EFFECTS OF MULTICULTURAL SCIENCE IN STUDENTS AND TEACHERS

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ABSTRACT

This paper focuses on critically reviewed literature about (1) research on faculty diversification; (2) teaching from multicultural perspectives; (3) enhanced multicultural science education emphasized in preservice programs and teacher-candidate training programs with its resultant impression on (a) students' understanding and performance and (b) students' attitude toward science. This paper also reviews literature that questioned the effects of enhanced multicultural perspectives among teacher-candidates in science education, as well as the relevance of multicultural science education on students' understanding and attitudes. The expanse of this study covered public middle schools and high schools in the United States' suburban, rural, and interurban areas, as well as schools in metropolitan districts, tribal high schools, and colleges. The international demographic distribution of students and teachers included the United Kingdom, countries in Asia; students and teachers in Africa, students and educators in Australia, the Pacific Islands, and Canada. The majority of these students were African-American, Latin-American, Asian, and Native American and had a middle and lower class socioeconomic status; likewise with the students' faculty. The students were in the secondary grades seven nine through twelve and postsecondary students. The age of the students ranged from twelve to eighteen. This paper proves that a diversified faculty has little influence on student performance or attitudes toward science. Compiled and analyzed data proves some positive results among teachers' perspective influence on students'

attitudes and performance when teaching from a multicultural-based approach incorporated in preservice programs and teacher-candidates’ training protocols.

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CHAPTER ONE: INTRODUCTION

Scientific facts existed long before the dawn of society. Until the present, science governed every aspect of our life; environmentally, there is always an interplay of science phenomenon; we harvest the fruit of science—and sometimes we pay a high price when science is misused. Health-wise we turn to science, and science has improved by leaps and bounds, especially in the later part of the twentieth century.

Science had increased the bounties of our labor, but inordinate ambitions and competitions have unmasked its face on the living and the nonliving across different societies. By natural selection, some theories just fade away. In spite of awe-striking theories upon theories and postulates upon postulates, science can regress man centuries back "scientifically" because of greed. However, science has manifested its glorious might in the area of military establishment.

Humanity's resilient nature has been adapted and tested by the grinding forces of science. Cultures have different ways of perceiving science because each culture are becoming more distinct form each other creating different ways of perceiving scientific principles. Humanities mysterious nature has reached out for scientific concepts from the time humans discovered fire to the time they conquered the moon. From solitary existence to the congregation of society that gave way to culture, science has played a part in their inception.

To the simple mind, science is a thing of wonder; to the spiritual mind, science is a divine law, to the superstitious mind, science is magic, and to the intellectual mind, science is a discipline. Collectively, humanity is a society of cultures mixed in one salad bowl.

This paper deals with issues related to indigenous science, Western science, and multicultural science. These categories have three major topics that will be discussed: the diversification of schools; the integration of indigenous science in science curricula; and the ways and means of enhancing multicultural perspectives that help teachers establish effective teaching methods in science.

The Rationale

Today, society has become more culturally and ethnically diverse compared to past decades and centuries. As a result, classrooms have accumulated diverse students of many cultural backgrounds. Yet, educators' curricula show a lack of cultural sensitivity in addressing students in their teaching. Barton (2006) noted the lack of effort in adopting multiculturally oriented curricula. Barton stated (2006), "…multicultural is rarely modeled or discussed within the context of content-based learning" (p. 185). A good example is how Western science dominated the science community, which can be observed as the natural characteristic of a science classroom and curriculum. However, one must recognize the importance of perceiving science through different spectra—specifically from a variety of cultural viewpoints—in order to achieve the goal of teach students from many cultures. Tobin (2005) pointed out that, "a primary goal for teaching for diversity in science and mathematics is to make mathematics and science accessible to all students, especially students from under represented and marginalized groups" (p. 185).

With the increasing diversity in classrooms and school grounds, there is a huge shortage of minority teachers in different grade levels. Epstein (2005) noted that 40% of public school students were African-American, Latin-American, Asian-American, or Native American. With this number of minority students, it is incongruent that more than 90% teachers are white. Epstein (2005) stated that during 1994, the enrollment of students in teaching programs consisted of 85% white, 7% African-American, 5% Native American, 4% Latino, and less than 1% Asian/Pacific Islander. In the 2002 Economic Census, the U.S. Census Bureau showed the population of student-teachers were 12.2% African-American, 11.8% Latino/a, 3.8% Asian-American, and 0.7% of Native Americans (Daufin, 2001). The emphasis on a Western approach to science and the shortage of minority teachers are two factors that bring potential problems in learning for students of different ethnicities and cultural backgrounds.

There are those who question the idea of approaching or perceiving science through different cultural perspectives. Barton (2006) noted that these questions were reinforced by the common perception that science is based on empirical theories that favor no sides and sees theories through the same lens regardless of cultural beliefs. Barton (2006) further notes that these findings were derived and confirmed with rational methodologies that were independent of culture and not subjective viewpoints (Barton, 2006). Because of the perception that science is impartial and culture-free, it is not surprising that using indigenous concepts to introduce science is not commonly practiced in this area.

A teacher who presents science from different cultural perspectives, not only highlights the relevance of but also the contribution of that culture in the field of science. Students representative of such cultures promote the sense of connection and presence in class. This also allows teachers and students to have a mutual understanding with a sense of connection. On the other hand, conflicts can arise between students and teachers of different cultures. Gordon (2000) stated that contentions can happen when teachers and students collide along socioeconomic lines. Such collisions invite problems in classroom discipline, take away time for teaching, and can influence teacher retention and turnover. Such issues can be avoided if there is enough support in the emphasis of multicultural on preservice and teacher training.

Research (Tobin, 2004; Tobin, Roth & Zimmerman, 2001; Ramanthan, 2006; Khine & Fisher, 2004) indicates that a diverse faculty and staff can have a positive effect in schools. In some cases, minorities represented in the faculty create role models for minority students (Avery & Burling, 1997). It may be possible that a more diverse faculty and staff in schools will have a positive influence on a number of minority students enrolled in science classes. Hollins and Oliver (1999) pointed out that most African-American teachers displayed an effective interaction with African-American students. They implied based on their research that teachers use terms and metaphors that establish a common identity and reflect strong relationships with their students, being drawn together because of common cultural experiences as an oppressed group (Hollin & Oliver, 1999, p. 64-65).

Similarly, Viadero (2001) noted how elementary students whose teachers are of similar race tend to do well in class. Viadero (2001) stated, “Both black and white children scored higher on mathematics and reading tests when their teachers are the same race as they are…” (p. 3), which he derived from a study of 6,000 Tennessee school children. It was even noted by Quezada and Louque (2004) that increasing the number of ethnically and culturally diverse faculty will help develop “culturally proficient educational administration leaders” (Quezada & Louque, 2004, p. 213).

On the other hand, there are others who see ethnic- and culturally-oriented science curricula having little effect on student learning (Sweeney, 2001; Kesamang, 2002: Carr & Klassen, 1997; Brok, fisher, Richard & Bull, 2006; Dzama & Osborn, 1999). Gordon (2000) noted one of the teachers who was interviewed in his study stated, “You don’t have to be black to teach blacks. Every teacher has to be versatile: you do what is best for different groups of students” (p. 71). Similarly, a Latino/a-American teacher in Gordon’s (2000) study pointed out that a teacher’s ethnicity or race is independent from their ability to connect to students of color. Furthermore, she stated that it is not valid to make an assumption that teachers can handle students due to sharing a similar race and ethnicity (p. 74).

