n = 1,252</td>
<td>n = 1,209</td>
</tr>
<tr>
<td>White</td>
<td>257</td>
<td>258</td>
</tr>
<tr>
<td>n = 9,467</td>
<td>n = 9,183</td>
<td>n = 9,102</td>
</tr>
</tbody>
</table>

Note: Score range is 200–300 points, where the maximum score a student can achieve is 300. All differences between American Indian and White scores are statistically significant at p < .001.

In the data, it is observed that a score of 200 is reserved for students who either respond incorrectly 100% of the time or fail to provide an answer for any item.

Based on an examination of the 3 years of data it was noted that 686 students
have a score of 200, (446 White and 240 American Indian) which in the overall sample accounts for less than 3% of the total population of students taking the test.

When examining mean scaled scores from eighth-grade American Indian and White students, White students consistently achieve higher average scores on the state standardized science test than American Indian students across all 3 years. For each year there is about a 22-point difference in average scores between the two groups of students. This point difference is statistically significant at $p < .001$ and also in that it could mean the difference of a change in proficiency level.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>American Indian</td>
<td></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>White</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

Note: 1 = novice, 2 = nearing proficient, 3 = proficient, 4 = advanced. All scores are statistically significant at $p < .001$.

Looking at student performance level scores per year, it is clear that the average American Indian student consistently achieves a score of 2, which translates into nearing proficient according to Montana state standards and indicates that the student has partial mastery or prerequisite knowledge and skills fundamental for proficient work at each benchmark. The average White student consistently achieves a score of 3, which is considered to be proficient, indicating that the student demonstrated competency over challenging subject matter, including
subject-matter knowledge, application of such knowledge to real-world situations, and analytical skills appropriate to the subject matter.

Although American Indian students on average have lower mean scores than their White counterparts, there is a great deal of variability in scores for all 3 years. For both groups the range in scores is between 200-300 as can be seen in Figure 2.

Figure 2. Box plot of overall mean score for 3 years on science standardized test for American Indian and White students

![Box plot](image)

Figure 2 displays a box plot depicting student achievement on the overall standardized science test based on race. Through this diagram we are able to see that the mean score of American Indians is lower than that of White students. There is also noticeable variability for both groups in their overall scores. The standard deviation for American Indian students is 22.899 and 23.923 for White students, thus the White group has students who are scoring across a slightly wider range of scores while American Indian students are tending to score mostly
toward the lower end of the range. Each group has a range of 100 points, given that the highest score achieved by a student was 300, while the lowest was 200. The median score for American Indian students is 236 points and the median score for White students is 260 points. American Indian students score lower than White students overall, however there is a portion of students that score in the same range as White students.

Although White students have reportedly higher scores, this does not mean that all American Indian students are performing poorly, but implies that not enough American Indian students are scoring high enough to make a significant difference in the overall combined test scores for all American Indians.

Table 4. Mean Scaled Score and Performance Level by Race and Gender for 3 Years

<table>
<thead>
<tr>
<th>Race</th>
<th>Gender</th>
<th>Mean Scaled Score for 3 Years</th>
<th>Performance Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Indian</td>
<td>Male</td>
<td>238</td>
<td>2</td>
</tr>
<tr>
<td>N = 3,684</td>
<td>Female</td>
<td>236</td>
<td>2</td>
</tr>
<tr>
<td>N = 1,829</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N = 1,855</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>Male</td>
<td>260</td>
<td>3</td>
</tr>
<tr>
<td>N = 27,752</td>
<td>Female</td>
<td>257</td>
<td>3</td>
</tr>
<tr>
<td>N = 14,321</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N = 13,431</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 = novice, 2 = nearing proficient, 3 = proficient, 4 = advanced.

Note: Score range is 200–300 points, where the maximum score a student can achieve is 300. All scores between male and female American Indian and White students are statistically significant at $p < .001$.

When comparing scores between all American Indian male and female students for 3 years (Table 4), data shows that there is only a 2-point average difference between the two sexes. This 2-point difference does not account for any difference in performance level scores, therefore it would not be considered
significant. Another comparison is shown in Table 4 between overall scores for both male and female White students for 3 years. There is an overall difference of 3 points between White male and White female scores, which is not seen as being significant. The overall points for both male and female White students translate into a performance level of proficient.

When comparing the two races, differences in mean scaled scores and performance levels for both male and female students are noticeable. American Indian male students tend to score 22 points and one performance level lower than their White male counterparts. American Indian females tend to score 21 points and one performance level lower than their White female counterparts.

The conclusions drawn from initial descriptive statistics of White versus American Indian overall achievement for the 3 years of data, support previous findings (Freeman and Fox, 2005; Hall & Kennedy, 2006; National Center for Education Statistics, 2007; Nelson, et al., 2009) claiming that American Indian students achieve lower scores on standardized tests when compared to their White counterparts. The next chapter will provide data illustrating the effects that incorporating items constructed using "Indian Education for All" had on students' performance on these specific items.
CHAPTER 4

RESULTS

The purpose of this study was to examine whether there were differences in standardized achievement scores for American Indian students when compared with standardized achievement scores for White students when culturally relevant knowledge is included on the state science test in Montana. The research questions addressed in this study are as follows:

1. Are there differences in eighth-grade students' standardized science test scores based on non-Native standards for American Indian versus White students? Is the relationship between science achievement and race different when achievement test items based on Native standards are used?

2. Using students' standardized science achievement test scores based on non-Native and Native standards, are there differences in achievement for boys versus girls, for students of different socioeconomic backgrounds, or for students attending schools in different locations (rural vs. urban, reservation vs. non-reservation)?

3. Using students' standardized science achievement test scores based on non-Native standards, and then science achievement test scores based on Native standards; is the relationship between science achievement and race attenuated when controlling for gender, student
SES, and school location (rural vs. urban, reservation vs. non-reservation)? Is the relationship between science achievement and race different for boys versus girls, for students of different socioeconomic backgrounds, or for students attending schools in different locations (rural vs. urban, reservation vs. non-reservation)?

**Description of the Sample**

The overall findings from the three-year data analysis explored in Chapter 3 and the two years of data used to answer the stated research questions focusing on White and American Indian student achievement on standardized test scores show that American Indian students tended to score statistically lower than their White counterparts. This finding is consistent with the findings in current research examining testing trends in indigenous students (Cajete, 1988; CCL, 2007; Deyhle, 1983; Freeman & Fox, 2005; Fuchs & Havighurst, 1973; Hall & Kennedy, 2006; National Center for Education Statistics, 2007; Nelson et al., 2009).

**Descriptive Analysis, Years 2008–2009 and 2009–2010**

**Description of Overall Student Achievement**

Using Table 5, the first part of research question 1 is addressed: *Are there differences in eighth-grade students' standardized science test scores based on non-Native standards for American Indian versus White students?* Table 5 displays student overall mean scores on the Montana state standardized science test forms, which included items developed using the Indian Education for All curriculum. The data reveals that American Indians tend to score statistically
lower on average than White students. In 2008–2009, American Indian students scored 234.82 out of 300 points (SD 22.26), while White students scored 258.64 (SD 23.42). The overall mean test score for both ethnicities was 255.79, with a standard deviation of 24.56. An independent samples t-test was performed to determine the difference in science standardized test scores between American Indian students and White students: The difference proved to be statistically significant, with a t statistic of −16.945 and p < .001. American Indian students scored, on average, 23.82 points lower (234.82) than White students, who scored, on average, 258.64. The 2009–2010 school year, the second year of indigenous item inclusion, included a greater number of indigenous items on the test across four forms, and 1,176 American Indian students and 9,071 White students were administered the test. During this testing year, American Indians scored 240.03 (SD 21.81), while White students scored 261.69 (SD 23.18). The American Indian students participating in the second year of testing scored an average of 5.21 points higher than the American Indians in the first year of testing. A similar trend was displayed by White students in the second year; they scored an average of 3.05 points higher than White students in the first year of testing. The overall mean test score for both ethnicities for the 2009–2010 school year was 259.20, with a standard deviation of 24.04, which was an increase of approximately 3 points.
Table 5. Average Science Achievement for Categories of the Main Predictors for 2 Years of Data

<table>
<thead>
<tr>
<th></th>
<th>2008–2009 (n = 2,584)</th>
<th>2009–2010 (n = 10,247)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Race</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>258.64</td>
<td>261.69</td>
</tr>
<tr>
<td>n = 2,268</td>
<td>n = 9,071</td>
<td></td>
</tr>
<tr>
<td>American Indian</td>
<td>234.82</td>
<td>240.03</td>
</tr>
<tr>
<td>n = 316</td>
<td>n = 1,176</td>
<td></td>
</tr>
<tr>
<td><strong>Difference</strong></td>
<td>23.82***</td>
<td>21.66***</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>257.75***</td>
<td>261.08***</td>
</tr>
<tr>
<td>n = 1,292</td>
<td>n = 5,278</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>253.69</td>
<td>257.21</td>
</tr>
<tr>
<td>n = 1,292</td>
<td>n = 4,969</td>
<td></td>
</tr>
<tr>
<td><strong>Difference</strong></td>
<td>4.06***</td>
<td>3.87***</td>
</tr>
<tr>
<td><strong>SES</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low income</td>
<td>245.66***</td>
<td>249.74***</td>
</tr>
<tr>
<td>n = 918</td>
<td>n = 3,898</td>
<td></td>
</tr>
<tr>
<td>Not low income</td>
<td>261.27</td>
<td>265.01</td>
</tr>
<tr>
<td>n = 1,166</td>
<td>n = 6,349</td>
<td></td>
</tr>
<tr>
<td><strong>Difference</strong></td>
<td>15.61***</td>
<td>15.27***</td>
</tr>
<tr>
<td><strong>Reservation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On</td>
<td>239.32</td>
<td>245.35</td>
</tr>
<tr>
<td>n = 282</td>
<td>n = 1,152</td>
<td></td>
</tr>
<tr>
<td>Off</td>
<td>257.75</td>
<td>260.96</td>
</tr>
<tr>
<td>n = 2,282</td>
<td>n = 9,095</td>
<td></td>
</tr>
<tr>
<td><strong>Difference</strong></td>
<td>18.43~</td>
<td>15.61***</td>
</tr>
<tr>
<td><strong>Urban</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>257.32</td>
<td>259.58</td>
</tr>
<tr>
<td>n = 1,652</td>
<td>n = 3,559</td>
<td></td>
</tr>
<tr>
<td>Not urban</td>
<td>254.84</td>
<td>259</td>
</tr>
<tr>
<td>n = 913</td>
<td>n = 6,688</td>
<td></td>
</tr>
<tr>
<td><strong>Difference</strong></td>
<td>2.48</td>
<td>.58***</td>
</tr>
</tbody>
</table>

Note: Score range is 200–300 points, where the maximum score a student can achieve is 300. ~p < .10, *p < .05, **p < .01, ***p < .001.

Figures 3 and 4 provide a clear indication that White students are scoring higher on average than their American Indian counterparts, confirming the results.
in Table 5. On average, for 2008–2009 the White student mean score is 259 and
the American Indian mean score is 235, as compared to an overall mean score
of 256. For 2009–2010, the White mean score is 262, the American Indian mean
score is 240, and the overall mean score is 259. However, within each of the
groups, variability in test scores is apparent when examining each group’s
median, leading one to believe that the variability in how students within racial
groups are scoring depends on other factors, such as those examined in Table 5.
More than half of the American Indian students are scoring below the median
value of 235. More than half of the White students are scoring above the median
of 258.

![Figure 3. Box plot of American Indian and White eighth-grade student overall scores on the state standardized science test during school year 2008–2009.](image)

![Figure 4. Box plot of American Indian and White eighth-grade student overall scores on the state standardized science test during school year 2009–2010.](image)
Student Achievement on Native Items

The first set of research questions—Are there differences in eighth-grade students' standardized science test scores based on non-Native standards for American Indian versus White students? and Is the relationship between science achievement and race different when achievement test items based on Native standards are used?—were additionally addressed by comparing differences in scores on indigenous items versus non-indigenous items for the 2008–2009 school year. For this first year of inclusive testing, American Indians answered the indigenous item correctly 61% of the time, and White students answered the item correctly 72% of the time, which was statistically significant with a $t$ statistic of $-3.754$ and $p < .001$. American Indian students answered non-indigenous items correctly 44% of the time, with White students answering correctly 59% of the time, which was statistically significant with a $t$ statistic of $-17.463$ and $p < .001$. The given hypothesis that American Indians would tend to score better on items relating to their knowledge than those unrelated did not hold true, as indicated by the differences in scores between the two groups. This comparison was not as easily computed for the 2009–2010 school year owing to the inconsistencies in data, including differences in numbers of test forms and items across all forms.

The second part of the research question—Is the relationship between science achievement and race different when achievement test items based on Native standards are used?—was more thoroughly answered by applying logistic regression to the 2009–2010 test forms. Because of multiple test forms and the
fact that varying numbers of indigenous items were included on the test forms, as well as the inclusion of dichotomous outcome variables (correct/not correct), ordinary least-squares regression was not possible. Logistic regression was used to examine student performance on the indigenous items for both school years, which allowed for modeling the probability that an item was answered correctly, given the predictors. The estimated odds ratio is utilized to determine the odds of an event occurring in one group as compared to the odds of the event occurring in another group. In this instance, an odds ratio larger than 1 indicates that White students have a larger probability of answering the item correctly, while an odds ratio under 1 would indicate that American Indian students would have a larger probability of answering the item correctly. The results of logistic regression displayed in Table 6 indicates that in all cases White students have a larger probability of answering the items correctly.

The results of the logistic regression can be seen below in Table 6.

**Table 6. Comparison of Logistic Regression Parameter Estimates for Indigenous Items (Effect of Race on Probability of Answering Item Correctly)**

<table>
<thead>
<tr>
<th>Item</th>
<th>Uncontrolled Effect of Race (Model 1)</th>
<th>Estimated Odds Ratio ( \text{exp}(B) )</th>
<th>Controlled Effect of Race* (Model 5)</th>
<th>Estimated Odds Ratio ( \text{exp}(B) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 1</td>
<td>.470 ***</td>
<td>1.6***</td>
<td>.298~</td>
<td>1.3***</td>
</tr>
<tr>
<td>Item 2</td>
<td>.364***</td>
<td>1.4***</td>
<td>.216~</td>
<td>1.2***</td>
</tr>
<tr>
<td>Item 3</td>
<td>.695***</td>
<td>2.0***</td>
<td>.524***</td>
<td>1.7***</td>
</tr>
<tr>
<td>Item 4</td>
<td>.606 ***</td>
<td>1.8***</td>
<td>.413**</td>
<td>1.5***</td>
</tr>
<tr>
<td>Item 5</td>
<td>.668***</td>
<td>2.0***</td>
<td>.439***</td>
<td>1.6***</td>
</tr>
<tr>
<td>Item 6</td>
<td>.632***</td>
<td>1.9***</td>
<td>.461***</td>
<td>1.6***</td>
</tr>
<tr>
<td>Item 7</td>
<td>.547***</td>
<td>1.7***</td>
<td>.218~</td>
<td>1.2***</td>
</tr>
<tr>
<td>Item 8</td>
<td>.218**</td>
<td>1.2***</td>
<td>.078</td>
<td>1.1***</td>
</tr>
<tr>
<td>Item 9</td>
<td>.508***</td>
<td>1.7***</td>
<td>.274*</td>
<td>1.3***</td>
</tr>
</tbody>
</table>

*Control variable: gender, SES, urban, and reservation.

~\( p < .10 \), *\( p < .05 \), **\( p < .01 \), ***\( p < .001 \).
Table 6 provides data indicating that White students are more likely to obtain correct answers on the indigenous items than are their American Indian counterparts. A positive coefficient indicates that there is a larger probability that White students will answer the indigenous items correctly than will American Indian students, although for some items the difference is small. Based on the results, variation can be seen across the nine different items. For example, item 8 displays no difference by race with a coefficient of .078 after controlling for race, which was not statistically significant. Items 1, 2, 7, and 9 display small differences when controlling for race: .298, .219, .218, and .274, respectively, with p values of less than .10 and .05. Items 3, 4, 5, and 6 display the greatest differences across all items, with coefficients of .524, .413, .439, and .461, respectively, and are statistically significant with p values ranging from less than .01 to .001.

The construction of items is an important consideration when discussing student performance on standardized tests. Though they are written with the intention of addressing and assessing specific content, items do not always act as intended, affecting achievement outcomes.

**Individual Item Analysis**

After completing analysis of individual items using logistic regression, obvious differences emerged, displayed by race and student achievement on each of the items identified as indigenous in nature. A more in-depth examination of the items revealed certain themes under which each item could be categorized.
These categorizations reveal that much needs to be considered when developing test items that are cultural in nature. It is important for a test item developer to address the issues of item bias that may emerge not only within the body of the item but also within each of the distractors\textsuperscript{15} so that students are not misled. This is an interesting challenge for culturally based items, as will be explored in the individual category and item descriptions. When referring to item bias, multiple-choice items have historically been identified as being culturally biased in nature given that "[correctness, however, is reliant on students having the same 'cultural capital' as that of the test material, which in mainstream institutions is the culture of the dominant group" (Johnston, 2010, p. 3). Bias is also elucidated by standardized assessments in that a "cultural norm" which, in this case, is based on White students, is relied upon by test developers, leading to a greater likelihood that minority students will not be able to relate to the test material and therefore have a greater chance of choosing an incorrect response.