Western Modern Science

What is Western modern science? Snively and Corsiglia (2000) defined Western modern science as “the most dominant science in the world” (p. 8). Cobern and Loving (1998), on the other hand, referred to Western as a term as a standard account of science. They drew the term Western based on the historical origin in the Ancient Greek and European cultures. There are speculations that as the term evolved over time from nature, natural philosophy, and science it mesmerized many Western cultures. Thus, the length of Western cultures' exposure to science was long enough for their Western perspective and culture to develop into a great influence on science. Cobern and Loving (1998) further stated that early Western cultures sprung from European settlers perceived the world only through their own lens. Be it Western science or Western technology, they misused education to convert societies that they perceived to be insufficient and limited.

Emphasis on the Term Universal

Cobern and Loving (1998) pointed out Matthew's perspectives on the universalistic viewpoint. They stated that Matthew's interpretations on universalistic science behavior is shaped, constructed, evaluated, and measured by humanity. In addition, they cited that behaviors being evaluated in itself influences the fitness of the study field, not the foundation that dictates the behavior of what should be observed and evaluated (Cobern & Loving, 1998).

Snively and Corsiglia (2000) defined universal by Western Modern Science as isolated from the revelation-based knowledge of empirical definition of Traditional Ecological Knowledge. However, the definition of universal had brought along standards that placed indigenous cultures under the same umbrella, thereby dismissing their cultural approaches and perspectives of universal science (Snively & Corsiglia, 2000). In this case, the term universality brought conflicts in regard to ways the science community should be taught in classrooms. To settle the arguments, the scientific community discussed ways to define and distinguish science with universality. Not only defining science and universality but many debated how to segregate reality with knowledge and Universalist from relativist position (p. 7).

Cobern and Loving also stated that expansion to accommodate more cultural perspectives is no longer in question: the question is how much can be included (Cobern & Loving, 1998). Regardless of where the inclusion line is drawn, one will always establish his or her own meaning of universal science regardless how far he or she will expand the boundary around the term science (Cobern & Loving, 1998).

Traditional Ecological Knowledge

Although the term traditional ecological knowledge (TEK) began to be widely accepted in the 1980s, it has no universal accepted definition (Snively and Corsiglia, 2000). Cobern and Loving (1998) pointed out in one of Laudan’s literature that many refused to acknowledge TEK scientifically because they believe that it is based on superstition. Snively and Corsiglia (2000) brought out Berke’s point that states that it is hard to embrace the validity of the knowledge because it was handed from generation to generation, where practical knowledge evolved for better adaptation and survival. The preservation of its authenticity is questionable since it has been handed down from different periods distinct from one another (Snively & Corsiglia).

The term traditional science has an etymology derived from a Latin word meaning “handed across (Snively and Corsigla, 2000) the science from generation to generation through oral tradition.” In this case, Snively and Corsigla (2000) defined “traditional” as passing down as a cultural practice, belief, principle, and behavior that has been embedded in a history from one generation to another. Snively and Corsiglia (2000) refers to Berkes belief that the term indigenous knowledge is widely used to deter dispute or conflict between the terms traditional science and indigenous knowledge.

Multiculturalism in Science Classrooms

Integration of multiculturalism in science allowed many to question its influence on students of science. Cobern and Loving (1998) stated that modern multicultural definitions of science accommodate students from different cultures and ethnic origins by providing a better understanding on principles and resources. Not only has this benefited students, but it neutralized the clashing effects of Western knowledge and non-Western or indigenous approach (Cobern & Loving, 2000). However, Snively and Corsiglia (2000) noted that some science educators who have grown accustomed to Western modern science considered it to be the last frontier and the greatest of science with tendency to dismiss multicultural scientific approaches.

Influence of Multiculturalism in Faculty

Apart from bringing cultural-based science approaches into classrooms, there has been a recent study that points out underrepresentation of minority students in the field of science. Barba (1995) pointed out that this underrepresentation can be attributed to students' lack of interest in science because of anxiety toward the subject, personal reasons, depiction of white male dominance in science, lack of minority role models in scientific fields, and socioeconomic handicaps. There is also an issue of improper counseling in regard to academic track course, teacher's expectations and attitudes, and the lack of academic preparation (Barb, 1995, p. 6).

Apart from the integration of a multicultural-based approach in science and attempts to improve the number of students of color in the classroom, there is an approach of improving multiculturalism in teacher learning to bring diversity in the student body that had been proposed.

Limits and Definitions

This paper focuses on tribal colleges, public high schools, and middle schools in the United States across rural, suburban, interurban, and metropolitan areas. Literatures evaluate students from different countries in the United Kingdom (Kearsey & Turner 1999), in Asia (Chin 2007), students and teachers in Africa (Dzama & Osborne, 1999, Osborne, 1999; Klos, 2006), and students and educators in Australia (Fisher & Waldrip, 1999; Tobin, 2004), the Pacific Islands (Feinstein, 2004; Glasson, 2006; Rodriguez, Jones, Pang & Park, 2004), and Canada (Carr & Klassen, 1997). Also evaluated are students whose ethnicity is African-American (Odom, Stoddoard, and LaNasa, 2007; Tobin, Seiler, and Walls, 1999; Catsambi, S. 1995; Rodriguez, et al. 2004; Carr & Klassen, 1997), Latino/a-American (Barton & Yang, 2000; Odom et al. 2007; Ash, 2004; Catsambis, 1995; Rodriguez et al.2004), Asian (Feinstein, 2004; Odomet al.

2007; Chin, 2007; Ramanathan, 2006; Carr & Klassen, 1997), Native American (James, 2006; Rodriguez et al. 2004; Carr & Klassen, 1997; Haukoos, Bordeax, LeBeau, & Gunhammer, 1995; Carr & Klassen, 1997). This study will focus on students in secondary grades (grades seven through twelve), postsecondary students (vocational, college, and university students). The ages of the students range from age twelve on up. The majority of students within the United States are either from middle or lower socioeconomic class families.

Furthermore, this paper takes into account the social class and economic status of families reflected in the research reports. Through the process of exploration, this paper analyzes students of different ethnic origins and socioeconomic statuses among African-American, Asian-American, European, Euro-American, and Latino/a-American. Similarly, it will study teachers from different socioeconomic status.

Most of the terms used will appear throughout this text are concepts of Traditional Ecological Knowledge and Western Modern Science. Snively and Corsiglia (2000) defined Western Modern Science as “the most dominant science in the world” (p. 8). Cobern and Loving (1998), on the other hand refer to Western as a term that connotes a standard account of science. They drew the term Western based on an historical origin in Ancient Greek and European culture (p. 53). In chapter two, various perspectives emphasize the weaknesses and strengths of these two concepts. In addition, there will be illustrations of its relevance to science education from authors that conducted studies on this subject. There will be authors who provide their own perceptions of the word “science”. The term “universal” will be mentioned along the way as part of the illustration of the relationship between indigenous science and Western science. Cobern and Loving (1998) pointed out Matthew’s perspectives on universalistic viewpoint. They stated that Matthew's interpretation on universalistic scientific behavior is shaped, constructed, evaluated and measured by humans. Snively and Corsiglia (2000) defined universal by Western modern science isolated from the revelation-based knowledge of empirical definition of scientific facts.

Statement of Purpose

The focus of this paper is to critically review the literature that studied how (1) having a diverse faculty, (2) teaching from a multicultural perspectives (3) enhanced multicultural science education emphasized in preservice programs and teacher-candidate training programs with its resultant impression on (a) students’ understanding and performance and (b) students’ attitude toward science. This paper also reviews literature that questions the effects of enhancing multicultural perspectives on teacher-candidates in science and nonscience teachers. Chapter three presents critical reviews and analyses on literature and articles that address these items, as well as research that analyzed studies elaborating the relevance of multicultural science on students’ understanding and attitudes on science.

Chapter three is subdivided into five sections; each will focus on the role of multicultural science and ways that it played an important role on teachers and students. These sections observe how indigenous and Western perspectives play an important role in science by analyzing literature that touches the main question of this paper. The first section discusses literature on the effects of incorporating indigenous science in the classroom. It also illustrates the effects of this approach on students' performance and attitudes in science. The second section focuses on teacher-training programs and preservice program resources. This section looks at approaches to enhance multicultural perspectives of teacher-candidates in science and observe its effects on students and teachers. The third section discusses publications that illustrate the influence of diversification of science teachers on students' performance and attitudes in science. The forth section discusses and analyzes how indigenous knowledge incorporated in science curricula is related with students' performance and attitude in science.

Summary

Chapter one presented a rationale for studying the question of how using the approach of teaching both Traditional Ecological Knowledge and Western Modern Science when teaching science can effect minority students' performance and enrollment numbers in science class. This chapter introduced two conflicting sides regarding diversifying faculty in schools and students' performance in the classroom. In this chapter, Gordon (2000) proposed caution on making assumptions regarding race and the ability of relating to minority students. This chapter introduced and discussed the terms universalism, Western Modern Science, indigenous, and Traditional Ecological Knowledge. This chapter also discusses the implications and relevance of multicultural perspectives in natural science.

Chapter two will explore a historical trend on how science was interpreted and viewed over the centuries from different cultures, and how the term science evolved through different periods. It will briefly discuss historical developments of the philosophy of science and its derivation from philosophers in the early millennia of documented history. Chapter two will also discuss how people in current times perceive science. It will show how the Eurocentric approach has dominated the science community over hundreds of years. Finally, it will discuss the importance of other cultures and their contributions to science.

Chapter three will critically review the research literature concerning teaching science from different cultural perspectives and the influence of different cultural perspectives on student learning and attitudes in science class. Chapter three will also explore the effects of having a more diverse faculty in students' learning and attitudes toward science. Finally, Chapter three will critically review publications concerning the influence and effects of improving teachers' education on teachers' perspectives and on students enrolled in science curricula.

Chapter four will conclude this paper by revisiting the questions, the results, and findings of the literature critically reviewed in chapter three, as well as the implications of these results in classroom practice. Some suggestions for further research on certain areas are also covered at the end. The scope of chapter four spans (1) having a diverse faculty; (2) teaching from multicultural perspectives; (3) and enhancing and emphasizing multicultural science in preservice programs and training teacher candidates will impact students in the area of (a) understanding and performance in science and (b) attitudes in science and the effects of enhancing multicultural perspectives on teacher candidates in science and nonscience teachers.

CHAPTER TWO: HISTORICAL BACKGROUND

Introduction

Chapter one discussed how Western perspectives dominate the science arena. The chapter also discussed how classroom science emphasizes the Western approach in science curricula. Furthermore, the chapter introduced the idea of using approaches that expand the spectra of looking at science concepts from different perspectives. In addition, chapter one also addressed the issues of the small number of minority educators in the field of science and the influence the shortage has in science classrooms. It also discussed definitions of Western and Traditional Ecological Knowledge. This chapter will begin with illustrations on how Eurocentric perspectives dominated science community through various examples of scientific theory. Chapter two will have a brief overview of historical trends in science and how the trends were derived from philosophers in the early centuries. The chapter will briefly discuss how people in current times perceive science. This is followed by a section that acknowledges the importance of other cultures in their contributions to science and the importance of their multicultural perspectives in science.

Eurocentric Perspectives

A Eurocentric perspective has dominated the science community. There were centuries upon centuries of different scientific theories, unraveled through different voices or more commonly from dominant groups. History has it that most white European males generated the Eurocentric voices in the early centuries and dominated the science community. Snively and Corsiglia (2000) brought the idea from Pomeroy's use of the acronym WMS as White Male Science to underscore the dominant voice that framed science in early centuries. Cobern and Loving (1998) noted that the world brought in a greater purpose for their understanding of science, and the flame of their interest in nature. Western cultures took the world as their own to experiment with and to investigate principles of (Cobern & Loving, 2000). A good example was Darwin's expedition (Cobern & Loving, 2000, p.54). Take the theory of evolution for instance; Charles Darwin, a British scientist whose original interest was in the area of medicine, derived the theory of evolution.

His five-year voyage on the Beagle led to his inception of the four postulates that showed natural selections' inability to produce perfection. He also introduced reproduction as the central basic mechanism of evolution through the process of natural selection (Campbell, Reece, Mitchell & Taylor, 2003, p. 264). The underlying mechanism of this theory was the genetic variation that exists in allowing mutation, gene flow, genetic drift, and selection (Campbell, Reece, Mitchell & Taylor, 2003). Unfortunately, Darwin's discovery was not fully accepted by the scientific community until after he was deceased. Later, Gregor Mendel, who was known as the father of genetics, made a discovery that brought supporting evidence on Darwin's idea of genetic variation as part of natural selection (Freeman, 2002). Darwin and Mendel brought new perspectives to the scientific community and exemplified the influence of Eurocentric perspectives in science.

Similar to biology, white male Europeans also took an interest in the area of the timetable of historical development of philosophy in chemistry. Collections of ideas and perspectives contributed to what was commonly known as a Euro-centric image of science. For instance, more and more scientists discovered the principles of atomic structures, making knowledge of atomic structure a strong pioneering discovery. In 1808, an English chemist named John Dalton published the atomic theory (Zumdahl, 2005). The first postulate of atomic theory explained how each element consists of tiny particles called atoms; the second postulate stated that for a specific element, all atoms were identical and each element had unique atoms; the third postulate stated that chemical compounds formed from combining atoms, retaining the same relative numbers and type of atoms. The last postulate explained how chemical reactions are the process of reorganizing the atoms that involves breaking and forming bonds, leaving atoms unchanged (Zumdahl, 2005, p. 18). Antoine Lavoisier, a French chemist, discovered the law of conservation of mass that aligned with the forth statement in Dalton's Atomic Theory (Zumdahl, 2005). Another French Chemist, Joseph Proust, drew the Law of Definite Conservation, which paralleled with Dalton's fourth statement as well. Another chemist from New Zealand, Ernest Rutherford, did an experiment on the alpha particle bombardment of metal foil that led to the discovery of the nuclear atom (Zumdahl, 2005), which aligned with the second statement of Atomic Theory.

In addition, white males mostly dominated the roles of physicist and discoverers. Galileo, an Italian physician, came across the discovery of motion of body and its philosophy. Though he made a remarkable analysis, he did not address the question as to why bodies accelerate (Serres, 1995, p. 308), which brought Newton to his discovery of the mathematical explanation of how bodies move using Leibniz's calculus.

Although many of these scientific facts were derived from Eurocentric, viewpoints the term science seemed to limit the meaning within this boundary. The Western science definition of "scientific" seems to narrow down ways of interpreting the underlying scientific concepts. Harding (1998) pointed out that conventional scientific theorists consider using the term "science" with reference to social institutions, technologies, metaphors, and social meanings as controversial and believe that the term itself should refer to science as "abstract cognitive core-the law of nature-and/or the legendary scientific method" (p. 354). She also explained that such a definition excluded other cultural perspectives in the natural sciences.