With regard to item bias in particular and test bias in general, Aikenhead and Michell (2011) state that for non-Native individuals, "[Knowledge] is something that can be given, taken, accumulated, banked, and assessed by paper-and-pencil examinations. Knowledge is something that exists independently of people; it exists separately from the knower" (p. 68). In contrast to this Eurocentric view, indigenous people are "intimately and personally interconnected with what it is they know" (p. 68). Indigenous individuals tend to have an intimate connection to knowledge and not just a superficial acquaintance

\textsuperscript{15} Distractors are the incorrect answer choices from which the student may choose for each item.
with it, which is what tends to be the norm for majority students who are competing for grades and scores rather than learning for the sake of knowledge. The way in which tests are constructed, with a multiple-choice format containing knowledge that is readily accessible and understood by majority students, seems to perpetuate the idea of bias within assessment. This idea can be seen in the examples used in this study throughout the various categories.

Three different categories—(1) historical (relating to American Indian past), (2) majority science affecting or benefiting American Indians, and (3) lack of cultural relevance—will be used as a framework for analysis and discussion of student performance by race on each of the items. Items are numbered to correspond with Table 6, addressing differences in estimated odds ratios, which explain the odds that White students would answer the item correctly as compared to American Indian students.

The first and largest theme that emerged as a result of analyzing items written on the basis of Native standards concentrated on historical ideas and focused on American Indian experiences and what these people had contributed to society from the past. This theme is defined by events occurring in the past, which were deemed “pseudo-science” by Western scientists and were not valued for the traditional knowledge that could contribute to current science (Bala & Joseph, 2007). Traditional ecological knowledge contributions to the world of science today are often ignored, suggesting the possibility that they were also ignored in the past (Bala & Joseph, 2007). Another common view of Native knowledge can be viewed as a type of “museumization,” where indigenous
knowledge is seen as obsolete and viewed as more of an artifact that is useful only in a historical context such as a museum (Kraak, 1999). Six of the nine items fell into this category.

**Historical (Relating to American Indian Past)**

The first item in this category displays differences by race when incorrect options are examined (Table 7).

Item 3: During the spring, the Salish traditionally gathered bitterroot and camas roots. During the summer, they fished for salmon and trout and gathered huckleberries and raspberries. During the fall, they hunted bison and deer. Why did the Salish traditionally harvest, fish, and hunt different types of food throughout the year?

A. These foods were easiest to keep fresh.
B. Food preferences changed throughout the year.
C. Trading preferences changed with other tribes in Montana.
D. These foods were the plants and animals available each season.

<table>
<thead>
<tr>
<th>Race</th>
<th>White (n = 2,282)</th>
<th>American Indian (n = 310)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Response</strong></td>
<td><strong>A</strong></td>
<td><strong>B</strong></td>
</tr>
<tr>
<td></td>
<td>6.7%</td>
<td>14.7%</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>153</td>
</tr>
<tr>
<td></td>
<td>11.9%</td>
<td>22.3%</td>
</tr>
<tr>
<td></td>
<td>37</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td>6.4%</td>
<td>19%</td>
</tr>
<tr>
<td></td>
<td>145</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>72.0%</td>
<td>53.9%</td>
</tr>
<tr>
<td></td>
<td>1,642</td>
<td>167</td>
</tr>
</tbody>
</table>

The distribution of responses differs by race ($\chi^2 = 44.53, p < .001$).

A much larger percentage of American Indians chose response A as compared with White students. Of the 310 American Indians who answered this question, 11.9% (37) chose A, while only 6.7% (153) of the 2282 White students chose A.

For response B, there was a closer percentage of American Indian and White students who chose B (22.3% American Indians vs. 14.7% White
students). Of the 2282 White students, 335 chose B as compared with 69 of 310 American Indian students. A much larger percentage of American Indians chose response C than White students (19% vs. 6.4%).

This item appeared to cause American Indian students a great deal of difficulty. A significant number of these students chose an incorrect response as compared to White students. The test item focuses on reasons for collecting different food at different times of the year, and the distractors all provide reasonable explanations. Given the incorrect item response rate by Native students, the state of Montana would most likely throw this test item out of the item pool for this particular testing year, and the item either would be rewritten prior to repeat testing (to better meet the focus of the standard) or would not used altogether.

Data related to the second item in this category also illustrate that a greater percentage of American Indian students than White students responded incorrectly, as displayed in Table 8.

Item 4: Which sentence describes how the Blackfeet people’s knowledge of astronomy was historically important to their culture?

A. They predicted changes in the seasons by observing the movement of stars.
B. They predicted changes in the migration of animals by observing the orbits of comets.
C. They predicted changes in the daily weather by observing different shapes of the Moon.
D. They predicted changes in the number of buffalo born each year by observing the brightness of the Sun.
Table 8. 2009–2010 Item 51, Form 1

<table>
<thead>
<tr>
<th>Response</th>
<th>White (n = 2282)</th>
<th>American Indian (n = 310)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>60.3% 1,377</td>
<td>46.5% 144</td>
</tr>
<tr>
<td>B</td>
<td>12.3% 280</td>
<td>17.4% 54</td>
</tr>
<tr>
<td>C</td>
<td>17.8% 406</td>
<td>21.9% 68</td>
</tr>
<tr>
<td>D</td>
<td>9.2% 209</td>
<td>13.2% 41</td>
</tr>
</tbody>
</table>

The distribution of responses differs by race ($\chi^2 = 23.360, p < .001$).

For each response, there was a 4–5% difference between the two groups. This particular item displays particular cultural bias in the distractors, given the plausibility that American Indian students could understand astronomy in a much different way than do White students. When referring to differences in understanding scientific ideas, one must take into account the differences between traditional ecological knowledge and Western modern science and the fact that Native students view the world holistically rather than piecemeal. The situation with this item is that astronomy, as viewed by Natives, can be seen as relating to much of the environment and their perspective of the interconnectedness of the astronomical and living world seems to have not been taken into account given the choice of distractors. Each of the distractors is a plausible answer given that the sun, moon, and stars could affect weather and living species and might cause the different changes mentioned in the item. Whereas a White student may see a cause-and-effect relationship between two entities, Native students may take a holistic view of the world and believe, based on experience, that any or all of the distractors are valid responses. The fact that American Indian students chose B, C, and D incorrectly with almost the same
frequency provides evidence that any of those scenarios described in the distractors might have been historically true for some Native American peoples.

In this particular case, American Indian students could associate different aspects of astronomy with different predictions made throughout the year, an association that White students would be unlikely to make, as demonstrated by the reduced frequency of their choice of an incorrect response as compared with American Indian students' choices. This item displays cultural bias in that it asks students to think about how a particular nation contributed to the understanding of astronomy for American Indian culture rather than for the culture of all Americans. What the item is insinuating is that Native knowledge can be seen as valuable only to other Natives and does not contribute to the scientific understandings of the greater population.

American Indians had higher percentages of all incorrect responses for the following item, shown in Table 9, than did White students.

Item 6: The Cheyenne traditionally used an extract from licorice root to treat upset stomachs. Scientists later found that this extract helps stomach ulcers heal more quickly by protecting the stomach's lining. What does the use of this extract by the Cheyenne demonstrate about their scientific understanding?

A. They knew that this extract coated the stomach.
B. They knew that stomach ulcers were the cause of some upset stomachs.
C. They knew that some substances found in nature could be used as medicines.
D. They knew that many tests have been done on the effectiveness of licorice root.
For responses A and D, there was minimal difference between the two groups' percentages. Response B had the greatest difference, with American Indians at roughly 17% and White students at about 9%. This particular item reflects the scientific contributions of American Indians and, in this regard, differs from most of the other items, which focus on historical aspects or effects that today's technologies will have on tribal nations. It is plausible that American Indians had knowledge of ulcers from their medical experiences with caring for sick individuals and made a logical conclusion that upset stomachs could have resulted from ulcers; hence, their treatment of upset stomach with licorice root extract. This could also be seen as a reason for students' choice of response D, in that it may be true, and is even probable, that many tribes came upon remedies through trial and error, testing the effectiveness of each natural remedy. Because this distractor does not distinguish between the ways of knowing of Western modern science, which categorically organizes items and ideas and uses the scientific method as a means of testing theories, and Native ways of knowing, which are constructed as a series of relationships discovered over time, Native students could interpret it as true. Some Native students might

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Table 9. 2009–2010 Item 17, Form 3

| Response | Race | | | |
|----------|------|------|------|
|          | White |      | American Indian | |
|          | (n = 2302) | | (n = 272) | |
| A        | 9.9%  | 228  | 10.7%  | 29 |
| B        | 8.8%  | 202  | 16.9%  | 46 |
| C        | 76.9% | 1,770| 67.3%  | 183|
| D        | 4.3%  | 99   | 5.1%   | 14 |

The distribution of responses differs by race ($\chi^2 = 20.57, p < .001$).
have access to information regarding the statement in response D that is
unknown to other individuals, particularly if the students are Cheyenne, thereby
increasing the likelihood that they would choose this response over the "correct"
response, C.

The data in Table 10 show that a greater percentage of American Indian
students than White students chose incorrectly regarding responses A, C, and D.

Item 1: American Indian civilizations named the stars and studied astronomy.
How did they learn about stars?

A. by studying books given to them by European traders
B. by studying the regular movements of stars over years
C. by studying how weather patterns are related to stars
D. by studying how animals use stars to migrate

<table>
<thead>
<tr>
<th>Response</th>
<th>White (n = 2,093)</th>
<th>American Indian (n = 296)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4.2% 88</td>
<td>9.5% 28</td>
</tr>
<tr>
<td>B</td>
<td>71.1% 1,488</td>
<td>58.8% 174</td>
</tr>
<tr>
<td>C</td>
<td>9.9% 208</td>
<td>14.9% 44</td>
</tr>
<tr>
<td>D</td>
<td>14.3% 300</td>
<td>15.5% 46</td>
</tr>
</tbody>
</table>

The distribution of responses differs by race ($\chi^2 = 31.62, p < .001$).

Distractors A and C were incorrectly selected by approximately 5–6% more
American Indian students than White students. These distractors provide for
ways in which both American civilizations, White and American Indian, could
have learned about stars, given that both groups read books and may have
learned that at different times or seasons throughout the year the stars that can
be seen are different. These "incorrect" responses can be construed as
confusing to both groups of students. As it is currently developed, the item asks students to think about American Indians in a historical aspect rather than a scientific aspect; it asks students to think about how American Indians named the stars and studied astronomy in the past rather than asking about scientific relevance and current contributions and understandings.

On examining the distractors and the percentage of students who chose incorrectly, A and C stand out as being somewhat plausible responses, given that American Indians did have contact with European traders and information was exchanged and that the Indians associated weather patterns at different times of the year with location of the stars in different seasons. Response A perpetuates the idea of colonization by indicating that White European explorers provided information to American Indians in order for them to formulate ideas about astronomy, rather than suggesting that American Indians provided to the explorers information based on scientific research regarding astronomy. Likewise, historically, the United States used education as a means of providing students with knowledge that was deemed valuable by the majority population and disseminating ideas that were thought worthy by Eurocentric society (Rizvi, 2008; Said, 1979). The item does not necessarily acknowledge and credit the American Indians for their contribution to scientific inquiry regarding astronomy.

The next item situates American Indian knowledge in the past rather than acknowledging the techniques employed by members of the Confederated Salish and Kootenai Tribes (CSKT) and Blackfeet nations today. This item assumes that
American Indians are stuck in the past and have not advanced to other methods of research and tracking.

Item 8: Scientists conducted research to determine the size of the grizzly bear population in northwestern Montana. Members of the CSKT and Blackfeet nations helped the scientists with the research. Which tribal knowledge was most helpful to the efforts of the scientists?

A. their knowledge of weather prediction
B. their knowledge of how to use GPS systems
C. their knowledge of the land and movement of the bears
D. their knowledge of computer software to help analyze the data from the bears

Table 11 displays the percentage of students from each race who answered this item correctly. This percentage is relatively close, with roughly 87% of White students and 73% of American Indian students responding correctly. For incorrect responses A, B and D, the percentages were about twice as high for American Indians as compared to White students.

### Table 11. 2009–2010 Item 41, Form 4

<table>
<thead>
<tr>
<th>Response</th>
<th>White (n = 2,218)</th>
<th>American Indian (n = 314)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3%</td>
<td>66</td>
</tr>
<tr>
<td>B</td>
<td>3.9%</td>
<td>87</td>
</tr>
<tr>
<td>C</td>
<td>86.8%</td>
<td>1,925</td>
</tr>
<tr>
<td>D</td>
<td>6.3%</td>
<td>139</td>
</tr>
</tbody>
</table>

The distribution of responses differs by race ($\chi^2 = 62.80, p < .001$).

Owing to the nature of the distractors, this item may show little difference in the way that American Indians answer it. This item, unlike others, focuses on technology as a plausible response, when actually the question is asking about tribal knowledge. Historically, tribal knowledge has not included working with a GPS and computer software to track bear, thus making the correct choice less
difficult to distinguish if one assumes that Native individuals do not use technology in their research. The distractors in this item suggest that tribal knowledge does not include the use of and experience with a GPS or other technological equipment, which can be seen as biased because modern tribes may very well make use of tracking technologies to manage their lands. The question is based on a historical way of thinking about American Indians and does not take into account the possibility that modern nations use technological tools, thereby skewing responses from Native students who are a part of those communities. The item does not explicitly ask for students to answer the question based on historical tribal knowledge, thus lending itself to open interpretation by those students whose tribal members may have access to technology and utilize it for working with bear and other animals.

The final item listed under the Historical category also displays bias with regard to item distractors and assumptions related to the limitations of Native design that is/was utilized by members of the Crow nation.

Item 9: As part of a scientific investigation, students from the Crow Nation built a model straw-bale house out of wheat straw that grows abundantly on the Crow Nation reservation. They covered the model house with stucco concrete. The students' scientific investigation showed that these houses were fireproof, waterproof, and energy efficient. How did their investigation demonstrate the use of scientific understanding to promote technological advances?

A. The students created a new material for their investigation.
B. The students used a renewable resource as an insulator for the home.
C. The students showed that these types of homes can be built anywhere in the country.
D. The students developed building methods that require technology that is rare in Montana.
Table 12. 2009–2010 Item 51, Form 4

<table>
<thead>
<tr>
<th>Response</th>
<th>White (n = 2,218)</th>
<th>American Indian (n = 314)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>10.4% 231</td>
<td>13.7% 43</td>
</tr>
<tr>
<td>B</td>
<td>61.4% 1,362</td>
<td>50% 157</td>
</tr>
<tr>
<td>C</td>
<td>19.4% 431</td>
<td>20.7% 65</td>
</tr>
<tr>
<td>D</td>
<td>8.5% 189</td>
<td>14.6% 46</td>
</tr>
</tbody>
</table>

The distribution of responses differs by race ($\chi^2 = 24.70, p < .001$).

Displayed in Table 12 are the individual distractor analyses. Distractor A showed a slight difference in responses for American Indian students (13.7%) and White students (10.4%), with more American Indian students choosing this response. The data for response C show very little difference in the percentages between American Indian and White students, meaning that both races chose this incorrect distractor almost equally as frequently although, of the incorrect distractors, it was selected most often by both groups. When examining distractor C more closely, it appears that students are being asked to reflect on understanding and promoting technological advances. The question then arises as to why couldn’t these materials be shipped across the country and used to build houses just like other supplies? Since these houses are being constructed in Montana, which experiences extreme weather, students might think that providing these types of resources and technologies to other parts of the country is plausible. Another important consideration is that scientific technology based on the findings of majority scientists are used all over the world, so why should Native technological advancements not be made readily available to the public?
Response D had the greatest difference in percentages, with a greater percentage of American Indian students (14.6%) than White students (8.5%) choosing this distractor. While this item focuses on the technological advancements made by the Crow Nation in the construction of well-built, long-lasting houses, students are still having problems identifying the correct response. More Indian students chose distractor D as the correct response than did White students, possibly because the most common types of dwellings probably are built using the ideas and technologies of the majority in that their ideas and scientific advancements have been deemed superior to others' for many years. This distractor errs on the side of colonization in that students may think that the type of technology addressed in the item is not available in Montana when, in fact, it was developed by one of the local tribal nations.

**Majority Science Affecting or Benefiting American Indians**

The next set of items fall under the category of majority science either affecting or benefiting American Indians in some way rather than addressing the contributions that Native individuals have made to society. This way of thinking again exhibits tendencies toward a belief that majority ideas are more greatly valued and those ideas are impressed on the minority culture as being superior to their own Native ways of knowing, as was historically common during the initial period of schooling of America Indians (Rizvi, 2008; Said, 1979). Davis (2001) provides support for the concept that majority ideas and contributions are valued over those of American Indians in his discussion of the assimilation of American Indians through control of their autonomy and sources of self-determination, in
that the government ensured that the Indian culture was being eradicated and replaced by majority understandings. Gilliland (1995), in his book, *Teaching the Native American*, explains that at the time of colonization, "American and European natives were approximately equal in scientific knowledge, and that much of the Indians' traditional knowledge is still useful today" (p. 150). He also provides the example of North American tribes being more knowledgeable in zoology and herbal medicines than their White counterparts.