Another illustration of a common approach of a clean-cut Western science contribution to the science community is from Gjertsen (1984), which states:

> What Newton and Darwin did in their classic works which was completely novel was not simply to state such views but to draw their consequences, shape them, point out the difficulties and how they could be met, deploy them in various areas to which they apply and attempt to developed theory which can be examined, evaluated, and advanced; they have not simply uttered some motto or dictum. New ideas may well be the lifeblood of science but developed theories are then its heart and arteries. (p. 6).

It brought many debates as to how to incorporate indigenous science and questions about the expansion of science to accommodate cultural values.

Historical Trends in Science

Science has existed through the passage of history; as science came into being, history was unfolding—it has no origin. Homo sapiens, inquisitive and rational beings, inevitably became the catalyst of understanding nature and the exploration and shaping of modern science. Before the Ionian school and Greek philosophers of 600 B.C. (Hall & Hall, 1964; Hellermans & Bunch, 1988), science was not defined under the dictate of Western perspectives as a systematic investigation to gain understanding and knowledge of how the world works. Rather science was identified by the emergence and birth of a culture. Man's struggle to adapt to his environment used science from its simplest forms to the most complex of phenomena, from man's discovery of fire to man's creation of tools for survival.

Science from 2,400,000 B.C. to 599 B.C.

Man paid tribute to modern science through the evolution of technology. From prehistoric times, technology has developed from its infancy not formally organized as science. Sumerians and Babylonians, for instance, are major contributors through mathematics and astronomy—though not with a significant exposition to explain some intricacies and principles of modern science. These early societies laid the foundations of modern science. Egypt's contribution to medicine was the oldest recorded in medical texts, dating from 1700 B.C. The Edwin Smith papyrus revealed a medical protocol of antiquity. In it is a concise treatise of injury and wound management, a systematic approach of medical evaluation, prognostication, and treatment (Hall & Hall, 1964).

Science During 600 B.C. to A.D. 529

In this era, three major contributors laid the basic principles in the science of medicine; the Egyptians, the Babylonians, and the Greeks. The Egyptians and Babylonians distinguished themselves on skill development and established mechanics and procedures with no regard to principles of functions. They were adequate in technical skills and knowledge of the mechanics, yet devoid of expository protocols proving the relevance and significance explaining why certain procedures work. The Greeks in the early part of that millenia silhouette the science of the Egyptians and Babylonians. But soon the Greeks began to extend their views and questioned beyond what is obvious and began to see some guiding principles that made their observations and ideas in science more significant and relevant, practical and applicable even to this generation.

Speculations and theories on the universe and Earth's environment began to emerge, driven by curiosity and the demand for understanding. Around 600 B.C. to A.D. 529, early science, enhanced by Western influences from the Greek civilization, developed and laid the foundation of modern science and the precursor of its different disciplines. The Greeks were the first to adopt scientific methods based on reasonable observations, although not by experimentations (Hellermans & Bunch, 1988). Aristotle was considered to be the first philosopher of science in the fourth century B.C.

In addition, as the first civilization that shaped scientific Western perspectives, Greece was the first to advocate scientific thinking. The Ionian philosophers Thales, Anaximander, and Anaximenes were considered to be the first scientists. They claimed that understanding the universe does not lie in mythical belief of Grecian gods but through reason (Hellermans & Bunch, 1988). In 146 A.D., when Rome dominated Greece, science began to dissipate and its demise was not directly related to or influenced by Rome’s control of Greek traditions.

Science in Other Cultures During 530 A.D. to 1452 A.D.

After the Byzantine emperor closed the Athenian educational institutions of the Academy and Lyceum in in 529 A.D., science was revived in the middle of the fifteen century. Islamic culture, on the other hand, contributed to science through mathematics and arithmetic. One of the factors that mainly influenced Islamic science was their contact with different cultures in China, India, Turks, and the Jewish diaspora by giving the Arabs great ideas that brought science to their culture (Hellermans & Bunch, 1988). During the fifteenth century A.D., China was known to be the most structured culture in traditions and more successful in scientific application. They discovered magnetism and developed theories on matter and living things. Their perspectives were far more different from Europe in that they do not isolate the sacred world from the materials. Their interests were not dependent on developing scientific methods. and therefore many of their theories were not based on observations and experiments.

Though science was revived in the middle of the fifteenth century A.D., Hellermans and Bunch (1988) noted that science in Europe was unstable because of the influence of Rome. The eventual fall of the Roman Empire destroyed Roman infrastructures, buildings, cities and aqueducts, which led to deterioration of the preservation, and propagation of science in Europe (Hellermans & Bunch, 1988). The revival of science in Europe, according to Hellermans and Bunch (1988), occurred around the 12th century and all that time the church was able to preserve ancient learning since monks at the monasteries were the only ones who could read and understand the antique knowledge.

However, Europe’s contact with Islamic culture strongly contributed to the revival of science in Europe (Hellermans & Bunch, 1988). Many scholars took interest and sought this new knowledge from Islamic civilization during contacts on travels and crusades (Hellermans & Bunch, 1988). Between 1150 A.D. and 1270 A.D., European scholars gained access to Greek works and many of these scholars translated Greek works from Arabic to Latin (Hellermans & Bunch, 1988). Gerard translated Ptolemy’s *Almagest*, Euclid’s *Elements* and works from Aristotle, Galen, and Hippocrates (Hellermans & Bunch, 1988). Circa 1270 A.D., the whole collection of Aristotle’s written work became available to all scholars after translating the majority of the Aristotle’s manuscripts from Greek to Latin by William of Moerbeke (Hellermans & Bunch, 1988).

By the thirteenth century, Christian philosophers integrated this new knowledge with church doctrines. However, these scholars later discovered that church doctrine and scientific work—especially Aristotle’s works—conflicted with one another. Many Christian members and ministries refused to teach Aristotle's work in universities and by circa 1277 the Pope condemned 219 propositions regarding the integration of Aristotle's principles with the church. By the fourteenth century, many scholars approached philosophy in a way that deflected Aristotle's principles (Hellermans & Bunch, 1988).

Science During the Renaissance, 1453 A.D. to 1659 A.D.

During the Renaissance, science began to take shape as different scientific societies began to form. Concurrently, in this era the science revolution began. In addition, Copernicus's *Hedonistic Theory* was published circa 1543 A.D., which the Catholic Church and the Protestants opposed (Hellermans & Bunch, 1988).

Two scientific societies in Italy, the Academia Secretorum Naturae and the Academia dei Lincei, were the first scientific societies established during the scientific revolution. Founded circa 1560 A.D., the academia Secretorum eventually closed, leaving the Academia dei Lincei (founded circa 1603 A.D.), to be the oldest scientific society in existence (Hellermans & Bunch, 1988).

During this era, both Catholics and Protestants were against Copernicus's teaching on religious principles and believed that anyone, particularly scholars, ought to be burned at the stakes. Works that reflected Copernicus's ideas were either banned or burned (or both). Later, circa 1734 A.D., the ruling that condemned Copernicus's work was lifted (Hellermans & Bunch, 1988).

It was also in this era that Galileo invented the first thermometer and the pendulum clock. In addition, Galileo introduced protocols on experimentations in science and laid the foundation of modern science. He also introduced the principle of motion in modern science (Hellermans & Bunch, 1988).

In this era, mathematics was at its highest stage of development. It was during this time that the symbol of multiplication, the letter of constant, the concept of variables, and and the concept of exponents were introduced and became the universal language of mathematics. Furthermore, mathematics contributed in furthering the expanse of science, particularly in physical science and modern equipment. For instance, Galileo’s method of expressing natural events mathematically was derived from Newton’s principle of gravity (Hellermans & Bunch, 1988).

Science 1660 A.D. to 1734 A.D.: the Newtonian Epoch and the Twentieth Century

Scientific thought during 1660 A.D. through 1734 A.D. was main dominated by Sir Isaac Newton and Gottfried Wilhelm Leibniz. Science became more organized during the Newtonian epoch. In addition to this, scientific communication and nomenclatures were standardized by the scientific societies like the Royal Society in England and the Academia des Science in France. In addition, scientific institutions like the Greenwich Observatory and Academia del Cimento defended the preservation of scientific community (Hellermans and Bunch, 1988).

According to Snively and Corsigla (2000), Western Modern Science, otherwise known as standard science or conventional science, had been around since the early twentieth century. Not until the arrival of abstract theories like

Darwin's theory of evolution and natural selection, John Dalton's atomic theory, and French chemist Antoine Lavoisier's law of conservation of mass in the nineteenth century did science began to lean towards empirical and abstract reasoning (Snively & Corsigla, 2000). Nevertheless, history showed that the Western perspective brought a major influence in today's science (Snively and Corsigla, 2000; Hellermans & Bunch, 1988).

What is Science?

As for Cobern and Loving (1998), many of their resources defining the term science were tethered to the idea of objective reality. Cobern and Loving (1998) projected the definition of standard account, which they used concurrently with science. Collecting data and using scientific explanations to frame findings is one of the criterion in Western Modern Science (p. 58). Another perspective Cobern and Loving (1998) use in defining science states that objectivity in relation to standard science is not contaminated with subjective evaluation based purely on human judgments or viewpoints based on personal experience or belief. With this, Coban and Loving (2000) questioned the validity of Traditional Ecological Knowledge (p. 59). They stated, "The building up of traditional knowledge through trial and error in relation with native has produced important knowledge. However, it lacks the formal, controlled features of scientific experimentation" (Coban & Loving. 1998. p. 59). Cobern and Loving (1998) stated that science possesses authorship to circulate facts, as well as truth and knowledge, ensures validity and credentials, and control over education, which provides strong influence over how power is employed (Cobern & Loving, 1998).

In education, science is perceived to have a detector that selectively screens what can be included in science curricula, or what they refer to as gatekeeper (Cobern & Loving, 1998).

Cobern and Loving (1998) claimed that multiculturalism has difficulty embracing the narrowed definition of science due to its exclusive nature. Snively and Corsiglia (2000) noted that each culture has a specific approach or perception towards science, and different indigenous cultural knowledge that explains how the world works. They defined indigenous science as perception that defined world's internal and external connection based on cultural perspective. The domination of Western science in the scientific community and general public brought discomfort because of the tendency to exclude and defeat competitors to public access. In this case, indigenous sciences include themselves into the definition brought by the Western science to gain access to public scrutiny (Cobern & Loving, 1998, p. 61). They noted that such an approach, which seems commonly used by multiculturalism, homogenized all perspectives, including other indigenous knowledge. Therefore it destroys diverse and distinct voices within the community, for instance traditional ecological knowledge, and other indigenous knowledge (Cobern & Loving, 1998).

Acknowledging the Importance of Other Cultures in Science

There are cultures who made the early discovery of these ideas—and yet they did not place their names on the discoveries or have recognition world-breaking discoverers of science. For instance, Native Americans had practiced artificial selection in planting and harvesting maize. This process involved selection of the longest ears of corn, and reproducing this physical trait to dominate the next generation. The Native Americans who favored the longest corn artificially selected the favorable trait by collecting an abundant number of the crop (Freeman, 2002; Barba, 1995). Another example was the indigenous medicine for treating smallpox discovered by the Banyoro tribe in Africa. Like the Native Americans, these tribes were not recognized or credited in textbooks, or even in the scientific community (Barba, 1995).

Barba (1995) exclaimed that the Eurocentric view of science excluded the founders and the seekers of these native cultures. In addition, European tradition was embedded in science that certain steps are established to be considered scientific in science community. Barba (1995) stated that ideas must go through a five-step scientific method to confirm the ideas' scientific essence. The five-step scientific methods are stating the problem, collecting information, forming a hypothesis, testing the hypothesis, and drawing a conclusion (Barba, 1995, p. 56). New discoveries were isolated from daily routines, and reexamined the content using these five-list of scientific method.

Yet, even though most modern scientists derive their ideas from other cultures, they merely establish the backbone for conversations. Harding (1998) interestingly pointed out that modern science is itself multicultural because of the early, non-European authors from different cultures who, even though unacknowledged by the scientific community, had practiced or had integrated their scientific knowledge in the course of their lives. What she considered to be the issue was the "Eurocentric failure to acknowledge the origins and importance of ‘real science’ of these borrowing from non-European cultures…” (Harding, 1998, p. 348). She pointed that modern science was enriched by the knowledge derived from other cultures that were not recognized and credited. It is an accumulation of knowledge originated from different cultures that makes it diverse and cultural.

Implications and Importance of Multicultural Perspectives in Natural Science

The preexisting dominance of Western perspectives provides an opportunity for students to learn and share their cultural knowledge related to science. This idea of rigid scientific method brought by Eurocentric views in science is a stepping-stone for science educators to turn their curriculum into a learning opportunity by bringing approaches from other cultures. It is up to educators to incorporate multicultural science into their approach. Though most of the Eurocentric failed to acknowledge these cultures, it is the educator’s role (and opportunity) to bring non-European cultures into the classroom—especially classrooms filled with students from different cultures. In this case, teachers bring students closer within the community by establishing this sense of importance by exposing science in multicultural perspectives Barba (1995).

In contrast to a deficient model, those who adhere to a multicultural model (Sleeter & Grant, 1990) will see the cultural and linguistic backgrounds of diverse students as being valuable educational resources. A multicultural approach to education promotes cultural pluralism and social equality by reforming the school program to reflect diversity and benefit all students (Sleeter & Grant, 1990, p. 139). If one adopts this worldview, children who speak a primary language different from the dominant language in the classroom will learn science in different sociocultural contexts than others in the class and thus bring added resources to the classroom. Those who advocate the use of multicultural approaches to education see diversity as a strength in the classroom, as a vehicle for increasing the learning of all students (Barba, 1995, p. 13). Barba (1995) pointed out how students' cultural backgrounds contribute to education.

The implications of these different approaches help bring forth a common group within a science classroom consisting of diverse students. Western science segregates the value and importance of other cultural perspectives due to its Eurocentric approach of what is scientific and what is not. In public schools, many students of color bring different cultural orientations. Such orientations could tie natural science to indigenous knowledge. Nevertheless, multiculturalism, universalism, and science education need to find a common ground within a given boundary (Snively & Corsiglia, 2000, p. 9).

Summary

This chapter covered a brief description of Eurocentric perspectives. This chapter briefly discussed the historical perspectives of science, its philosophical views from philosophers in early centuries. In addition, this chapter discussed people how in current times perceive science. A section acknowledging the importance of other cultures' contributions to science, and the importance of multicultural perspectives in science will follow this discussion.

Chapter three will provide critical reviews and analyses of research study that addresses the three questions introduced in chapter one. These questions are as follows: (1) about establishing a diverse faculty, (2) teaching from a multicultural perspectives, and (3) enhancing and emphasizing multicultural science in preservice programs and training teacher candidates will impact students in the area of (a) understanding and performance in science and (b) attitudes in science and the effects of enhancing multicultural perspectives on teacher candidates in science and other fields.