Examples of majority science being favored and more valued over Native science can be seen in the example provided by Lewis (1972), who suggested that Native Polynesians' ideas and concepts about navigation were not valued by explorers. In a comment about why the islanders were not questioned about how they navigated, Lewis remarked, "The idea that people without instruments, charts or writing could have developed an elaborate and effective art (or 'pre-science') was so utterly foreign as not to enter the minds of most Europeans. With few exceptions they were satisfied with rather vague statements about using the stars, sun and waves as guides" (p. 9). This set of test items can be seen as addressing only those contributions from the past and not current progressive contributions.

Item 5: An archaeologist uses satellites to map the historic sites of Montana Indian tribal nations. She also uses digital photography to study the rock art created by the Montana Indians. How will the use of these technologies most likely affect Montana Indian cultures?

A. Digital photography will replace existing tribal art.
B. Satellites will identify tribal artifacts buried under soil.
C. Both technologies will help modern-day tribes to preserve and study their history.
Table 13. 2009–2010 Item 51, Form 2

<table>
<thead>
<tr>
<th>Response</th>
<th>White</th>
<th>American Indian</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 2,269)</td>
<td>(n = 301)</td>
</tr>
<tr>
<td>A</td>
<td>11.5% 261</td>
<td>15.3% 46</td>
</tr>
<tr>
<td>B</td>
<td>7.6% 173</td>
<td>15.6% 47</td>
</tr>
<tr>
<td>C</td>
<td>71.7% 1,628</td>
<td>56.8% 171</td>
</tr>
<tr>
<td>D</td>
<td>8.8% 199</td>
<td>12% 36</td>
</tr>
</tbody>
</table>

The distribution of responses differs by race ($\chi^2 = 34.43, p < .001$).

While American Indian students had the higher percentage of incorrect responses among the three distractors (as displayed in Table 13), answer B showed the greatest amount of variability between the two groups. Roughly half the number of White students as American Indian students chose answer B (7.6% vs. 15.6%, respectively). This particular item focuses on how American Indians will be affected rather than on their contributions to science. With regard to response A, it is plausible that students would consider this to be correct, given the advancement in technology and the prevalence of digital media as compared to the frequency with which rock art is being created. Given that events in U.S. history have resulted in the annihilation of some Native knowledge (U.S. Commission on Civil Rights, 2003), this distractor could elicit negative reactions from students and has colonial undertones, suggesting that modern White technology will supercede Native art and that the practice of tribal art will die out with increased use of digital technology. Though digital photography may be an important way to capture images that are fading, it is not the only option for Natives. The majority idea of using technology to capture the past is not
exclusive of the continuance of rock art creation to pass along Native ideas and knowledge, a practice that may be integral to the survival of the American Indian culture.

As regards response B, it is reasonable to assume that satellites could help locate buried artifacts, thus contributing to American Indian culture by providing access to historical artifacts. Once again, this item focuses on how Montana Indians will be affected by majority technological advancements rather than on contributions by tribal nations to the majority population.

The second item in this set again addresses the use of majority technology as a means to help American Indians communicate. This item assumes that American Indians either want or need help with communication strategies, rather than asking students to consider ways in which American Indian nations communicate and pass on information to individuals of the same or different nations.

Item 2: Military scientists invented a recording device that translates languages. Some Montana Indian people are using the device to record Native languages. How will the use of this device most likely affect Montana Indians?

A. It will limit communication between tribes.
B. It will allow tribes to maintain their cultures.
C. It will help children better understand English.
D. It will prevent the development of new Native languages.
Table 14. 2009–2010 Item 6, Form 1

<table>
<thead>
<tr>
<th>Response</th>
<th>White (n = 2,282)</th>
<th>American Indian (n = 310)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6.7% 152</td>
<td>17.1% 53</td>
</tr>
<tr>
<td>B</td>
<td>60.6% 1,383</td>
<td>51.9% 161</td>
</tr>
<tr>
<td>C</td>
<td>21.1% 482</td>
<td>17.4% 54</td>
</tr>
<tr>
<td>D</td>
<td>11.4% 260</td>
<td>12.9% 40</td>
</tr>
</tbody>
</table>

The distribution of responses differs by race ($\chi^2 = 45.21, p < .001$).

As is apparent in Table 14, a much larger percentage of American Indians (17.1%, or 53 of 310) chose response A as compared with White students (6.7%, or 152 of 2282). Native students may believe that this type of technology will limit their ability to communicate between different tribes owing to limited accessibility to this type of technology, or they may assume that the recordings will replace direct communication between tribal members.

A somewhat smaller percentage of American Indians chose response C than did White students (17.4% vs. 21.1%), this distractor gaining the greatest percentage of incorrect selection from both groups. This distractor seems plausible in that even for Natives for whom English is a second language, gaining a better understanding of English via this device may not necessarily be a negative, however the concept that this technology will be applied so that children will better understand English can be viewed as another form of colonization. Why is it that this device is not utilized by Native English speakers to learn American Indian languages? Many Native students may learn English as a second language and may consider it important not to lose their Native language.
Another colonizing idea surrounding the learning of languages is that this item addresses the U.S. military’s contribution to science and how American Indians will be affected by this technology and points out which Native tribes are using this technology rather than addressing the ways in which American Indians pass on Native knowledge and languages. This seems to assume that White technology is a superior way to pass along information and does not address the contributions of American Indians to the advancement of information technology.

A greater number of American Indian students got this item incorrect as compared to White students, with a specific focus on distractor A, illustrating that students believe this technology and the advancement of it is a limiting factor among the tribes.

**Lack of Cultural Relevance**

The last category elucidates the fact that cultural items must include cultural knowledge and that simply incorporating a name that may be familiar to the minority culture taking the test does not make the item culturally relevant. Cultural relevance should take place as the relationship and significance in learning in terms of Native contexts, based on community knowledge and application (Kawagley & Barnhardt, 1998).

Lack of cultural relevance in all facets of schooling is not surprising, owing to the fact that a school’s curriculum determines the material to which students are exposed during the daily classroom routine (Castagno & Brayboy, 2008). The curriculum in the United States is mostly devised from a Eurocentric focus that has been narrowed since the implementation and emphasis on standardized
testing. It is no secret that the demands of standardization have imposed a lack of focus on cultural curricula.

Item 7: Russell Stands-Over-Bull, a Crow Indian, is a sedimentologist. He studies how rocks are formed and the matter that makes the rocks. How is a job like his most important to our understanding of Earth?

A. We learn more about Earth's water cycle.
B. We learn the ways Earth's crust has changed.
C. We understand how energy from the Sun changes Earth.
D. We can find new ways to explore space rocks near Earth.

Table 15. 2009–2010 Item 17, Form 4

<table>
<thead>
<tr>
<th>Response</th>
<th>White (n = 2218)</th>
<th>American Indian (n = 314)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4.9% 109</td>
<td>6.7% 21</td>
</tr>
<tr>
<td>B</td>
<td>78.1% 1,732</td>
<td>62.1% 195</td>
</tr>
<tr>
<td>C</td>
<td>7.6% 169</td>
<td>16.2% 51</td>
</tr>
<tr>
<td>D</td>
<td>9.3% 206</td>
<td>14.6% 46</td>
</tr>
</tbody>
</table>

The distribution of responses differs by race ($\chi^2 = 43.61, p < .001$).

The differences in student responses for each of the distractors are displayed in Table 15. For response A, there was not much difference in percentages for American Indian and White students (6.7% vs. 4.9%) thus indicating that most students seem to understand the water cycle and its relationship to Earth, although there is some room for interpretation, given that water does play a role in how some rocks and sediments are formed and dispersed throughout the earth. Approximately twice the percentage of American Indian students selected distractor C as compared to White students. A large difference also existed for response D, with 14.6% of American Indian students as compared to 9.3% of White students choosing this incorrect response.
This item focuses less on scientific contributions and more on the importance of a job in relation to understanding of Earth. Most students who responded incorrectly chose distractor C, possibly because of their understanding that the sun does change the earth in that it provides heat and energy for certain processes to be carried out. Students may not necessarily be thinking about geologic changes but rather natural life process changes that are completely plausible. Most Native students were brought up to understand science by way of traditional ecological knowledge (TEK). In TEK, the world is viewed holistically; every part works together to form the whole. For example, in indigenous science, the world is viewed as an ecosystem in which plants and animals work conjointly and have their own roles to carry out in order to sustain the entire system. Freeman (1992) states that TEK “is directed toward gaining a useful understanding of how ecological systems generally work, to how many of the key components of the total ecosystem interrelate, and how predictive outcomes with respect to matters of practical concern can best be affected” (p. 1). This understanding is based on direct experience with the natural environment. Cajete (2000) adds to the description of Native science:

“Concerned with the processes and energies within the universe, it continually deals in systems of relationships and their application to the life of the community. Science cannot divide its application into departments; it is integrated into the whole of life and being and provides a basic schema and basis for action” (p. 66). As student’s, particularly Native students, are taught to value the
sun for its life-giving power, this answer may not be so far-fetched and therefore considered a confusing distractor for many students.

The main issue with this item resides in the fact that no Native knowledge is included; the sedimentologist is merely given a Native name. Native students might relate to the possibility of Native people becoming scientists, but the item content does not provide any insight into how American Indians contributed to the understanding of Earth's formation and how materials change and are recycled over time.

**Overall Comments**

An overall examination of this group of Native items reveals that knowledge was included that could be interpreted by Native students in a much different way than by White students, given the differences in their backgrounds and upbringing. The items with the greatest differences in percentage correct between the two races include those with distractors that incorporate Native knowledge in a way that unintentionally causes a greater number of Native students to have difficulty answering "correctly," as they may misinterpret the item. Even when test developers take great care in item writing, the possibility remains that ideas may be confused or understood in a way that was not intended. Murphy (2007) writes "even the most culturally knowledgeable item writers and reviewers may write items that students misconstrue" (p. 235).

Overall themes emerged as the items were individually assessed based on the odds that White students would answer correctly a greater percentage of the time than would American Indian students. Various issues arose with the
construction of the items, whether it was the focus of the item itself and the way in which it was written or the options provided from which students may choose. Either way, each of the items proved to be problematic for Native students.

**Examination of the Effect of Race on Achievement by Gender, SES and Location of School**

To address the second research question—*Using students' standardized science achievement test scores based on non-Native and Native standards, is the relationship between science achievement and race different for boys versus girls, for students of different socioeconomic backgrounds, or for students attending schools in different locations (rural vs. urban, reservation vs. non-reservation)?*—data from the two years (2008–2009 and 2009–2010) in which indigenous items were included on the state standardized science tests were examined. Table 5 provides evidence for differences in students' average science achievement based on the categories of the predictors for each of the school years. The sample included 316 American Indian students and 2,268 White students, and 1,176 American Indian students and 9,071 White students, respectively. The number of students over the two years was 1,492 American Indian students and 11,340 White students, providing for a total sample size of 12,831. The 2008–2009 numbers of students are noticeably lower than those of the 2009–2010 school year owing to the number of students receiving test forms that included items of an indigenous nature. In the first year, only two of eight

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18 The options refer to the entire group of responses while the distractors are only the incorrect responses, and the correct answer is the key.
possible test forms contained items based on Native standards, so only the students receiving one of those two test forms were included in the data analysis. In the second year, all four test forms included items based on Native standards and therefore all White and American Indian students taking the test that year were included in the data analysis. Scores in Table 5 reveal that male students outscored female students for both years which was determined to be statistically significant. SES also played a role in student achievement, with students who were not low income outscoring low income students. Attending school on a reservation was also found to be statically significant, with students attending schools on reservations scoring considerably lower (15 or more points) than those attending schools off of reservations. The final predictor examined did not provide much of a difference in scores, finding that the URBAN in Montana did not play a significant role in student achievement.

**Relationship of Student Achievement and Race When Controlling for Predictors**

To address the third research question—Using students’ standardized science achievement test scores based on non-Native standards, and then science achievement test scores based on Native standards; is the relationship between science achievement and race attenuated when controlling for gender, student SES, and school location (rural vs. urban, reservation vs. non-reservation)? Is the relationship between science achievement and race different for boys versus girls, for students of different socioeconomic backgrounds, or for students attending schools in different locations (rural vs. urban, reservation vs. non-
reservation)?—multiple-regression analysis was conducted to examine various control variables and possible interactions in relation to mean overall student test scores and SES, location of school, and gender. In addressing the research question, the regression-model findings displayed in Tables 16 and 17 reveal that much of the variability in student achievement scores can be explained through the addition of the variables examined: race, gender, SES, and location of school. The models refer to the relationships between these specific variables and the outcome achievement scores.
Table 16. A Taxonomy of Fitted Multiple-Regression Models for Eighth-Grade Student Mean Standardized Test Scores by Gender, Student SES, School Location, and the Interactions Between Student Achievement and Student- and School-Level Variables for School Year 2008–2009

<table>
<thead>
<tr>
<th>Predictor</th>
<th>M1</th>
<th>M2</th>
<th>M3</th>
<th>M4</th>
<th>M5</th>
<th>M6</th>
<th>M7</th>
<th>M8</th>
<th>M9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>235.04 ***</td>
<td>237.06 ***</td>
<td>245.741 ***</td>
<td>247.36 ***</td>
<td>247.567 ***</td>
<td>244.923 ***</td>
<td>243.916 ***</td>
<td>250.619 ***</td>
<td>243.443 ***</td>
</tr>
<tr>
<td>Gender</td>
<td>-3.86 ***</td>
<td>-3.903 ***</td>
<td>-3.82 ***</td>
<td>-3.817 ***</td>
<td>11.13 ***</td>
<td>-3.852 ***</td>
<td>-3.778 ***</td>
<td>0.804***</td>
<td>-2.743 ***</td>
</tr>
<tr>
<td>Urban</td>
<td>-0.395</td>
<td>-0.36</td>
<td>-0.444</td>
<td>-0.512</td>
<td>-0.593</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Race*Gender</td>
<td>-5.634 *</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Race*SES</td>
<td>-5.95</td>
<td>-9.36 **</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Race*Reservation</td>
<td>9.42 **</td>
<td>12.305 **</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td>0.10</td>
<td>0.11</td>
<td>0.149</td>
<td>0.15</td>
<td>0.153</td>
<td>0.155</td>
<td>0.155</td>
<td>0.156</td>
<td>0.159</td>
</tr>
<tr>
<td>Error df</td>
<td>2582.00</td>
<td>2581.00</td>
<td>2580.00</td>
<td>2559.00</td>
<td>2558.00</td>
<td>2557.00</td>
<td>2557.00</td>
<td>2557.00</td>
<td>2555.00</td>
</tr>
</tbody>
</table>

*p < .10, * p < .05, ** p < .01, ***p < .001
Table 17. A Taxonomy of Fitted Multiple-Regression Models for Eighth-Grade Student Mean Standardized Test Scores by Gender, Student SES, School Location, and the Interactions Between Student Achievement and Student and School Level Variables for School Year 2009–2010

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M1</td>
</tr>
<tr>
<td>Intercept</td>
<td>240.03***</td>
</tr>
<tr>
<td>Gender</td>
<td>-3.75***</td>
</tr>
<tr>
<td>SES</td>
<td>-12.223***</td>
</tr>
<tr>
<td>Reservation</td>
<td>-3.72***</td>
</tr>
<tr>
<td>Race*Gender</td>
<td>-2.859 —</td>
</tr>
<tr>
<td>Race*SES</td>
<td>2.63</td>
</tr>
<tr>
<td>Race*Reservation</td>
<td>4.748**</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.08</td>
</tr>
<tr>
<td>Error df</td>
<td>10245.00</td>
</tr>
</tbody>
</table>

~ $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$
The column in Tables 16 and 17 denoted as M1 allows for differences in achievement between races to be explored without controlling for any of the variables, demonstrating a difference in achievement between races as shown on standardized tests. The results from 2008–2009 indicate that White students are, on average, outperforming American Indian students by approximately 24 points. An average of 22 points' difference is noted for 2009–2010, which, although it has decreased from year 1, still exists, from which one can conclude that there is a relationship between race and student achievement. This model has an $R^2$ value of .10 for year 1 and .08 for year 2, suggesting that roughly 8–10% of variability in mean total achievement scores is explained by race. In other words, adding race to the equation results in an 8–10% difference in achievement scores, correlating race and achievement. Such a correlation suggests that other factors might be involved in student achievement scores; therefore, other variables were added to determine their relationship to student achievement.

When gender is added to the logistic model, only a very slight change is seen, with less than 1 point (23.53) difference in scores for 2008–2009. For school year 2009–2010, the difference is even smaller (21.62), leading us to conclude that gender has very little effect on achievement scores for either race. This model has an $R^2$ value of .11 for 2008–2009 and .09 for 2009–2010, suggesting that when race is added to the equation, roughly 9–11% of variability in mean total achievement scores is explained by the differences in gender and race. There is only a 1-percentage-point change in the $R^2$ value when gender is
added, indicating that this variable is not as substantial in explaining the variability in scores as are other predictors having values of 8% or larger; hence, gender appears not to wield much power in predicting student achievement scores.

When controlling for SES, in addition to race and gender, there is a difference, on average, of about 18 points between student achievement scores for White and American Indian students in 2008–2009 and about 16 points for 2009–2010, indicating that SES has a significant effect on student achievement scores. The achievement scores are correlated with whether students are identified with either a low or high SES, thus affecting their scores in either a negative or positive manner. The trend for both gender and SES is negative and statistically significant, leading one to conclude that female low-income students have lower student achievement scores, on average. This model has an $R^2$ value of .15 for 2008–2009 and .14 for 2009–2010, suggesting that when SES is added, roughly 15% of variability in mean total achievement scores is explained by student SES, gender, and race. This is the largest difference seen among all the variables: Approximately a 5-percentage-point difference is seen when including only gender and race, suggesting that SES plays a more significant role in the variability of student achievement than does gender.

When the location of the school is added as a variable, a trend similar to that observed in the other three models is apparent, with a statistically significant difference. The variable addressing the difference in student achievement when the school’s location was considered urban was taken into account but
demonstrated no statistically significant differences, so this variable was omitted and replaced with location of the school (on or off reservation). When controlling for gender, SES, and school location, one sees a positive and statistically significant difference between White and American Indian students’ scores for both years: 2008–2009 (16.66) and 2009–2010 (14.14). On average, when controlling for race, gender, and SES, there is a relationship between mean student achievement and whether students attend schools on or off a reservation. For each student either attending school on a reservation or off, the average difference in achievement between these two groups of students equals about 17 points for year 1 and about 14 points for year 2 controlling for the other variables in the model, suggesting that students who attend schools on reservations have lower rates of achievement on average as compared to students who attend schools off reservations. This model has an $R^2$ value of .15 for both years, suggesting that roughly 15% of variability in mean total achievement scores is explained by school location, student SES, gender, and race. There is no change in this value when adding location of school to the previous model that included student SES, indicating that both SES and school location explain the same amount of variability in student achievement scores.

The findings from these models indicate that the addition of each variable helps to explain the variability in achievement scores between White and American Indian students. The greatest variability can be explained by students’ SES as well as where students attend school, given that these students who have lower SES and attend reservation schools score the lowest regardless of
their race. The amount of money and resources a student’s family has is reflected in the school that a child attends, and research shows that schools located on reservations tend to have fewer resources, resulting in lower average student achievement (Arroyo, 2008; NCSL, 2008).

Interaction models, shown in Tables 16 and 17, were used to determine whether the effect of race differs between genders, students of different SES, and students attending schools on a reservation. It was determined that each of these models, except for race and SES (model 7) for year 2009–2010, produced interactions that were statistically significant across both testing years (p values are noted for each interaction model in Tables 16 and 17). The $R^2$ statistic for all interaction models is .16 for 2008–2009 and .15 for 2009–2010, indicating that nearly 15–16% of the variability in test scores can be attributed to the different variables explored. The significance of these statistical interactions implies that the effect on average student achievement scores is different for the different types of students who take the state standardized science test. Table 18 displays the results for final model testing for interactions between all the variables—race, gender, SES, and location of school. This model helps to explain the research question, Is the relationship between science achievement and race different for boys versus girls, for students of different socioeconomic backgrounds, or for students attending schools in different locations (rural vs. urban, reservation vs. non-reservation)?
Table 18. Predicted Achievement for Various Groups of Students Based on Fitted Model 9

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low-SES students on reservation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White male</td>
<td>250.662</td>
<td>259.678</td>
<td></td>
<td>+9.016</td>
</tr>
<tr>
<td>American Indian male</td>
<td>229.451</td>
<td>247.059</td>
<td></td>
<td>+17.608</td>
</tr>
<tr>
<td>White female</td>
<td>251.222</td>
<td>258.145</td>
<td></td>
<td>+6.923</td>
</tr>
<tr>
<td>American Indian female</td>
<td>230.051</td>
<td>245.526</td>
<td></td>
<td>+15.475</td>
</tr>
<tr>
<td><strong>Low-SES students not on reservation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White male</td>
<td>261.871</td>
<td>261.461</td>
<td></td>
<td>−0.41</td>
</tr>
<tr>
<td>American Indian male</td>
<td>240.7</td>
<td>248.842</td>
<td></td>
<td>+1.842</td>
</tr>
<tr>
<td>White female</td>
<td>262.475</td>
<td>259.928</td>
<td></td>
<td>−2.547</td>
</tr>
<tr>
<td>American Indian female</td>
<td>241.304</td>
<td>247.309</td>
<td></td>
<td>+6.005</td>
</tr>
<tr>
<td><strong>High-SES students on reservation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White male</td>
<td>253.365</td>
<td>266.698</td>
<td></td>
<td>+13.324</td>
</tr>
<tr>
<td>American Indian male</td>
<td>232.194</td>
<td>254.079</td>
<td></td>
<td>+21.885</td>
</tr>
<tr>
<td>White female</td>
<td>253.969</td>
<td>265.165</td>
<td></td>
<td>+11.196</td>
</tr>
<tr>
<td>American Indian female</td>
<td>232.798</td>
<td>252.546</td>
<td></td>
<td>+19.748</td>
</tr>
<tr>
<td><strong>High-SES students not on reservation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White male</td>
<td>264.553</td>
<td>268.481</td>
<td></td>
<td>+3.928</td>
</tr>
<tr>
<td>American Indian male</td>
<td>243.443</td>
<td>255.862</td>
<td></td>
<td>+12.419</td>
</tr>
<tr>
<td>White female</td>
<td>265.157</td>
<td>266.948</td>
<td></td>
<td>+1.505</td>
</tr>
<tr>
<td>American Indian female</td>
<td>244.047</td>
<td>254.329</td>
<td></td>
<td>+10.282</td>
</tr>
</tbody>
</table>

This table provides overall findings that account for differences in SES, gender, and whether the school is located on a reservation. As can be seen in the results, students who are of low SES and attend reservation schools tend to score the lowest regardless of race, whereas students with a high SES and attend non-reservation schools score the highest regardless of race. White males with low
SES on reservations score 251 and 260 for each of the two testing years, respectively, while White males with high SES who are not on reservations score 264 and 268, respectively. American Indian students continue to score the lowest even when accounting for all other differences: American Indian males of a high SES who attend non-reservation schools scored 243 and 256, respectively, as compared to White students in the same category, who scored 21 and 12 points higher for each of the two years. An examination of the differences between male and female students among the two races illustrates that females tend to score relatively close to the males’ scores, scoring slightly higher than males in a few instances (less than a 1-point difference; year 2008–2009 data). The data imply that SES and school location play a major role in how students are scoring on the standardized science test.

Further examination of SES results indicate that, on comparing year 1 (2008–2009) to year 2 (2009–2010), the predicted average score of the low-SES reservation students who are White increased by fewer than 10 points, whereas American Indian students in the same situation had a much larger increase, at 15 points for female students and more than 17 points for male students. When high-SES students on reservations are examined, there is less of a difference.

**Conclusion**

The purpose of this study was to investigate the differences in achievement of American Indian and White students in Montana on the state standardized science test. Several variables, including race, gender, SES, and school location, were examined to identify possible reasons for the existence of an achievement
gap. Descriptive statistics, bivariate analyses, review of distributions, visual analysis of box plot, estimating correlation coefficients, and taxonomy of multiple and logistic regression models were conducted to investigate the research questions. Careful examination of different aspects of the relationship between race (White and American Indian) and students' achievement scores on the standardized test leads to the conclusion that a statistically significant relationship exists between mean overall score and race, controlling for other predictors such as gender, SES, and school location. On average, when gender is taken into account, White students score 22–24 points higher than do American Indian students. When SES is taken into account, White students score 16–18 points higher on average than do American Indian students. Finally, when school location is taken into account, whether on or off the reservation, White students score 14–17 points higher. The data reveal that White students continue to outscore their American Indian counterparts in every situation.

Examination of the variability in scores demonstrates that a large percentage can be accounted for by adding the other factors to race. With the inclusion of each additional factor, the percentage of variability that can be explained increases, leading one to conclude that gender, SES, and school location all play a role in overall student achievement scores. SES and location have the largest impact on student achievement.

Another issue of which we must be cognizant is the (presumably unintentional) bias in each of the items. From experience, I can attest to the measures taken to avoid bias in items and to ensure that students are not misled
by questionable distractors. However, the items analyzed in this study illustrate that bias is occurring and may be a factor in more American Indian students' than White students' choices of incorrect responses. Though a greater percentage of students, regardless of race, choose the correct response, there is still a fair amount of room for error given the different distractor choices, as evidenced by the individual item analyses explored earlier in this chapter.

The next chapter builds on the findings of this chapter and explores possible explanations for the perpetuation of the achievement gap as evidenced by the current research. Much of what has been revealed through this study can be used to refocus energies toward accomplishing an educational system conducive to Native students' understanding and ability to learn and interpret the knowledge being constructed in the classroom. The explanations we will explore include the role that standardized testing plays as a means of accountability and colonization; possible gains made by Native students when greater numbers of Native items are included on the test in a non-biased manner; various instructional methodologies that might be used to teach the "Indian Education for All" curriculum; and, finally, the presence of colonization in our educational system.
CHAPTER 5

CONCLUSION AND IMPLICATIONS

This study examined American Indian and White students' achievement on Montana's eighth-grade standardized science testing, years 2008–2009 and 2009–2010. This assessment included one to eight test items based on indigenous knowledge from the Native curriculum guide, "Indian Education for All." The purpose of this study was to determine whether there were any differences in standardized achievement scores for American Indian students as compared with standardized achievement scores for White students when culturally relevant knowledge is included on the state science test in Montana.

The research questions addressed in this study are:

1. Are there differences in eighth-grade students' standardized science test scores based on non-Native standards for American Indian versus White students? Is the relationship between science achievement and race different when achievement test items based on Native standards are used?

2. Using students' standardized science achievement test scores based on non-Native and Native standards, are there differences in achievement for boys versus girls, for students of different socioeconomic backgrounds, or for students attending schools in different locations (rural vs. urban, reservation vs. non-reservation)?
3. Using students' standardized science achievement test scores based on non-Native standards, and then science achievement test scores based on Native standards; is the relationship between science achievement and race attenuated when controlling for gender, student socioeconomic status (SES), and school location (rural vs. urban, reservation vs. non-reservation)? Is the relationship between science achievement and race different for boys versus girls, for students of different socioeconomic backgrounds, or for students attending schools in different locations (rural vs. urban, reservation vs. non-reservation)?

Results have indicated that White students continue to outscore their American Indian counterparts, as has been seen in previous studies examining student achievement based on race (CCL, 2007; U.S. Department of Education, 2007; Nelson et al., 2009). White students performed statistically better on all items (Native and non-Native), which resulted in a greater examination of the individual Native test items for the presence of bias.

On the basis of this study, I offer three explanations into the persistence of the achievement gap between White and American Indian students, using colonization as a framework to discuss race as a factor in student achievement, SES, location of schools and gender and, finally, the persistence of colonization influences in our public schools. The first section focuses on race being a significant factor in student achievement. I will discuss cultural appropriateness of the tests and also the practice of testing for American Indian students. The second section examines how SES, the location of the school that students
attend, and gender all play a role in student achievement. The third and final section explores how the existence of colonizing influences in public schools may help explain the results seen in this study. Building on the information presented in these three sections, I elaborate on some possible modifications that may be more aligned to the way in which indigenous students are taught and assessed.

**Race as a Factor in Student Achievement**

Montana's implementation of Native American standards in "Indian Education for All," which requires all Montana students to learn some indigenous knowledge from the state's 12 American Indian nations, has been a positive step toward establishing a more equitable learning environment. The development of a set of standards and associated assessment is the first of its kind in the United States and embodies the mission of No Child Left Behind (NCLB) by enriching the school experience and encouraging more American Indian students to be motivated to learn and to stay in school. While there was some closing of the achievement gap, the results of this study show White students continuing to perform better statistically than their American Indian counterparts on all items on the state standardized science test. Concomitantly, analysis of the 2 years of data available demonstrates a larger probability that White students would answer items based on Native American standards correctly as compared to American Indian students.

The question remains: If the state of Montana has implemented a form of curriculum and assessment that is supposed to minimize the issues of inequality of learning by using culturally relevant materials, then why are American Indian
students continuing to score lower on these tests than their majority White counterparts? The answer may be found in the way in which the tests are designed and implemented.

**Cultural Capital and Its Role in Testing**

Test developers argue that tests are written and validated with the intention of being able to measure all students' knowledge, regardless of the students' race, gender, or background, claiming that measures are taken to ensure that poorly written items are eliminated (Murphy, 2007). However, some researchers argue that tests are written with an "ideal" test taker in mind, usually those students of the majority culture (Johnston, 2010). Johnston (2010) supports the findings of this study in her literature review of culturally appropriate assessment. In that review, she describes many instances in which researchers found that the cultural inappropriateness of most tests cause indigenous students to fail because the students lack what Bordieu refers to as the "cultural capital" of the dominant group after whom the tests are modeled. Johnston defines *cultural capital* in the context of testing: "Tests developed and validated with dominant groups include culturally inappropriate test-item content and rely on first-language skills and meta-cognitive test strategies that further exacerbate existing social, educational, and vocational inequities for culturally diverse participants" (p. 233). Assessing students' knowledge can be difficult because the test items may embody the nuances of meanings and understandings of the dominant society's understandings of the world. Johnston (2010) reports that current assessment systems marginalize indigenous students. The results of this study
support her conclusions that students of the majority culture tended to score higher on average than their American Indian counterparts on standardized assessments.

The very act of assessing knowledge through a multiple-choice type test can add to the cultural incongruencies witnessed in standardized assessment. Johnston’s literature review—which includes Christensen and Lilley, 1997; Cockburn et al., 2007; Craven, 2003; Gopaul-McNichol and Armour-Thomas, 2002; Philpott et al., 2004; Sakrzewski, 1997; and Verjee, 2003—supports the “provision of changing environments and assessment practices to account for the uniqueness of specific cultural groups” (p. 237). Johnston challenges the assessment’s foundational belief that standardized testing is “neutral, universal and with no need to be qualified.” An important concept that emerges from Johnston’s meta-analysis of the assessment literature is that assessment continues to reside within the realm of politics.

Deyhle (1983) provides additional insight into why some students may come into the classroom with more cultural capital in the area of test taking. She says:

Learning through mistakes or failure informally in classroom discourse, and formally on classroom tests, is clearly not a method shared by all children, even though some children function quite easily in learning through individual performance in the classroom. In some families, learning through mistakes or failure has been inculcated and is evident in child-rearing techniques. Thus, these students come to school with the advantage of having already learned a valuable lesson, either through verbal instruction or by having experienced rewards in “test-like” situations in their home environment in pre-school years. (pp. 80–81)
These ideas are not new or novel, given that Bordieu has encompassed these views in his theory of cultural reproduction, believing that children from middle-class, dominant-culture families are advantaged in gaining educational competencies because of their possession of cultural competency (Bordieu, 1974; Sullivan, 2001). Bordieu (1974) explains how students who are part of the "culturally privileged groups" are not alarmed by the testing practices that are encouraged in the schools, stating that "cramming is not an absolute evil when it consists simply of realizing that pupils are being prepared for an examination and making them aware of this" (p.38). The act of testing is a learned behavior such that, over years of schooling, students are taught how to take tests and how to learn the language and nuances of testing (Eakins et al., 1976).

Today, with the No Child Left Behind Act, the United States is focusing on equality in education, yet the emphasis on using standardized tests to determine academic achievement may have unexpected and unintentional results if tests are written by and for the dominant group. Decades ago, Bordieu (1974) spoke to the presence of this inequality being perpetuated by a move toward greater equality: "[B]y treating all pupils, however unequal they may be in reality, as equal in rights and duties, the educational system is led to give its de facto sanction to initial cultural inequalities" (p. 39).