CHAPTER THREE: CRITICAL REVIEW OF THE LITERATURE

Introduction

Chapter one discussed how the western perspective dominated the science field. The chapter also discussed how classroom science emphasized western approach in the science curricula. Furthermore, the chapter introduced the idea of utilizing approaches that expanded the spectrum of looking at science concepts from different perspectives. In addition, chapter one also addressed the issue of the shortage of minority educators in the science field, and its influence towards science classroom. It also discussed definition of Western, and Traditional Ecological Knowledge. Chapter two briefly discussed the historical evolution of science philosophy, and how it was derived from philosophers from different eras. Chapter two also discussed the importance and the contributions of different cultural perspectives in science. Chapter three will critically review research on multicultural science. This chapter is divided into five sections. The first section explores the influence of integrating and utilizing indigenous knowledge in the teaching of science. This section will critically review the research that investigates the effects of using indigenous knowledge in teaching science to students. The second section discusses the effects of emphasizing multicultural science preservice teacher education programs. Furthermore, it will discuss teachers' perspectives toward this approach and how this can influence the inclusion of indigenous knowledge in the classroom. The third section discusses the effects of diversifying faculty on students' performance and attitudes toward science. The fourth section discusses other forms of integrating indigenous knowledge in the science curriculum, and classroom. The fifth section will discuss studies that emphasized how indigenous knowledge and multicultural science have little effect on students' performance and attitude.

The Effects of Incorporating Indigenous in Science Curriculum

This section will discuss research that studies the effects of incorporating indigenous knowledge in science curriculum on students' performance, and attitude towards science. Herbert (2004), Klos (2006), Chiu, Chow, and Mebride-Chang (2006), Odom, Stoddard, and LaNasa (2007) studied the effects of this approach on students' performance. Barton and Yang (2000), Feinstein (2004), and James (2006) studied the effects of this approach on students' attitude toward science.

Effects on students' performance:

In a case study, Herbert (2004) explored how students performed on the teacher-made tests from work involving a strategy to build bridges between conventional and traditional approaches to science. The researchers compared the students' performance after studying the traditional perspective with modern science with their performance after exposure to unit work that compared traditional knowledge with conventional science. The students were secondary students chosen from two schools of different native cultural practices and beliefs.

Subjects were separated into two groups, based on the school they attended. Each school assigned with different cases. Parkview Secondary, an all female school with students of ages 12 to 16 from different socioeconomic background, and exposed to different cultural practice. Students from Seablast Secondary were from age 13 to 17. Herbert (2004) noted that this set of students lived most of their lives in a rural area.

During the first cycle of the case, teachers at Parkview taught a seven-lesson plan to students within the eight-week time related to physical and biological science. Herbert (2004) used the summative responses that assessed their understanding of the concept in the lesson to revise the teaching approach. The revised teaching approach was tested on students from Seablast. Herbert (2004) utilized students' summative responses and reflections as the basis for information from Seablast secondary. A teacher-made test was used to document and analyze student's performance after the study.

According to the assessment, 20% of the students used traditional responses, and 57.5% used conventional science to respond to the first question, "write an operational definition for the common cold" (Herbert, 2004, p. 146). About 55% of the students used the traditional viewpoint and 32.5% used the conventional science in respond to the second question, "how would you explain the observations stated above?" (Herbert, 2004, p.146).

This study stated that students used both of the approaches to respond to the scientific issues. According to Herbert (2004), the used of traditional approach and conventional approach depends on the cues of the context problem. This outcome showed that students connected two viewpoints, used them to make sense of the problem, and used their prior knowledge to enriched their responses.

Herbert (2004) included a thorough description of how the data was gathered for the study. She described the assessment process conducted on students' summative responses from the Parkview Secondary. She provided a descriptions and items used to collect reflections of students' understanding and progress. She also described the coding process for the Parkview Secondary, and the process of readjustments used based on the data collected. She did not indicate the process of sample selection, the internal, and external validation of the experiment.

This study indicates that students utilized indigenous knowledge in understanding science. This study illustrated how students used cues to tie their prior knowledge and understanding of how the world works with scientific concepts. This analysis tends to suggest that if students bridge science with indigenous for better understanding of the subject, then it would further benefit the students if indigenous knowledge incorporated in science curricula itself.

In a qualitative and quantitative study, Klos (2006) determined the influence of integrating indigenous knowledge in a curriculum with students' writing, and reading skills, on 80 science students from South Africa, and found students' development in writing skills, and scientific terminology.

Klos (2006) conducted a case study with 80 science and health science foundation students from Nelson Mandela Metropolitan University in Port Elizabeth, South Africa. The approach in the research involved incorporating indigenous knowledge in the academic language support program, English for Academic Advancement in Science and Health Science (LEA III). The students studied indigenous subjects through reading oral presentation, writing, audiovisual, lecture listening. Klos (2006) evaluated the students' progress with reading, listening, oral and writing skills in the context of indigenous knowledge. This study used unstructured interviews, observation, and case studies to collect data. Klos (2006) collected quantitative data from the formative and summative assessment to evaluate students' progress in developing their skills in scientific academic language.

The analysis involved unstructured interviews where common themes emerged. The themes that emerged during the interview were positive emotions, access to knowledge, enthusiasm towards learning, clear understanding of scientific concepts, acquired terms that allow them to communicate these scientific concepts, and self-reflection and realization of their potential to become better science students. The data derived from the formative and summative assessment showed that these students tended to performance much better when the topic focused on indigenous knowledge, compare to concepts derived from westernized science.

Although Klos (2006) provided a strong evaluation and interpretation of the data analysis, data points were not clearly produced and elaborated. He concluded the findings with charts describing the distribution of the students who performed the task in indigenous topic and their performance when learning westernize science. The charts, however, were not thoroughly explained.

Klos (2006) did not emphasize on the characteristics of the subjects. He did not specify the age of the subjects, gender distribution, and cultural ethnicity or tribes of the subjects. Furthermore, Klos (2006) did not indicate the subject's class. Since the subjects were examined on their language skills, Klos (2006) should have provided some form of background information on students' previous knowledge in academic language skills. However, she collected formative assessment and used it as a reference to observe any progress or development of understanding scientific academic language skills.

The study illustrated the influence of having indigenous knowledge incorporated in science curriculum. This study tends to show the relevance of incorporating indigenous knowledge to science curricula to provide a better understanding of science concept. This study showed that students who were native in South Africa benefited from using their cultural knowledge in making sense of scientific knowledge.

In a quantitative study, Chiu et al. (2007), studied a stratified sampling of 158,848 fifteen-year old students from 34 countries and conducted a demographic study on how country properties such as cultural values, income, inequality, and the learning strategies like memorization, elaboration, metacognitive affected students' achievements.

The Organization for Economic Cooperation and Development initiated a collaborative evaluation with Program International Students Assessment among fifteen-year old students. A population of 88,401 students took a 30-40 minute science examination and averaged 2 hours to finish. The research team used a multi-leveled regression approach in estimating scores and the results showed 25% of students from Italy and 81% from Hungary reportedly used memorization in learning strategies; elaboration strategies covered 41% from Iceland, 72% from Macedonia and metacognition applied to 38% in Norway and 67% in Macedonia.

This study showed that students who used memorization strategies obtained lower scores on the test. Furthermore, students who utilized elaboration in transferring information had little effect on achievement scores. Students who utilized metacognitive strategies scored higher on the achievement test. In addition, there is a strong link between students with high achievement score and cultural bearing. Collaborations between peers metacognitive strategy and collective culture scored higher in achievement test compared to students with individualistic approach. This study established the importance of cultural role in learning strategies and its outcome; provided external validity of the cross-country experiment and gave internal validity of the cross-school sample study. This study also showed that the test achievements were reliable and can be reproduced. The research team statistically controlled the variables to ensure reliability and reproducibility of the study and they also provided a sample test from the Program International Student Assessment via website.

This study addressed the importance of using indigenous knowledge in science class; it illustrated the link between students' understanding of science and cultural aspects that bring up issues on how indigenous knowledge influenced students' performance. This connection between students' understanding of science and cultural context suggested that incorporating indigenous knowledge in the curriculum improved students' performance in science.

In a correlative study, Odom et al (2007) comparatively explored the relationship between practices and outside influence on middle-school students' performance in science and established that students' achievement improved when strategize with student-centered teaching method.

The study is populated with 611 seventh-grade students from middle-school classes and selected 391 students from two urban school districts representing 63% of the sample; and 227 students from two suburban school districts a 37% sample.   Student on free and/or reduced lunch is 13% to 88% representing 7% to 98% of the sample. Ethnic distributions are; 7% to 98% African American, 0% to 20% of Asian origin, 4% to 25% Hispanics and 1% to 95% Caucasians.

The study used the survey instrument when information was obtained in regard to their attitude towards science, access to different classroom activities, support from home and peer interaction focused on science. The Science Achievement Influence Survey SAIS consisted of 31 items including Liker scales evaluated students with a 12 multiple choice constructed-response items and show-your-work questions as to content knowledge covering static electricity, electrical circuits, magnets, principles of motor and generator mechanics, heat and energy. The study scored a reliability coefficient between 70 and 82.

Research team gathered results data from SAIS and multiple regressions approach relating several factors i.e. attitudes towards science, peer participations, students-centered and teacher-centered teaching practices, home support and post-test. Results showed that positive attitudes towards science decreased exponentially as the frequency of teacher-centered teaching practice increased; conversely students who did more in laboratory activities scored a high average of 75% compared to those with little hands-on laboratory participation who only scored 57% average.

The research team confirmed the validity and reliability of the instruments that recommended specific classroom practices. Significance Coefficient for each correlative study maintained a significant correlation of p below .01 or 05 which established it to be beyond doubt with a probability of being questionable from zero to none. They provided socio-economic distribution that showed variation of the subject validating the study.

The study favored student-centered teaching approach because it allows for options of cultural integration in science that will assimilate students of color. The study underscored the positive effect of student-centered teaching approach on ease of learning and the appreciation of science. The study favored student-centered teaching approach because it promotes options for cultural integration in science that will assimilate students of color. The study underscored the positive effect of student centered-teaching approach on ease of learning and the appreciation of science. It had also uncovered a way to design a culturally oriented science curriculum embodied by students' cultural orientations and truly establishing an innovative system where students' initiatives are nurtured and goal-setting developed.

Effects on student's attitude towards science

In an ethnographic study, Barton and Yang's (2000) presented a case study survey of a 26 year-old male with 2 children, homeless and hails from Puerto Rico his name is Miguel. The reason why Miguel was selected for the study because Miguel typifies other homeless people in his neighborhood; Miguel has since long dropped out from high school but was able to earned his equivalency diploma GED thus he was able to attend a culinary school which unfortunately dropped out of the course due to financial constraints.

Most data collected by Barton and Yang (2000) focused on the following areas: Miguel's children science class after school; Miguel's involvement in his children's education at home and interviews with his wife; these are activities that covered nine months period. Barton and Yang (2000) noted that data gathered is close-code enclosed with pre-selected themes including how the parents connect their views and beliefs with science

Barton and Yang (2000) established that Miguel's experience is common to other many minority groups. They acknowledged that the study is inconclusive and that issues needs further study with the same description of individuals with similar experiences; they also noted the presence of low self-esteem and negative views towards science but then again Barton and Yang (2000) see the necessity of further studies and analysis from different groups of individuals.

The same study can target highly populated metropolis on minorities situated in inner city. Barton and Yang (2000) did not justify Miguel's reflection of demeanor as homeless. Although there are studies that Barton and Yang can relate their case.

They do not elaborate on methodology that will prove reproducibility. There is insufficient coverage on the process of gathering data, as well as a failure to outline how interviews were structured within a timeframe process. There is no emphasis on the decoding or description of data analysis. Furthermore, they failed to indicate the process of triangulation in the study.

The study addressed the importance of cultural ethnicity on students' attitude toward science. It inferred that students' cultural backgrounds played an important role in building the potential to succeed in science classes and stated that acknowledgement of these cultural identities contributed to their success in class. Although ambivalent feelings indicated that this study was not conclusive, the researchers acknowledged for certain that the role of cultural elitism or the culture of power contributed to students' low self-esteem. Suggestions from the data gathered may counter act this problem by reconstructing or incorporating a more culturally oriented science curriculum.

In a quantitative study of Feinstein (2004) bridging indigenous and Western knowledge positively affects student learning and influenced the student's performance in college science

The study is populated with twelve student participants' that include five males and seven females of various backgrounds, exposures, and academic goals. The subject is picked across four different levels in high school; two freshmen, six sophomores, three from junior high and one senior level. This is an international demographic collection of one Japanese citizen, one Swedish citizen, and ten are Americans. Out of the ten Americans in the study, two are born and raised in Hawaii and two began residing in Hawaii at an early age. In these twelve participants there are nine Caucasians, one Asian, and two participants who are ethnically mixed.

Feinstein (2004) confined their data collection around personal experiences gathered from written surveys, interviews, and observations. The study is an active research project involving the collection of data from artifacts, participant observations, and interviews with students; observations were conducted during class sessions. Artifacts were collected and analyzed from questionnaires, weekly journal entries, and final projects. Questionnaires were made up of conceptual pretests and posttests (meaning that the students were given the same questionnaires on the first day and on the last day of the class sessions.) These participants were required to answer questions and identify conceptual postulates. Test results were analyzed to determine the student's conceptual acumen in understanding fundamental Hawaiian environmental knowledge.

During the data collection, candidates documented their observation in the field notes. Feinstein (2004) shifted roles from instructor to being a participant for each weekly field experience. Local or indigenous experts conducted these experiences. Students recorded the content of the presentation and experience, their response to the experience, their interaction with the presenters and with each other during the experience, and the questions that arose from the students during the experience. These were documented in the field notes. For each class, reflections on the efficacy of the experience were recorded along with Feinstein’s (2004) closure.

The study showed that creating an environment where indigenous and Western worldviews enriched students’ understanding of science. This study also showed the shift in different perspectives from students. They noted the positive view they had on their experience and the indigenous culture. Furthermore, the study showed how students developed self-constructs of their own understanding of the subjects.

Feinstein (2004) was consistent with tracking students’ personal reflections though the number of questions asked. He also indicated gender and socioeconomic status. This study provided background information on the students’ education. This study provided a good description of theoretical position. The study conducted two interviews, which ensures the quality of the data. Questions were not open-ended; however, students’ provided journals and observation through field notes. Questionnaires contained pretest and posttest concepts. Shifts of role allowed Feinstein (2004) to see the condition of the candidates.