The results presented from this study provide a picture of what is currently being seen in schools throughout the United States, where majority students are performing better in school and on tests and have lower dropout rates than minority groups (Faircloth & Tippeconnic III, 2010). However, the question arises
as to the validity of our knowledge about how well American Indians students are performing in school if there is likelihood that the assessments used to test American Indian students' knowledge might be flawed. Bearing these inequities in mind, educators of American Indian students should consider that their students may not fit the mold of the typical test taker. Deyhle (1983) provides insight into the differences displayed in the dynamics of Native students versus majority students using data from her 2-year ethnographic study of 210 young Navajo students and the process involved in testing. Deyhle conducted her research at a Bureau of Indian Affairs day school located on a Navajo reservation in classrooms ranging from second through eighth grades. During this study, observations were made of and interviews were conducted with students and teachers with regard to their perceptions and feelings concerning testing. From her work, Deyhle concludes, "It may be, however, that not only the content but also the idea or concept of a 'test' is a factor that creates a disadvantage for some children. Failure to perform adequately on tests may indicate failure to accept or interpret the importance of tests in schooling, rather than simply a lack of knowledge" (p. 68). This was evidenced by students' responses to tests in school and their lack of seriousness with regard to testing. Many students in lower grades saw testing as a sort of game rather than being associated with grades and consequences. This attitude may be a result of the way Navajo students are raised in their homes and a reflection on cultural school practices that are not exhibited in non-reservation schools. Students are taught to self-test in private so as not to display their failures publicly. They observe and attempt
performance only when they feel that they are ready. This practice seems to run parallel to the way in which the majority school is conducted, which may pose a problem when students are faced with standardized testing practices. The cultural practices involved in the dynamics of reservation schools seem to contrast those displayed in other non-reservation schools, causing a sort of disconnect between the curriculum and the act of testing.

Cultural capital provides a lens through which to view how cultural inequalities arise as a result of not taking into consideration the participants of an event, such as is the case with the development of standardized tests. Bourdieu (1974), Johnston (2010), Deyhle (1983), and Sullivan (2001) have offered examples of how students who lack the cultural capital of the dominant culture tend to have difficulties on tests and forms of schooling that have been adapted by and for the majority culture.

**Cultural Capital within the Context of Colonization and Testing Practices**

Building on the concept of cultural capital, a second factor that must be understood is the effects that race have on student achievement outcomes. To more fully appreciate the current position of education in the United States, a brief reflection on the origins of American Indian education in this country is necessary. It is not possible to discuss the present status of American Indians without revisiting the origination of their education in boarding schools and the form of colonization that they experienced. The theory of educational colonization will be examined in greater detail later in the chapter; however, it is necessary to
define what is meant by this term in order to aid the reader in appreciating how colonization is present in the findings of this study.

Colonialism, as described by Said (1979), is viewed as a way of thinking and a system from which power is exercised over colonized people, ultimately spreading majority beliefs in a legitimized format (Rizvi, 2008; Said, 1979). As Said states in *Culture and Imperialism* (1993), “Life in one subordinate realm of experience is imprinted by the fictions and follies of the dominant realm. But the reverse is true, too, as experience in the dominant society comes to depend uncritically on the natives and their territories, perceived as in need of *la mission civilisatrice*” (p. xix). In this regard, Said is implying that dominant society needs Native populations in order to carry out the mission of civilization of these people (Fuchs & Havighurst, 1973). This has been the case in American Indian history in the United States, with European colonizers deciding what was best for the Natives in both living conditions and formal schooling (Highwater, 1995; Rogoff, 2003). This type of power struggle, common to imperialism, concerns who owns and has control over land or who settled it and the association of culture with the nation or state that controls that land. This identity therefore translates into an “us” and “them” mentality that enforces a sort of competition of whose way is better (Said, 1993).

From the very beginning of education in the United States, there has been a focus by politicians, clergy, and other education officials on having control over the way in which American Indians are educated (Fuchs & Havighurst, 1973). This history begins with boarding schools for American Indians, where Whites
believed they were acting in the best interest of the American Indians by providing American Indian students with an education that the Whites considered valuable.

This idea is still evident in today’s educational system, in which standardized assessment is organized to reward those students who conform to the majority ways of thinking, thus possessing the cultural capital of dominant society. Hartman (2003), basing his claims on Foucault (1991), believes that standardized testing is “both totalizing and individualizing”: “It is totalizing in that it orders the entire population according to statistics, and individualizing in that it divides people according to the process of categorization” (p. 14). Results from this study support Foucault’s (1991) premise that American Indian students are classified according to their proficiency or lack thereof with regard to knowledge of scientific concepts and then compared to their majority counterparts. These students are being categorized based on a set of standards defined by the majority-driven Montana Department of Education, as either novice, nearing proficiency, proficient, or advanced. In a review of the available data from this current study, 48% of all White students scored in the “proficient” category, while only 25% of all American Indians scored at this level, leaving the majority of American Indian students (40%) to score in the “nearing proficiency” category, as compared to 26% of White students. These results support the idea that the State developed standardized tests that are more in line with what the majority deems to be important and should be understood by all students, including those Native students who may not share the same degree of affinity for or
understanding of the material. The push for the majority viewpoint to be learned by all, coupled with the poor performance by American Indian students, illustrates that there is a need for some other method of assessment that does not group or compare students based on standardized test scores but rather addresses the individual’s ability to show evidence of academic growth.

Those that support a multicultural curriculum, where diversity of knowledge is acknowledged and explored, view the widespread practice of standardized testing as a “reassertion of national, and thus White, unity” (Hartman, 2003, p. 20). Hartman (2003) uses the history of forcing Blacks to assimilate into the White culture and the development of the SAT, which is grounded in New England culture, as the basis of his argument for the current status of standardized testing and its lack of multiculturalism. As the tests exist in present form, they exemplify the American identity of “whiteness, richness, and maleness” (Hartman, 2003, p. 20), which sets up the minority population for imminent failure, unless Black students are able to subscribe to White ways of knowing. Indigenous populations currently face the same issues as did Blacks during integration of schooling, where schooling is carried out using majority themes, which are not connected to Native ways of knowing, thus contributing to the issue of control and power over content and knowledge by majority groups (Aikenhead, 1996, 1997, 2000, 2006).

Though the content of the tests is of great concern and the information that is incorporated into tests must be given due acknowledgment, another possible contributing factor for consideration is that testing for American Indians
is a private, individualized practice. Results indicate that majority students accustomed to standardized testing practices scored on average 22–24 points and a whole achievement level higher than minority students. Again, testing can be seen as a means of colonization, because it requires that students who do not typically address assessment in this formal way to publicly perform on a test on which they will be judged and compared to other students; in addition, the tests are tailored to the cultural understanding of the majority, thus contributing to the finding that those lacking the cultural capital of Whites will exhibit continuous failure.

Acknowledging Cultural Differences

It is not only in the United States that the issue of educational equality in regard to Native peoples is being examined. With the heightened interest in student achievement and the awareness that Native students' scores on standardized tests are often at lower levels than their majority counterparts (CCL, 2007; Johnston, 2010), concern on a global level has arisen. In 2007, the United Nations composed a Declaration on the Rights of Indigenous Peoples that established multiple articles declaring equal rights for indigenous individuals across the globe. Understanding that each country and situation was different, the General Assembly produced 46 different articles addressing the needs of indigenous people. Article 14 addresses the topic of education:

1. Indigenous peoples have the right to establish and control their educational systems and institutions, providing education in their own languages, in a manner appropriate to their cultural methods of teaching and learning.
2. Indigenous individuals, particularly children, have the right to all levels and forms of education of the State without discrimination.

3. States shall, in conjunction with indigenous peoples, take effective measures, in order for indigenous individuals, particularly children, including those living outside their communities, to have access, when possible, to an education in their own culture and provided in their own language. (United Nations Declaration on the Rights of Indigenous Peoples, 2007)

With the declaration of this article, indigenous people are working to include their knowledge in the teachings of today’s schools. The state of Montana worked with indigenous individuals to provide an avenue of learning about Native American culture when they created the “Indian Education for All” curriculum. Adding Native American items derived from the indigenous curriculum to the standardized science test provides a way to ensure that the curriculum is, in fact, being taught. This inclusion acts as a means of accountability to verify that teachers are incorporating the Native American standards into their lessons.

From the data in this research, positive results of this inclusion can be seen, with American Indian students answering a greater percentage of Native items correctly than items identified as non-Native in nature. The construction of test items is an arduous task that entails ensuring that the item aligns with the state standards and is truly measuring the outcome that it is intended to measure. With this in mind, all indigenous items included in this research were further investigated to determine if, in fact, the question fully addressed the standard and provided distractors that would not confuse or mislead students. Inclusion of items that address Native knowledge are important to the future success of indigenous students; however, the construction of these test items
merits close attention, as this study has shown that the test items might not be accurately testing students' knowledge. Results of individual item analysis display tendencies to exhibit biased options from which students may choose the correct answer. Distractors, or potential test answers that are incorrect, were found to be difficult for American Indian students to perceive as incorrect. Test items, specifically Native ones, need to account for differences in language, context, and understandings of non-mainstream students. The findings substantiated the claims of many researchers who were concerned that tests do not exhibit appropriate language, content, and structure to address the needs of American Indian students (Hartman, 2003; Johnston, 2010; Koelsch, et al., 1995; Murphy, 2007; Sasaki, 2000).

Examination of the nine items from this study that were written using the standards addressing American Indian education appears to demonstrate a lack of focus on science content and greater focus on the history of different tribes. On careful examination of the content of the items, it was realized that each of them fit into one of three categories: (1) historical (relating to American Indian past), (2) majority science affecting or benefiting American Indians, or (3) lack of cultural relevance (items written to include Native names but not knowledge).

The intent of item developers was to design the items to address scientific concepts from an indigenous perspective based on the "Indian Education for All" curriculum, which was a step forward for the testing community, as other standardized tests do not incorporate Native American curriculum. However, none of the items actually addresses scientific principles; rather the items
address historical knowledge or contributions and the effects White modern 
science (WMS) has had on American Indians or simply show no measure of 
relating to American Indian knowledge. Six of the nine items were found to relate 
to the first category, two items were listed under the second category, and the 
last category contained one item. An example of this item bias can be found on a 
test question asking about how the use of technology will affect Montana Indian 
cultures. The question does not address the technologies developed by Native 
peoples. It would most likely be assumed by students that the scientist in the item 
is of the dominant culture because it is not stated otherwise, creating a sense of 
colonization within the question. This question illustrates how one culture can be 
seen as being studied and the other as the studier, but further studies should be 
conducted on how the American Indian students perceive the Native American 
test items.

Another issue that was addressed during the item exploration was 
distractor analysis. It could easily have been argued that many of the alternative 
(incorrect) answers provided to the students could be a correct response, 
depending on the perspective of the American Indian student, thus leading to the 
conclusions that “tests lack cultural equivalence for the differently advantaged 
group” (Helms, 1995, p. 704) and that items are constructed with a sense of 
dualism that supports the European-American belief that each test question has 
only one correct answer as determined “by the normative White response” 
(Helms, 1995, p. 701). The results of distractor analysis through logistic 
regression indicated that American Indians made up the greatest percentage of
students with incorrect responses for each of the items identified as being indigenous in nature. These findings support claims made by Ruth and Murphy (1984, 1988), who suggest that the intended meaning by the developers and the meaning constructed by the student depends on several variables, including “characteristics of the text of the item, the reader, and the context.” Using distractors that could have possible alternative meaning to indigenous students needs to be carefully examined in order to provide for a lesser chance of bias.

Sasaki (2000) provides evidence of how culturally sensitive language plays a role in student achievement. Sasaki (2000) investigated performance and levels of understanding of 60 Japanese first-year undergraduate students on language tests. The focus was on whether students achieve higher scores on language tests that use culturally familiar terms as opposed to unfamiliar terms. Sasaki asked four questions during his study, all dealing with student responses to culturally familiar versus culturally unfamiliar terms and the students' justifications for answering questions the way they did.

To find answers to the questions, Sasaki split the participants into two different groups, those receiving culturally familiar and those receiving culturally unfamiliar versions of the test. In the culturally familiar versions, names and places were changed to reflect Japanese culture rather than White culture. Students were given 30 minutes to complete the test and additional time to provide an oral response about their thoughts as to why they chose a specific answer, which provided insight into the test-taking process for the student. Through the use of this testing strategy, the author determined that students who
had familiar terms on their tests scored higher and attempted to answer more questions than those who did not have familiar terms. "Those who read the modified, culturally familiar version of the text demonstrated correct understanding of the key terms more often, tried to solve more items, and generally understood the text better. This resulted in a better test performance than that of the students who read the original text" (Sasaki, 2000, p. 24). The author also determined that the students who received the unfamiliar versions of the test would probably have answered correctly the items that they originally missed had the text been more familiar. Sasaki (2000) conjectured that students may have answered the unfamiliar items incorrectly because "[t]hey might have been too overwhelmed by the unfamiliarity of the text to try to solve these items" (p. 24).

Sasaki's findings are further supported by language bias found in the test items explored as part of the current study. When examining individual test items, many non-indigenous items contained higher-level vocabulary and very Western science-driven material. Scores of American Indian students' scores tended to be lower on these items as compared to scores on Native items, where the language may be more familiar. A connection to further the ideas of cultural capital and colonization of the American Indians is that there are American Indian students who were able to score at levels comparable to majority White students. When comparing students scoring at the proficient or advanced levels, White students were in the majority; however, 28% of all American Indians taking the standardized state science test scored just as well as their White classmates.
This finding may substantiate the claim that those students who are able to act and think like the majority will have a better chance of higher student achievement.

In her article "Culture and Consequences: The Canaries in the Coal Mine," Murphy (2007) also provides a detailed overview of the issue of validity in standardized testing. She believes that standardized testing is "firmly rooted in an objectivist tradition" (p. 228). Using language as her argument, Murphy discusses how not only minority students but all students are suffering from the way in which standardized tests are written where there is a "conflict of language and culture" (p. 228), which in turn could potentially threaten the validity of these tests. Language and culture are intricately linked and, as culture influences how knowledge is constructed, this knowledge is interpreted by the language of whomever is constructing the knowledge, making the interpretation and meanings different for individuals of different cultures (Koelsch, Estrin & Farr, 1995; Murphy, 2007). Based on her review of the literature of cultural inequity on standardized tests, Murphy suggests methods such as modifying the test to account for making sense for the student and the setting. Other possibilities include performance-based assessments, which have historically been used as alternative assessments to standardized multiple-choice tests but are now being recommended for all students, as such assessments are viewed as being "potentially more culturally fair" (Hood, 1998).

"If a test is 'standardized,' that test is a measurement of a 'standard' as defined by particular interests" (Hartman, 2003). Language is a factor that limits
indigenous students' participation in school in general but becomes even more of
a problem when tests are written to focus on the majority population and do not
take into account structures of the Native language (Mead, Grigg, Moran &
Kuang, 2010; Willett, 2000).

Students who have greater content familiarity and can see the
relationships between the concept and the meanings derived from the concept
tend to perform better and obtain better achievement (Kawagley & Barnhardt
1998). The results of this current study support Kawagley and Barnhardt's (1998)
findings which state that, in order for indigenous students to fully grasp a
concept, it first must be explained in Native American terms so the students are
able to relate to it and put it into context, and then explained in Western terms.
This study found that indigenous students tended to score higher on items that
were of a cultural nature as compared with items derived from a Western science
viewpoint. Thus, American Indian students answered the culturally based Native
American item correctly a greater percentage of the time.

Examination of the Native American test items included in this study has
given rise to the question of whether the items are acting as intended and are
truly addressing indigenous knowledge. Study of the individual indigenous items
represented on the test lead to the conclusion that they do not actually address
Native American scientific knowledge but, in fact, address historical questions
and ask students to think about what would happen to different aspects of the
culture if various scientific methods were introduced. From these items, it is not
quite clear how Native American knowledge is being implemented in the
classroom from the "Indian Education for All" curriculum and how it is being assessed on the state test.

Thus we have arrived at the current status of standardized testing, which lacks in cultural values. Much of the time when tests are constructed, the "quantity and quality of educational material present in one's home environment, parental education, or income (i.e., socioeconomic status [SES]), or personality characteristics (anxiety, lack of motivation) elicited by submersion in an unfamiliar (testing) environment" (Helms, 1995, p. 685) are not taken into account, thus providing an unequal testing experience for many students. All of these factors have an influence on student achievement, as has been shown by the results of this study, with minority and low-SES students tending to feel the greatest effects. The change that must be made to reach the vast numbers of students who are being left behind is the inclusion of cultural values. Changes must be made not only to the test itself but also to the standards and the curriculum that inform the test content and construction. It is through a combination of all these methods that the greatest gains can be made in closing the achievement gap for minority students.

**Socioeconomic Status, Location of School, and Gender as Factors in Student Achievement**

As stated in the previous section describing race as a factor in achievement, many Native students have difficulties when it comes to testing, whether it be due to an incompatibility between Western thoughts and Native traditions (Cajete, 2005; Kawagly & Barnhardt, 1998; Woolman, 2001), a language barrier
(Hartman, 2003; Johnston, 2010; Murphy, 2007; Sasaki, 2000), or the construction of the test and bias of the items (Dehyle, 1983; Eakins, et al., 1976).

In this study, SES, location of a school, and gender have been found to be confounding variables that also affect student achievement.

**Socioeconomic Status**

Based on results of this study, students with low SES tend to score the lowest regardless of race. Data showed that low-SES students were scoring on average about 15 points lower than students who were identified as not being of low SES. This result is supported by reports that individual students' SES plays a role in student achievement, as evidenced by their scores on IQ tests, standardized tests, and the rate and frequency at which students are retained (Jenesen, 2009).

An additional finding of this study is that those schools that tended to have the greatest numbers of American Indian students also tended to have the lowest achievement. This is consistent with studies indicating that schools with a majority of American Indian students also tended to have higher poverty levels, thus having an impact on achievement (Beck & Shoffstall, 2005; Darling-Hammond, 2000; McCall et al., 2006). According to the U.S. Department of Education (2007), American Indians had the second highest rate of poverty (26.8%), falling only a few percentage points short of Black students at 30.1%. Poverty has not only been seen to play a role in student achievement on the Montana state standardized science test, with low-income students scoring, on average, 15 points lower than non-low income students, but also has influenced
poor performance on both the Northwest Evaluation Association (NWEA) and National Assessment of Educational Progress (NAEP) assessments (U.S. Commission on Civil Rights, 2003). In recent studies, low SES has been linked to Black students' poor performance on NWEA and NAEP tests owing to the one-parent households that often exist for these students. Because of the lack of parental support and guidance, student academic achievement suffers (U.S. Department of Education, 2007). Jenson (2009) supports this idea, linking poor performance and SES to issues in the home, including limited parental academic exposure and the pressure to provide for their families economically rather than focusing on educational values.

Most American Indian students tended to attend reservation schools where scores were at their lowest, with an average difference in scores ranging from 16–19 points between students attending schools on versus off the reservation. Decreases in achievement levels could be attributed to the fact that areas with high concentrations of Native individuals have been found to have high poverty levels, which has been associated with low achievement (Arroyo, 2008; NCSL, 2008). The different location of schools, on or off the reservation, clearly had an impact on student achievement, which will be further explored in the next section.

**Location of School**

The location of the school that students attended—on reservations versus off reservations—played a significant factor in the overall average achievement scores between students at each. All students, regardless of race, tended to have lower achievement scores if they attended school on a reservation. This
indicates there may underlying issues present on reservation schools that need to be addressed to increase student achievement in science.

Several factors could contribute to students’ lack of success on standardized assessment based on the location of the school, including funding, limited resources, and quality of education (preparation of teachers). Beck and Shoffstall (2005) found that schools located in more rural areas tended to have fewer resources available to them, which might negatively influence student achievement. In the case of the current student, the majority of reservation schools are located in rural, remote locations away from larger cities or populated areas. Many of these types of schools tend to be underfunded and therefore perpetuate low student achievement.

McCall et al. (2006) state that “for every score level, students enrolled in low-income schools grow less than students in wealthier schools. This means that for two students who start the school year with the same score, the student who attends the high-poverty school is more likely to end the year behind the student who attends the low-poverty school” (p. 39). These studies indicate that no matter what their race, if a school has a high poverty rate, the schools tend to be underfunded and the students score lower on standardized tests (McCall et al., 2006). Although the current study did not look at academic growth across time or school funding, the data did show that students who were identified as being low-income scored, on average, 15 points lower than those identified as being not low-income.
Arroyo (2008) reported, on data provided in the 2004–2005 school year, that most states spend less to fund students in districts with high English language learner (ELL) and minority populations than to fund students who reside in districts with low ELL and minority populations. He found that Montana spent $505 per pupil less in the high-poverty districts than the state spends in the lowest-poverty districts. This lack of equitable spending by Montana may be cause for concern for American Indian families, owing to the fact that high poverty levels are associated with families living on a reservation (NCSL, 2010).

In the realm of testing, funding has been identified as an issue in two areas: first, as a catalyst for poor performance of students owing to the paucity of resources and a lack of highly qualified teachers and, second, as a way in which to provide rewards to those schools who are more accountable for student learning and achievement on standardized tests (Beck & Shoffstall, 2005; Miner 1999/2000; Moe, 2003). Lack of resources is commonly seen in rural schools that do not garner the same amount of funding as schools in more urban areas. In turn, schools in urban areas tend to have greater access to well-equipped libraries and teachers who are better educated, leading to a greater chance at educational opportunities (Okoye, 2009). The National Conference of State Legislatures hypothesized that the lack of quality teachers in schools with high populations of Native American students contributes to poor Native student achievement (NCSL, 2008).

As part of combating and working to close the achievement gap, issues of school funding and access to equal resources and quality of education must be
further addressed. Attention must be given to these issues to ensure equality of education for all students and aid in an increase in student achievement scores if standardized tests are going to continue to be a measure of student and school success.

Another area of interest that arose in the current study is that of gender. Although differences in student achievement based on gender was not as significant as SES, race, and the location of the school, differences did exist, which supports the findings of past studies investigating the differences in science achievement between male and female students.

**Gender**

Gender differences associated with achievement levels in math and science has been an area that has been well-explored by researchers (Mullis et al., 2000; NCSL, 2008; Okoye, 2009; Wigfield et al., 2002). Many studies focusing on achievement across gender focus only on White students rather than on minority students such as American Indians.

Gonzales et al. (2008) used data collected from the Trends in International Mathematics and Science Study (TIMSS) to determine that at the eighth-grade level, boys were found to achieve significantly higher average scores than girls in many countries. Particularly, in the United States boys outscored girls by an average of 5 points on the 2007 science portion of the test. The 2009 NAEP also provides data supporting the idea of males outperforming female students, where male eighth graders scored higher on the science portion than their female counterparts (National Center for Education Statistics, 2011b).
Findings from these national studies support the findings of the differences in achievement based on gender in this study, with male students outscoring their female counterparts by an average of 4 points for both years of the study. However, when scores are broken down by race and compared between males and females of the same race, some differences emerge. American Indian girls who were low income and attended school on a reservation outscored American Indian boys in the same category by 1 point, which is statistically significant, whereas there was no difference for White students. Both White and American Indian girls who were high income and attended school on a reservation outscored their counterparts by 1 point, which is also statistically significant. American Indian girls continued to outscore boys even when they were high income and attended school off the reservation; in this case, girls scored 1 point higher, on average, than male American Indian students. Thus, there is a difference in achievement between individuals of the same race, with female American Indian students tending to score higher than male students and White students generally scoring the same.

These findings provide support and some new insight into the literature on gender and race. Traditionally, research on achievement on standardized science tests comparing genders have found that male students outscore their female counterparts (Gonzales et al., 2008). This area has been well documented in instances of White students (Wigfield et al., 2002). The current study indicates that this is still the case, with White boys outscoring White girls most of the time. The difference in this case is that while White boys continue to
outscore American Indian girls, these same girls are outscoring their male American Indian counterparts a majority of the time, providing some new evidence and additions to the current literature that there may be differences in test-taking dynamics among different races that have yet to be explored.

Race, SES, location of school, and gender have all proven to be informative categories by which to explore student achievement. Through investigation into each of these factors, findings have revealed that American Indians are continuing to struggle and score lower than White students on standardized tests even with the incorporation of Native knowledge. These findings elucidate the fact that there are compounding issues related to student achievement. These issues appear to include the lack of cultural capital on the part of the American Indian student, which causes concern in that these students are not able to readily engage with the language and ideas of the current test design, which align more with the majority viewpoint. Another issue is that test items included in the Montana eighth-grade science test may be biased in construction and content. American Indians continue to perform poorly in comparison to White students on standardized science tests even when they possess a high SES and attend schools off reservations. Along with these results are the biases that are found within the design of the test items, in that the majority of items are focusing on a Western view of science. A final piece to consider is the performance of students attending reservation schools; regardless of race, these students are performing at the lowest achievement level, adding to the fact that reservation schools have been historically
underfunded. All these findings tend to support Said's belief that schooling for minority students is a form of educational colonization even despite the inclusion of Native items on the test.

Colonization as a Factor in Student Achievement

The focus of NCLB (2002) was to work toward creating a more equal school structure. The new standards incorporated into NCLB were designed to level the playing field for all students, increase accountability at the local level, and close the achievement gap in learning between minority and non-minority students. Though the research and findings from this study have highlighted efforts made to achieve these goals, such as including culturally relevant curricula, providing resources in different languages and, in the case of Montana, including indigenous items on standardized tests, an inequality still exists, as seen in the achievement gap, with White students continuing to outscore American Indian students.

Theory of Educational Colonization

As a means by which to explore this persistent inequality, I offer the ideas of Edward Said, a prominent figure in the field of post-colonialism. Through his ideas, I explore the concept that colonization may still be present in today's assessment regimen. The following sections briefly explore the history of colonization as it is situated in educational practices in order to provide a foundation for further discussion of the present-day educational system as a means by which to control student populations. The results of the present study,
which indicate that American Indian students are still lagging behind White students on the Montana state standardized test that includes Native knowledge, indicate that there is some disconnect between the way in which the knowledge is presented to students and their understandings of the questions and possible answers. The ways in which this disconnect relates to the presence of colonization in the education system will be detailed further in the next sections.

**Colonization of the Past**

With the advent of boarding schools for American Indians in 1879 also came the United State’s exercise of control and power over what was taught and learned in these schools. Said (2003) examines this idea in the context of Orientalism, in which people of the Middle East were colonized by Western Eurocentric countries. Said uses Orientalism to “describe the relationship between colonial knowledge and exercise of imperial power” (Rizvi & Lingard, 2006, p. 293). As Said defines power, he calls on Foucault’s (1970) writings to describe how the “Western textual representation of the Orient is an example of the Western ‘will to power’ over others and that it is inextricably linked to the material realities of political and economic domination” (Rizvi & Lingard, 2006, p. 297). This theory can be applied to how the view of education by the United States was a way to achieve success and attain necessities. The United States used this viewpoint as a means by which to remove students from reservations and place them in boarding schools, immersing them in the world of dominant White ideas (Fuchs & Havighurst, 1973). This immersion was a play on power by the non-Indian society, imposing dominant ideas through curriculum and pedagogy (Fuchs &
Havighurst, 1973). To align schools with the United States’ idea of achieving success through schooling, a form of greater accountability was put in place by way of standardized testing. In this way, educational stakeholders would have an even greater grasp on what all students were learning and expected to be proficient in (Hursh, 2001). Native students held no power and had no say in what their education consisted of, leaving them powerless in their own learning.

Said saw a sort of dualism in how power resided with those identified as colonizers and how the colonized appeared “powerless, silent, and objectified” (Rizvi & Lingard, 2006, p. 297). While this dualism may not be as explicit as it was in the past, the subtleties of inequality and presence of power are visible in today’s educational system also. It appears that the dominant culture is still acting as colonizers, deeming their information more important than American Indian knowledge, as evidenced by the modest number of Native items versus the majority of non-Native items included on Montana’s state standardized science test.

It has been many years since American Indians have been forced to attend boarding schools and encouraged to lose their sense of “Indian-ness,” yet there is still the push for them to measure up to their majority counterparts. The power exerted on American Indians in the past is not unlike that of today, in which standards are created and addressed by teachers and then assessed by standardized tests that were created for the majority students and contain language and ideas central to the majority culture. The practice of testing can also be used as a method of control if it does not allow for equality within the
tests with regard to content and language (Johnston, 2010). Results from the item analysis in the current study provided evidence for an inequality in language and content, as all nine items exhibited bias in the way in which they were worded, the tone they took, and the choices with which students were faced.

**Colonization in Present Times**

The practice of schooling is colonizing in the way that the educational system is established and run. Said viewed formal education "as a key institution through which colonial modes of thinking were produced and reproduced and where postcolonial aspirations could also be worked towards" (Rizvi & Lingard, 2006, p. 294). Thus, Native American children have to substantially modify or abandon their indigenous understandings and ways of learning in order to gain access to greater opportunities for success as defined by the dominant culture (Johnson, 2008; Ogbu, 1995).

Rizvi and Lingard (2006) use Said's theory in their conversation about the cultural politics of education to discuss how "identity, representation, and cultural exchange" (p. 295) is a present issue in today's educational system. The results from this research support the authors' discussion of how knowledge and power are players in current educational systems. In this study, the identity of American Indian students has played a role in their achievement, with race being a factor in student outcomes. The identity of American Indians also tends to situate them within another identifiable group, that of low-SES students and those who attend reservation schools. The issue of identity is also highlighted when American Indian students who achieve higher scores on the standardized achievement test
are seen as being able to identify with White culture, thus perpetuating the notion that White ideas or situated ways of knowing are more highly sought after than Native ways of knowing (Gardener, 1995; Helms, 1995).

The second issue regarding representation can be seen in the number of items regarding Native culture that are included in the data—9 indigenous items as compared to 70 or more White items. The fact that there is such a large difference in the inclusion of cultural items illustrates a clear lack of representation.

The final issue, cultural exchange, is again an example of cultural inequality. While all students are taught the "Indian Education for All" curriculum, given the number of non-Native items on the test, one would suppose that more time is spent focusing on majority culture and that minority students would be exposed to this type of learning in greater amounts than Native culture.

Rogoff (2003), in her book *The Cultural Nature of Human Development*, aligns with Rizvi and Lingard's (2006) ideas of knowledge and power by addressing the idea that government efforts to "civilize" the Native American members of society included an attitude that there was "One Best Way" which is the way of the dominant group—in this case, White individuals. In the chapter "Cultural Change and Relations among Communities," Rogoff (2003) brings to light the fact that even in situations where an intervention is taking place to "help" individuals of a different race, the idea of "One Best Way" continues. Whereas the dominant group may see themselves as trying to do what is in the best interest of the other group, they may be unintentionally pushing their views onto
the nondominant group. The notion of power and knowledge come to light when the White individuals see themselves as holding all of the power and knowledge that needs to be bestowed upon the American Indian. The cultural exchange that is taking place is that of the dominant culture "giving" their ideas and knowledge to those whom they deem to be of lesser knowledge (Rizvi & Lingard, 2006). Rogoff uses Jamake Highwater (1995), an American Indian writer and anthropologist, to make the point that sometimes when people are trying to do what they believe is best to eliminate intolerance, their efforts work in reverse and may instead make it seem as though all people are the same and need and want the same things. Highwater (1995), in his article “The Intellectual Savage,” discusses his personal experience with White ways of knowing; he describes his cultural disequilibrium with the English language and the naming of objects. Highwater (1995) provides examples of how educators, believing that they are helping American Indian students learn about the world around them, are, in actuality, doing a disservice to both the Native and non-Native students.

Indian children have long been urged by educators to see things and to name them in terms of the cultural package of White people, though such training essentially divests Indians of their unique grasp of reality, of their own dissimilar cultural package. Children of the dominant society are rarely given the opportunity to know the world as others know it. Therefore, they come to believe that there is only one world, one reality, one truth—the one they personally know; and they are inclined to dismiss all other worlds as illusions.” (pp. 207–208)

The message to take away from this is that educators must be cognizant of the fact that students see things in different ways, that different cultures have varying perspectives on how to interpret concepts and ideas, and that this difference is
what makes the world what it is—ever-changing and growing. The potential bias
found in each of the Native test items examined in this study reaffirms the
concerns associated with the development of test items and how important it is
for test developers to consider a variety of interpretations of information.
Movement toward a more equitable testing design could be achieved through a
greater awareness of what each culture values in terms of gaining certain
knowledge (i.e., cultural competencies) (Gardner, 1995). Given the widespread
influence of White culture, assumptions by test developers could made about
what knowledge is and how it should be transmitted. The transmission of
knowledge could be carried out with the most well-intentioned efforts, but those
supposedly benefiting from the knowledge may, in fact, see no value to
and power support Gardner’s perspective. Said states that often the minority’s
ideas are suppressed and seen as secondary or not even worthy of inclusion on
standardized tests. In today’s society, being competent in academics means
possessing “certain attributes associated with a white middle-class type of
success in school and society” (Ogbu, 1995, p. 246). The widespread practice of
standardized testing can be seen as a “reassertion of national, and thus White,
unity” (Hartman, 2003, p. 20), where the way in which tests currently exist
exemplify the American identity of “whiteness, richness, and maleness”
(Hartman, 2003, p.20).

In current American culture, being competent means achieving high
scores on standardized tests. The way in which tests are written favor majority
White students even when they are modified to include Native knowledge, making race a factor in student achievement, owing to the inequality in design of the tests. The results of this study indicate that Western science is still valued over Native science in that the items that were included and identified as "Native" included historical knowledge rather than contributions of current times, supporting Said's (2003) theory that knowledge resides with those that hold the power. In this case, schools are institutions that are teaching about the dominant culture's knowledge over others, thus holding the power.

The step taken by the state of Montana toward aligning the indigenous curriculum with the state standardized science test was critical in the movement toward providing a more equitable educational engagement opportunity for all students. While this step is monumental, perceived issues persist with the way in which the test items are constructed and the way the curriculum is taught. These issues need to be addressed in order to ensure that less of a colonizing approach is being employed. With further investigation and adjustments to their educational and assessment systems, Montana may be the first state to implement a fully functional inclusive approach to teaching, learning, and assessment. The findings of this study are in no way intended to negate the positive work that has taken place in the state of Montana but rather to point out areas where more attention is needed, with the hope that other states will follow in Montana's footsteps.
Conclusion

In 1995, as a result of her literature review (entitled Why Is There No Study?) focusing on the lack of cultural inclusion in standardized testing, Janet Helms proposed that test content be modified to include test items that reflect a diversity of cultural content. Helms's research shone a spotlight on the lack of cultural equivalence on standardized tests. The current study investigated the difference in achievement levels of American Indian and White students who were given some culturally diverse items on the Montana state standardized science test. The findings of this study reaffirmed and provided insight into the continued existence of an achievement gap between eighth-grade American Indian students and majority White students in Montana. Though this gap remains, it is closing slightly with advancement of the standardized test through the inclusion of Native material. The inclusion of indigenous items has had a positive effect on American Indian student test scores in science. This study provides insight for future research in the area of testing, especially with regard to the way items are constructed and what they actually are intended to measure.

The results of this study provide evidence that SES and the difference in location of schools, whether on or off a reservation, play a significant role in how students perform on the standardized science test. As found in studies leading up to the current one, students who have a low SES tend to score lower than students who are not labeled as low SES (Helms, 1995; Jensen, 2009; Okoye, 2009). The study also demonstrates that students who attend schools on the reservation tend to score lower than students attending off-reservation schools,
no matter their race or SES, thus indicating a significant difference in schooling between on- and off-reservation schools. This finding is in need of deeper exploration as many factors may be involved but not explored in this study, including (but not limited to) school funding, parental involvement, and levels of schooling of parents and teachers.

Montana and other states can use the findings of the current research to modify their standardized tests so that greater numbers of indigenous items are included on the tests. Such items would appeal to the understandings of their Native populations. The perpetuation of a difference in achievement scores on science standardized tests could be attributable to many factors surrounding the construction of standardized tests themselves. Although Montana has led the movement for a more equitable learning environment by including in their state curriculum and on the state tests cultural knowledge of their 12 American Indian nations, room for improvement remains, given the possibility of test item bias.

Overall, the results of this study indicate that colonization may still be influencing our education system today. The finding that race is a factor in student achievement substantiate that there is inequality between White and American Indian students with regard to testing. American Indian students are scoring substantially lower than their White counterparts even with the inclusion of Native items. This poor performance can be associated not only with the way in which tests are designed, tending toward a majority understanding, but also with other confounding factors such as the quality of the school environment. The inequality that exists in the funding of schools may be one reason for such a
disparity between the achievement scores of students attending reservation schools and those attending schools not located on a reservation. As the current status of education is situated, the achievement gap persists owing to inequality of funding, resources, and culturally relevant materials.

Given the results of this study, it is important to note the areas of research that still need attention. Much can be learned from studying cultural differences, especially in the ways in which assessment is viewed and knowledge is understood.

**Implications**

In this section, I discuss the implications of my analysis. I share the significance of my findings and discuss specific recommendations at three different levels: test construction, curriculum development and teacher support, and outreach. Attention should be paid not only to how the test items are constructed based on the Native standards and curriculum, to provide a well-rounded approach to cultural inclusion, but also to how the curriculum is taught and the ways in which this culturally relevant curriculum can be supported by community members to increase interest and participation in science.

**Test Construction**

Cultural background and context need to be considered during the process of test item construction to account for individual differences in the way students are brought up and learn science through multiple lenses. Rogoff (2003) poignantly addresses the matter of context when she makes reference to the fact that, for
years, testing procedures were believed to be context-free and were purely cognitive-based, which kept knowledge and schooling separate. Maintaining a curriculum and testing culture that keeps context and knowledge separate and tests them as such simply continues a state of cognitive imperialism and neocolonialism (Aikenhead, 2006). One solution would be to construct tests that take cultural values and beliefs into consideration.

When examining the contents of a specific test, one must be sure to take into account the producers of that test and, therefore, their knowledge base. Test companies produce standardized assessments, but one must ask exactly who is responsible for producing these documents and whether they are trained to integrate the cultural background of the students who are taking these tests. With the inclusion of culturally relevant material, test developers must pay attention to sociocultural factors such as students' epistemologies toward their culture and how they construct knowledge, as well as how their view of culture shapes language, taking into account their "ways of knowing and traditional knowledge" (Murphy, 2007). In addition to acknowledging and paying special attention to the language of the test and cultural connections that must be made for indigenous students, test developers must also ensure that the test items are authentic and truly measure what each item was intended to measure and assess. Battiste (2002) describes the importance of vetting research on indigenous knowledge and the way that this knowledge is presented in school through some sort of ethics committee, in order to protect indigenous knowledge in the future. This inclusion would be another step in the creation of a more equal assessment that
can benefit all students. Relatively little research has been done with regard to looking at students' response to and interpretation of individual test items. The results of the current study found that including culturally responsive test items on state standardized tests nets positive results. Items derived from Native standards are more likely to be answered correctly by indigenous students than are non-Native test items. With the inclusion of a Native curriculum in the classroom and items derived from this curriculum on the standardized test, indigenous students are more likely to answer the questions correctly. Nonetheless, during test item analysis, many of the individual test items were found to be culturally biased.

It is suggested that a greater diversity of individuals, possibly one member of each tribe, be included in the test development process to help alleviate concerns surrounding item content. Murphy (2007), in her literature review of test item validity, supports this notion, stating that "even the most culturally knowledgeable item writers and reviewers may write items that students misconstrue, so gathering information about test-takers' perspectives seems critical to the development of valid assessments" (pp. 235–236). Using Solano-Flores and Nelson-Barber (2001), Murphy (2007) provides an example of this biased perspective, recommending a "series of review-revise iterations in which wording is refined based on the observed performance and the verbalizations of pilot students" (p. 560).

Because majority students may be better suited than their non-majority counterparts to answer multiple-choice items, this item type may give an unfair
advantage (Johnston, 2010). With regard to the learning strategies employed by American Indian students, such as group-oriented, hands-on work (Aikenhead, 2001a, 2001b, 2006; Freeman, 1992; Kawagley & Barnhardt, 1998), performance-based assessments may be a fairer way to assess student knowledge. Therefore, item construction should focus more on a performance orientation rather than multiple-choice items (Kawagley & Barnhardt, 1998). Students should be given the opportunity to explain the reasons for the answers they select after having experienced a scientific concept. In this way, they are explaining their learning and understanding instead of simply choosing the best response. Test developers should take care to ensure that distractors deemed incorrect are not plausable for Native students, who may have a very different history than majority students and could therefore find truth in distractors that are supposed to be incorrect.

**Curriculum Development and Teacher Support**

The development of the "Indian Education for All" curriculum was a major accomplishment in the increased push for inclusion of indigenous knowledge representation in the school system of Montana and, in turn, in the state standards and on the standardized science test. This movement toward a more equitable learning environment has been very strongly advocated for by such proponents as Kawagley and Barnhardt (1998), who believed that integrating WMS and indigenous science would be beneficial to both worlds. Kawagley and Barnhardt (1998) have observed that Native American students are more successful when the topic is related to some sort of utility outside of the
classroom, such as "putting knowledge into practice," and reflects an interconnectedness. The "Indian Education for All" curriculum focuses on ideas and concepts that are often taught at home by Native American families and that are still valued by American Indian nations. Bringing this knowledge into the classroom allows students to see the relationship between school and Western science and their indigenous ways of knowing. As Kawagley and Barnhardt point out, this knowledge obtained in school is now useful in the students' home lives, and they are able to put the knowledge into practice outside of school.

Even with the integration of a culturally inclusive curriculum, students who attend schools on reservations continue to lag behind their counterparts in achievement. Kawagley and Barnhardt (1998, p. 7) make well-articulated points when they say, "There are ways to break out of the mold in which we are oftentimes stuck, though it takes some effort. There are ways to develop linkages that connect different worldviews." They go on to describe how there is a tendency in most literature on Native education to focus on how to get Native people to understand the WMS view of the world but very little literature that addresses how to get Western scientists and educators and students to understand Native worldviews. According to Kawagley and Barnhardt (1998),

We have to come at these issues on a two-way street, rather than view the problem as a one-way challenge to get Native people to buy into the Western system. Native people may need to understand Western science, but not at the expense of what they already know. Non-Native people, too, need to recognize the existence of multiple worldviews and knowledge systems, and find ways to understand and relate to the world in its multiple dimensions and varied perspectives. (p. 8)
Attention needs to be focused on identifying the factors that cause students of both races to achieve higher scores off a reservation than on a reservation. Two factors that require further investigation are the teaching methodologies employed by educators in each of the locations and the level of education each group of educators has achieved. Though the integration of the indigenous curriculum is clearly a positive move, teachers who are non-Native may struggle with how to teach this material, thus leading to less-than-optimal student experiences and interactions with the curriculum. All these factors are potential reasons for the differences in student learning and achievement.

Unfortunately, as a rule, White people are rarely expected to understand the origins of thoughts and perceptions of other races or cultures. One who is not indigenous can never truly "know" what it is to be indigenous or to think from an indigenous perspective, although an awareness of this difference can allow one to be more sensitive to the issue (Brayboy & Castagno, 2008). This appears to be an issue and concern for teachers of Native students who are required to teach a curriculum to which they have no connection, causing a disconnect for both the teacher and the students. Harraway (1991) believes that sensitivity can be brought about by simply being aware of situated knowledge and by creating an adequate level of empathy in order to see from the subjugated standpoints. Hammond and Brandt (2004) put it this way:

Once we have identified where local knowledges may be in tension with structurings that may force unequal translations and exchanges, we can work towards deconstructing the webs of knowledge and power and allow for a more equal playing field to be laid. In this way, to know the "other" may lead us to understand ourselves. (p. 37)
The feelings of empathy and awareness that these authors discuss are necessary for teachers of Native students if the teachers are to be able to deconstruct the idea that one science is superior to another.

Indigenous people in communities throughout the world have begun to demonstrate that a significant "paradigm shift" toward the integration of indigenous knowledge systems and ways of knowing is taking place (Kawagley & Barnhardt, 1998). This is evidenced in the inclusion of "Indian Education for All" in the main curriculum used by Montana. The participation of the 12 nations of Montana in the development of this curriculum is progressive. In addition to Native knowledge incorporation, the educational orientation is currently shifting toward an emphasis on the use of local culture and knowledge in the educational process (Kawagley & Barnhardt, 1998). An example of this shift can be seen in the work of Aikenhead (1997, 2001b) and Barnhardt (2005a, 2005b), whose work on an indigenous science curriculum has already been implemented into science curricula across Alaska and Canada. Such a shift will benefit all parties because "many of the issues that are being addressed are of equal significance in non-indigenous contexts" (Kawagley & Barnhardt, 2007, p. 5).

In this vein, Aikenhead (1996, 1997, 2000) suggests that when indigenous worldviews conflict with those of Western science, science education should be modified to accommodate both viewpoints, and teachers must understand indigenous and First Nations students' experience with science as a kind of "border crossing" that must be acknowledged, understood, and assisted. Aikenhead (1996), who has done extensive work with First Nations people in
Canada, proposes the following cross-cultural approach to teaching science and technology (also known as science, technology, and society [STS]): It must be

1. focused on empirical studies in educational anthropology;
2. directed by the goals of the First Nations people themselves;
3. illuminated by a reconceptualization of science teaching as cultural; and
4. guided by a cross-cultural STS science and technology curriculum and grounded in various types of content knowledge (common sense, technology, and science) for the purpose of practical action such as economic development, environmental responsibility and cultural survival. (p. 217)

Aikenhead's acknowledgment of the incorporation of First Nations people's goals is similar to Montana's belief that the knowledge of all 12 Native American nations should be included in the curriculum and that Native elders should be consulted as sources of information as often as possible. This type of consultation is imperative to the success of indigenous knowledge incorporation, and so this model should be followed by other states that are attempting to create and implement a Native curriculum.

Another example that provides evidence for the positive outcome of using an integrated curriculum to teach Native students successfully and help increase test scores is research conducted in the state of Alaska, where educational standards have been designed specifically to develop culturally responsive schools. This curriculum has made science learning for indigenous children understandable through demonstration and observation accompanied by thoughtful stories embedded in lessons (Cajete, 2000; Kawagley, 1995).

While working in Alaska with Native American students, Barnhardt et al. (2000) found that the students' standardized test scores improved uniformly over
4 years to meet national averages. These classrooms followed Alaska Standards for Culturally Responsive Schools—influenced "cultural standards" to forge a strong cultural fit between what is taught, how it is taught, and the context in which it is taught. The Alaska Department of Education (2009) defines cultural standards as

broad statements of what students should know and be able to do as a result of their experience in a school that is aware of and sensitive to the surrounding physical and cultural environment. The standards are meant to enrich the Content Standards and provide guidelines for nurturing and building in students the rich and varied cultural traditions that continue to be practiced in communities throughout Alaska.

Acknowledgment of the students' sense of place (i.e., when immersed in their natural surroundings, away from school), students reacted in a positive manner (Aikenhead, 2001b).

Although the state of Alaska has numerical data that can be used to analyze changes in standardized test scores over time and demonstrate that something positive is occurring in these classrooms, areas that need to be addressed remain. Alaska has made great gains in acknowledging indigenous knowledge and then integrating this knowledge into the curriculum, making it more relevant and easily accessible and understandable to students. The success of this integration is apparent in the standardized test scores (Barnhardt et al., 2000); however, the tests themselves are not being changed to fit the knowledge of the indigenous population. If students are making gains in their scores through changes in the curriculum, it seems logical to propose an alteration so the tests better fit the curriculum frameworks within which the
schools have been working, with possible outcomes of even greater positive gains in test scores, as evidenced by the results of the current study.

In addition to designing a culturally relevant curriculum and providing a means by which teachers can effectively teach the curriculum, attention should be paid to the contributions that community members can make to the learning and understandings of Native youth. By incorporating community programs into the teaching of science, there is a greater chance that students and their families will participate, potentially leading to an increased interest in science.

**Outreach**

Because students who have a lower SES tend to score lower on the Montana state science standardized test, additional outreach is recommended to increase student interest in science and help lower-SES families become more involved in their students' schooling. Interest and performance in science has been found to decrease not only for indigenous students but for students globally as they reach middle and high school (Gibson & Chase, 2002). Studies such as that of Sheridan, Szczepankiewicz, Mekelburg, and Schwabel (2011) focused on the need for science, technology, engineering, and mathematics (STEM) outreach. The authors used as the basis of their study a summer camp at a New York college that concentrated on the exploration of basic chemistry topics for inner-city and suburban middle school students. Roughly 300 students attended the camp over the course of a summer. Students came to the camp during their designated summer week and participated in all-day activities that rotated during each of the 5 days. Exit surveys were given to students to assess their interest in
science before and after attending the camp. The authors found that, "[a]ccording to the exit survey, a vast majority of the campers do not arrive at the camp with the expectation that it will be a boring experience. The effectiveness of the camp is demonstrated by the approximately 90% of the campers who indicated their increased interest in science and willingness to return to camp the following year" (Sheridan et al., 2011, p. 3). In the case of indigenous students, outreach could take the form of summer camps run by elders and educators or of weekend or after-school programming designed for children of all ages and their families. These programs and camps might be focused on current environmental issues on and off the reservation and provide a venue for indigenous perspectives to be heard, thus bringing to light the value in indigenous knowledge and ways of knowing.

Another study focusing on outreach—that of Shanahan, Pedretti, DeCoito, and Baker (2011)—explored responses of underrepresented elementary students who attended a science outreach program in Ontario, Canada. After they had participated in a Scientists in School workshop, during which science and technology concepts were presented via a hands-on methodology, students were given a survey regarding the ability of the program to engage and inspire interest in science. Findings indicated that students who attended schools with high levels of ELLs and low-achieving schools responded more positively to the outreach than did students who attended other schools. These students expressed great enjoyment of and excitement about the program. The workshop provided small-group work centered on hands-on
exploration that minority students and ELLs appreciated, possibly because students did not have to rely primarily on language skills for involvement but rather could participate physically and feel a greater sense of involvement. This type of outreach may be beneficial for American Indian students, given that some students’ first language is not English and that learning of science may be difficult for these students.

Outreach programming has proven successful as a method for including non-majority participants in a non-threatening science learning situation. The creation and promotion of such educational experiences by educators works toward decreasing the air of colonization that is still felt in our educational systems today.

Science relativity and the type of science that should be studied are relevant concerns that may arise in minority settings in first-world countries, becoming magnified and multiplied in indigenous settings where colonial, post-colonial, traditional, and indigenous voices blend. Whereas currently the trend in the United States is to pay increased attention to the needs of our students, testing can draw the focus away from equality for all students and instead train it on a need for success in the form of test scores. Special heed must be paid to how our students are learning and understanding science and whether what is occurring in the classroom is, in fact, the most beneficial for all students. For many years, science was taught in a White majority context, and American Indian students were forced to conform to the majority’s way of thinking and learning (Fuchs & Havighurst, 1973; U.S. Commission on Civil Rights, 2003). In recent
years, we have come to understand that learning science is not a one-size-fits-all model and should not be taught as such; rather, it should be taught through multiple lenses, giving proper acknowledgment to the diversity of learning styles in the classroom (Jegede & Aikenhead, 1999; Kawagley & Barnhardt, 1998). This method of teaching and learning should permeate all subject areas, not just science.

**Limitations and Implications for Future Research**

This study examined data only from eighth-grade students in Montana. Further research could be conducted to evaluate 4th- and 10th-grade data surrounding student achievement on the state standardized science test. This type of research could be expanded to examine tests in all disciplines that incorporate indigenous knowledge from the "Indian Education for All" curriculum, to determine whether student achievement differs across subject areas when Native American knowledge is incorporated on the standardized tests. A longitudinal study could be carried out that expands on the current data, using data from future years' tests to determine whether the inclusion of indigenous test items is actually making a difference over time. A larger volume of data over an extended period can provide valuable information as to how American Indian students continue to score, as compared to their White counterparts, after greater exposure to the "Indian Education for All" curriculum and experience with Native test items. Such data would offer insight into the effectiveness of including indigenous items for both indigenous and non-indigenous students and the extent to which students understand and answer the indigenous items correctly.
as compared to the typical non-indigenous items found on the tests. If the
increase in American Indian test scores continues, the data would strongly argue
in favor of other states with large indigenous or minority populations including a
Native curriculum and items on their state tests.

Another important area of research that is yet to be examined is the role of
the "Indian Education for All" curriculum and its use in the classroom. Future
studies focusing on the level of use of this curriculum and the way it is employed,
through teaching methodologies, is critical to understanding to what extent this
curriculum is responsible for student learning of American Indian knowledge of
science. This study was not able to address the methods in which the curriculum
was taught in the classroom by science teachers; nor was it able to address how
often and to what extent the curriculum was taught by science teachers. This
information is critical if we are to uncover the ways in which students are learning
this curriculum. If students experience the curriculum in varying degrees, then an
unequal learning experience results for all students, thus leading to a difference
in comprehending Native ways of knowing and understanding which, in turn,
contributes to the perpetuation of an achievement gap.

An additional suggestion related to the findings of this study is design of a
future study investigating students' perceptions of Native knowledge as it is being
incorporated into the classroom and on standardized tests. This type of study
might prove useful in helping us understand whether Native American students
are more motivated to learn the material given that it is more relatable to their
culture. If there is a relationship between student motivation to learn the
curriculum and a gravitation toward a favored learning methodology, recommendations could be made for vital changes to classroom instruction focusing on "Indian Education for All."

The construction of standardized test items would be greatly informed by the input and interpretation of the Native American student. Investigating how the Native student views the test item and why and how that student would answer a particular item can provide valuable insight into whether the item is being constructed to measure what was intended. This type of exploration also might offer a look at student motivation to learn about and answer items related to the Native culture and whether and how this affects a student's attitude toward school.

An important issue to bear in mind is that assessment can mean many different things for different groups of students and even for students within the same cultural groups. Some students view testing as a means of reaching a future goal, whereas others are afraid of testing and believe that it can inhibit their dreams for the future. As a caution, future researchers might take these viewpoints into account and ask these important questions of the study subjects in order to gain valuable insight into the way students of different cultures actually view testing and the meaning it holds for them. Such information can help establish the context for the study and provide deeper understandings of testing in today's ever-changing world. Another key take-away from the inclusion of cultural understandings of testing is how we can use assessment more broadly rather than simply as a single data point representing student academic
performance. Is assessment really only about student achievement, or could it be something deeper and more personal?

Attention directed to the suggested areas of research that have emerged from the current study can provide important information to help close the overall achievement gap between indigenous and White majority students. Classroom instruction can be modified to include multiple perspectives or learning methodologies and curricula. Test development can be focused on the inclusion of indigenous knowledge and the most effective way to formulate questions to best test student's knowledge. Great gains can be made in the area of standardized testing and the incorporation of indigenous knowledge with increased research and implementation of new ideas. The state of Montana has followed a model devised over many years by several prominent researchers mentioned in previous sections. The incorporation of both Western knowledge and indigenous knowledge in Montana's science curriculum and standardized test has contributed to positive achievement results.

An effort is being made currently in science education research to create science opportunities that meet the needs of all students rather than catering to only a privileged few, which leads to the creation of a scientific elite. However, even while the idea of equal opportunities for all students is being promoted, some still oppose and criticize the movement toward "science for all." Researchers who oppose this idea suggest that providing the same opportunity for all students can result in placing students into ability groups where the chance for failure is increased rather than allowing students access to other higher-order
knowledge and the chance for greater success (Hammond & Brandt, 2004). In an effort to provide equality, sameness has been pursued, but same and equal are not synonymous. The notion of viewing science as something that is for everyone assumes that indigenous people think and feel the same way as Western White researchers do. The major assumption behind this view is that indigenous people are unhappy with what they know and understand science to be and that, by integrating WMS with indigenous knowledge, we can create a science that is relevant to both worlds and will provide vast improvements for indigenous people who have not yet been enlightened. If we are to "do science" in places other than the West, we are challenging basic assumptions about epistemology, pedagogy, and methodology (Hammond & Brandt, 2004). The integration of knowledge and science in an indigenous educational setting leads to the question of relevance, because it is important to determine whether science serves as a vehicle to move elite students beyond their communities or as a tool to address the problems a community faces. It is hoped that students would be taught skills to combat issues residing in their own neighborhoods rather than learning skills that will allow only a few to escape poverty, a less educated neighborhood, etc. Another question to address is whether science is to be held responsible either for preserving traditional knowledge of the natural world and traditional languages or for destroying heritage by replacing traditional knowledge with global perspectives and local languages with international ones. Many questions that remain unanswered must be examined more closely when integrating WMS and indigenous science knowledge.
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APPENDICES
APPENDIX A

IRB APPROVAL LETTER

University of New Hampshire

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14-Apr-2011

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IRB #: 5126
Bilingual Student Science Achievement and the Integration of Indigenous Knowledge in the Classroom and on Standardized Tests

Approval Date: 07-Apr-2011

The Institutional Review Board for the Protection of Human Subjects in Research (IRB) has reviewed and approved the protocol for your study as Expedited as described in Title 45, Code of Federal Regulations (CFR), Part 46, Subsection 110 with the following comment(s):

1. The IRB is still uncertain that all prospective student participants will be able to understand the assent information. Therefore, when presenting the research opportunity to students, the researcher needs to provide an oral explanation of the assent information and to answer any questions that students may have about the assent information and/or study participation.

Approval is granted to conduct your study as described in your protocol for one year from the approval date above. At the end of the approval dates you will be asked to submit a report with regard to the involvement of human subjects in this study. If your study is still active, you may request an extension of IRB approval.

Researchers who conduct studies involving human subjects have responsibilities as outlined in the attached document, Responsibilities of Directors of Research Studies Involving Human Subjects. (This document is also available at http://uhsr.unh.edu/research/irb-education-resources.) Please read this document carefully before commencing your work involving human subjects.

If you have questions or concerns about your study or this approval, please feel free to contact me at 603-862-2003 or Julie.Simpson@unh.edu. Please refer to the IRB # above in all correspondence related to this study. The IRB wishes you success with your research.

For the IRB,

Julie F. Simpson
Director

cc: File
Abrams, Eleanor
APPENDIX B

ESSENTIAL UNDERSTANDING REGARDING MONTANA INDIANS,
FROM "INDIAN EDUCATION FOR ALL" (2006)

ESSENTIAL UNDERSTANDING 1

There is great diversity among the 12 tribal Nations of Montana in their
languages, cultures, histories and governments. Each Nation has a distinct
and unique cultural heritage that contributes to modern Montana.

BACKGROUND

[Map provided courtesy of Governor's American Indian Nations (GAIN) Council]

A reservation is a territory reserved by tribes as a permanent tribal homeland.
Some reservations were created through treaties, while others were created by
statutes or executive orders.

RESERVATIONS: TRIBAL GROUPS

<table>
<thead>
<tr>
<th>Tribe</th>
<th>Tribe</th>
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<tbody>
<tr>
<td>Flathead</td>
<td>Salish, Kootenai, Pend d' Oreille</td>
</tr>
<tr>
<td>Blackfeet</td>
<td>Blackfeet</td>
</tr>
<tr>
<td>Rocky Boy's</td>
<td>Chippewa-Cree</td>
</tr>
<tr>
<td>Fort Belknap</td>
<td>Gros Ventre, Assiniboine</td>
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<tr>
<td>Fort Peck</td>
<td>Sioux, Assiniboine</td>
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<td>Northern Cheyenne</td>
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The Little Shell Chippewa Tribe is without a reservation or land base, and
members live in various parts of Montana. Their tribal headquarters is located in
Great Falls, MT.

About 35 percent of Montana's Indian people do not live on reservations. They
reside in small communities or urban areas of Montana. The historical and
personal experiences of Montana’s urban Indian people are as diverse as the
people themselves.

With only two tribally controlled K–12 schools in Montana, most Montana Indian
students attend public schools. Each of the seven reservations has its own
tribally controlled community college.
ESSENTIAL UNDERSTANDING 2

There is great diversity among individual American Indians as identity is developed, defined and redefined by entities, organizations and people. A continuum of Indian identity, unique to each individual, ranges from assimilated to traditional. There is no generic American Indian.

BACKGROUND

Identity is a universal issue for all human beings. We ask "Who am I?" and "How do I fit in?" However, the culture of students' homes and communities is not always evident in their schools. Consequently, they can experience difficulty and frustration as they search for a way to define themselves and to belong within such a system. To help young people explore and affirm their unique identities, educators need to support each student's inclusion in the classroom either through materials or through pedagogical practices.

Larger questions of "Who is an Indian/Tribal Member?" exist even among Indian people themselves, with no universally accepted rule for establishing a person's identity as an Indian. For its own purposes, the Bureau of the Census counts anyone an Indian who declares to be such (Native American Rights Fund). The criteria for tribal membership differs from one tribe to the next. While federal, state and tribal governments may have separate and unique definitions of tribal membership, this is the general principle: an Indian is a person with some degree of Indian blood and is a person recognized as an Indian by a tribe/village and/or the United States.

Considering these issues, educators must remember that Indian students come to school from a variety of backgrounds. They may differ in skin color, dress, and behavior, as well as in deeper and more subtle characteristics that include values, ways of being, and learning styles. Some may not bear the "physical characteristics of American Indians" while they carry more traditional ways of being and belief. On the other hand, some may bear American Indian physical characteristics without the traditional or stereotypical behaviors and beliefs.

Most important—all humans deserve to feel and to express personal integrity and pride connected with who they are and with whom they choose to identify. When educators respect this need, they can help their students to develop the self-esteem and integrity that will enhance their learning.

It should also be noted that not a group of styles or a single American Indian learning style fits all American Indians, either as individuals or tribal groups. When educators recognize this fact, they can adapt their teaching methods to individual learners while they build on and expand the individual students' approaches to learning. However, this does not mean that culture doesn't
influence learning styles. The differences in the cultures of home and school certainly do impact the teaching-learning process.

Classrooms need to integrate culture into the curriculum to blur the boundaries between home and school, with schools becoming a part of, rather than apart from, the communities they serve. (Collected Wisdom)

**ESSENTIAL UNDERSTANDING 3**

The ideologies of Native traditional beliefs and spirituality persist into modern day life as tribal cultures, traditions and languages are still practiced by many American Indian people and are incorporated into how tribes govern and manage their affairs. Additionally, each tribe has its own oral histories which are as valid as written histories. These histories predate the “discovery” of North America.

**BACKGROUND**

American Indian languages, cultures, and traditions are alive and well throughout Indian country. While many have changed through a process of acculturation, the cultures are not dead. Indigenous languages are still spoken, sacred songs are still sung, and rituals are still performed. While educators might not understand all of the complexities of contemporary American Indian cultures, they should be aware of their existence and of the ways they might influence American Indian thinking and practice today.

When asking students about their histories, ceremonies, and stories, educators should understand that such histories and traditions may be private, to be used and understood only by members of that particular tribe. Educators should respect policies surrounding “religious/spiritual activities” and include Native practices and beliefs equally with other religious traditions and spirituality.

Each tribe has a history that can be traced to the beginning of time. Valid as any other mythology or belief, many of these histories will be told only orally as they have been passed down through generations. Some tribes may only tell certain stories during certain times of the year, and this knowledge should be respected in classrooms. Many tribal histories place the origins of their people in their current traditional lands in Montana. Educators should respect these beliefs when teaching about “the history of mankind,” particularly regarding the Bering Strait Theory.
ESSENTIAL UNDERSTANDING 4

Reservations are land that have been reserved by the tribes for their own use through treaties, statutes and executive orders, and was not "given" to them. The principle that land should be acquired from the Indians only through their consent with treaties involved three assumptions:

I. Both parties to treaties were sovereign powers.
II. Indian tribes had some form of transferable title to the land.
III. Acquisition of Indian lands was solely a government matter not to be left to individual colonists.

BACKGROUND

Indian Nations that were located in Montana Territory prior to the passage of the Montana Constitution in 1889 held large land bases as negotiated through their treaties with the United States. The treaties assigned tribes to certain areas and obligated them to respect the land of their neighbors. However, in the 1860s, the rush of miners and settlers into the prime gold fields, that often lay along or within the designated tribal lands, disrupted tribal life. The new inhabitants demanded federal protection, which resulted in the garrisoning of Montana and the eventual relocation of tribes to smaller and smaller reserves.

The federal government and many Montana citizens did not understand the lifestyles of Montana's Indian tribes. Consequently, the expectations of both sides were not met because each side was coming from a different point of view. However, the federal government did regard these tribal groups as sovereign nations when the government entered into treaty negotiations for land exchanges.

ESSENTIAL UNDERSTANDING 5

Federal Indian policies, put into place throughout American history, have impacted Indian people and still shape who they are today. Much of Indian history can be related through several major federal policy periods:

Examples:
- Colonization Period
- Treaty Period
- Allotment Period
- Boarding School Period
- Tribal Reorganization
- Termination
- Self-determination

(See the OPI Publication "A History and Foundation of American Indian Education Policy")
BACKGROUND

Public schools began to operate on Indian reservations in Montana in the early 1900s. Originally opened to meet the educational needs of non-Indian children residing on Indian reservations, Indian students began to enroll almost from the beginning. The public schools provided an opportunity for Indian people to receive an education in their local communities. Designed to meet the standards of the state education system, the curriculum offered limited information on local Indian culture, history and traditions of the local tribal groups. It also did not encourage participation from local tribal government officials in its decision-making policies. However, this trend is beginning to change as Indian people take on leadership roles and make decisions regarding their local schools. Indian people today are involved in the system as teachers, administrators, and school board members who are cognizant of the fact that communities and schools must be linked together in order to improve educational outcomes for all students.

ESSENTIAL UNDERSTANDING 6

History is a story most often related through the subjective experience of the teller. With the inclusion of more and varied voices, histories are being rediscovered and revised. History told from an Indian perspective frequently conflicts with the stories mainstream historians tell.

BACKGROUND

Much of America's history has been told from the Euro-American perspective. However, in the last century American Indians have been writing their history from an Indigenous perspective. Books such as Lies My Teacher Told Me by James Loewen expose the underlying bias that exists within much of our history curriculum by leaving certain voices out of the stories. In examining current curriculum content it is important to keep the following in mind:

Children's history books use terms such as "westward expansion" and "Manifest Destiny" to describe what would be more accurately called ethnic genocide. These books alternately portray Indians as "noble savages," "faithful Indian guides," or "sneaky savages" who lead "ambushes" and "massacres," while in contrast, cavalrymen fight "brave battles." These books propagandize the "glory and honor" of taking land and oppressing Native people for European purposes that are portrayed as holy and valid (Loewen, 1996).

A multicultural history curriculum that features the experiences of men and women of diverse racial, ethnic, and religious groups in United States history will provide students with a broader, more complex, and more true historical context. Young people can grow to understand the experiences and perspectives of these
diverse groups in American society today (Mehan, 1995). A transformation such as this would benefit all Americans as we work to build a free and democratic society for all.

**ESSENTIAL UNDERSTANDING 7**

Under the American legal system, Indian tribes have sovereign powers, separate and independent from the federal and state governments. However, the extent and breadth of tribal sovereignty is not the same for each tribe.

**BACKGROUND**


Before colonization, Indian tribes possessed complete sovereignty. However, given the governmental structure of the United States and the complex history of tribal-federal relations, tribes are now classified as domestic dependent nations. This means tribes have the power to define their own membership; structure and operate their tribal governments; regulate domestic relations; settle disputes; manage their property and resources; raise tax revenues; regulate businesses; and conduct relations with other governments. It also means that the federal government is obligated to protect tribal lands and resources; protect the tribe's right to self-government; and provide social, medical, educational and economic development services necessary for the survival and advancement of tribes.

A very important but often unappreciated point is that tribal sovereignty does not arise out of the United States government, congressional acts, executive orders, treaties or any other source outside the tribe. As Felix Cohen puts it, "perhaps the most basic principle of all Indian law... is that those powers which are lawfully vested in an Indian tribe are not, in general, delegated powers granted by expressed acts of Congress, but rather inherent powers of a limited sovereignty, which has never been extinguished (NARF)."

Sovereignty can be defined as "The supreme power from which all political powers are derived." It is "inherent"—It cannot be given to one group by another. In government-to-government negotiations, states and Indian nations exercise or use their sovereign powers. Sovereignty ensures self-government, cultural preservation, and a peoples' control of their future. Sovereignty affirms the political identity of Indian Nations — They are not simply a racial or ethnic minority.