This study showed that creating an environment where indigenous and Western worldviews enriched students’ understanding of science. This study also showed the shift in different perspectives from students. It addressed the question regarding the effects of indigenous knowledge integration in the science curriculum on the students’ performance. The article tends to imply that integrating indigenous knowledge in the curriculum will bring positive effects on students' understanding of science.

In a qualitative study researching how Native American students' cultural identities and cultural values affect their views of scientific and technological products, James (2006) conducted a survey of 196 tribal college students, urban high school students, and reservation high schools students. Jame (2006) found that their cultural beliefs had a strong negative impact of how they view science. James used four cultural values to establish the students' stand point. The students' attitudes and beliefs toward science were evaluated using the Cognition and Beliefs about Technology and Science (CABATS) survey. This survey contained eight items written by the team of faculty members and PhD students. This study also used the Confirmatory Factor Analysis (CFA) to enhance the eight items. The researchers used Native American /Alaskan Native participants and other United States' ethnic groups to validate the analysis.

Using the linear structural modeling, this study showed that Native American cultural identity had a negative impact on the students' perception of science. Native American identity had a negative correlation while the Anglo participants had a positive correlation on individualism. This study also showed a negative correlation between individualism and belief, but positive a correlation between individualism and belief of technology as heroic. James (2006) implied that a strong Native American identity would deter students from any cultural values that promote scientific views.

This study did not provide a process for sample selection, and gender distribution. This study did not indicate the age of the participants. However, James (2006) provided data gathering information, and the framework of the study. Furthermore, the probability coefficients for the findings were less than .05.

This study suggested that students' strong preferences and beliefs influenced their perspective towards science, which becomes a disadvantage in their learning science. James (2006) emphasized from this study the importance of integrating and approaching science through indigenous perspectives as one alternative approach in science teaching. He also argued that alternative approaches in teaching science could influence students' performance and encouraged a positive perspective towards science.

The Effects of Emphasizing Multiculturalism in Teacher Training

This section addresses the issue of the effects of emphasizing multicultural science education in teacher training and preservice programs on students and teachers. The first part discussed the effects of emphasizing multicultural science education in preservice to students' performance in science classes and attitude toward science. Fisher and Waldrip (1999), Glasson, Frykholm, Mhango, and Phiri (2006), Luft (1997), and Tobin, Seiler, and Walls (1999) conducted analyses to see the effect of incorporating and emphasizing multicultural science education in preservice. Haukoos et al. (1995), Chin (2007), Luft et al. (2003) discuss teachers' perspectives of this approach and how this can influence the implementation of indigenous knowledge in the classroom and students' learning in the second part of the section.

Effects on Students

Fisher and Waldrip (1999) examined the quality of the Cultural Learning Environment Questionnaire (CLEQ) that was used to survey students. The survey was meant to determine the relationship between culturally sensitive learning environments with students' attitudes toward science and enquiry skill development. It found positive associations between students' inquiry skills and competitive, less-modeled structured lessons.

The research team selected 3,785 of science students from 186 classes in sixty-seven secondary schools across Australia. They included students' responses on the CLEQ, the Questionnaire on Teacher Interaction (QTI), the attitude scale, and the inquiry skills item. The student responses validated the instrument information regarding the relationship between teacher and student, and their interaction, as well as the students' perception of their culturally sensitive learning environment, and their attitudes towards science.

The research team found associations between students' culturally sensitive learning environments and their attitudes toward science, as well as the cultural learning environments with their students' inquiry skills development. Fisher and Waldrip (1999) suggested that students' inquiry skills development correlated with more competitive, less-modeled, more congruent teaching approach. Furthermore, they found associations between the QTI and CLEQ tests. Friendly, approachable, culturally sensitive teachers and great leadership were closely associated with students' inquiry development. These teachers provided congruent between school and students' homes. Students who perceived congruent between their home and school enhanced their students' independence.

They provided a good description of the procedures used in constructing the CLEQ and, QTI. They also provided valid external evidence that validated these questionnaires by sending the questionnaires to multinational corporations working in forty countries. They also provided internal validity, consistency, and reliability of the QTI test. They used selected questions from the Test of Science-Related Attitudes, which generated an alpha reliability of .79. Aside from providing validation of the instrument, they also indicated the alpha coefficient for this study, which ranged between 0.67 and .88 for the QTI. For the students' attitudes toward science, the reliability of this measure was .69.

Though this provided numerical information on the subjects, this did not indicate the process of selecting the candidates. It did not state the way they selected schools or gender distribution for the study. This study showed the influence of teachers' cultural sensitivity with their student's performance and inquiry development. This study manifested the value of enhancing teachers' knowledge and exposure to more culturally sensitive aspects that would help students relate to and benefit from learning science. Furthermore, the article illustrated another way of expressing a student-centered approach through cultural sensitivity.

Glasson et al. (2006) explored the possible influence of a methods class on Malawian educators’ views and practices on teaching place-based ecological sustainability issues in the primary grades with a specific focus on traditional ecological knowledge and the colonial legacy on deforestations. The candidates participated in a two-year study. The methods class met three times per week for six hours each meeting in an intensive science and mathematics methods course that addressed issues related to ecological sustainability, culture, and place-based education. The pedagogy adapted the recommendations provided in the National Science Education Standards.

The candidates represented five ethnic groups in Malawi: the Chewa, Yao, Lomwe, Mang’anja, and Tumbuka. They all spoke dialects of Chichewa and were fluent speakers. English was a second language. They all earned their bachelors degrees from the University in Malawi in the fields of science, social studies, mathematics, literacy, agriculture, and home economics.

The analysis was conducted on the data information collected from videotapes, audio recorded class discussions, lesson observations, and interviews (Glasson et al., 2006). These data were transcribed, coded, and categorized based on their common themes according to the Malawian educators. One of these themes was the idea that colonial influences were strong that it reflected itself in the sustainability of indigenous ethnic groups, and the disintegration of the environment.

Glasson et al. (2006) found that Malawian educators had a good understanding of scientific concepts that were grounded in indigenous concepts.

Their perspectives on indigenous concepts enriched their grasp on Western scientific concepts. Glasson et al. showed the educators' use of indigenous knowledge to enhance their understanding of Western scientific concepts can supplement students' current understanding of science. They stated that such approach could be beneficial to students since it allow them to perceive science based on their prior knowledge, their cultural familiarity, and orientation.

Despite these observations, the researchers questioned impact of the approach integrating indigenous knowledge with Western scientific concepts in a country that either lacks resource or government support in education. They believed that such cases need further investigation and research. Glasson et al. (2006) also acknowledged some problematic factors that could influence the intent effect on education. These factors range from lack of trained teachers to the lack of resources.

One of the strengths of this study is a strong description of the methods class. Glasson et al. (2006) used a clear ethnographic approach to research by using multiple methods of data collection. A connection between indigenous knowledge and teachers' themes is clear and well-substantiated, though the authors failed to provide a clear picture of the demographics of the participants and no information as to number of years the educators had taught.

In a case study of Luft (1997) on ways of enhancing teaching diverse science class, Luft identified three factors that will prepare preservice science student-teachers to handle classes that are culturally different from theirs. This study involved a student-teacher named Jill who was assigned to observe a middle school that is predominantly Latino/a-American (Luft 1997). An in-depth interview with the student-teacher regarding her experience at Center City Middle School, this study discussed the student-teacher's observations and journal documentation of her daily teaching experience.

After collecting her data, Luft (1997) inductively analyzed her journal, transcripts, documented interviews, and observations. The student-teacher spent the summer contributing to the analysis with frequent evaluation, classification, and verification of her theme; the team further reviewed the analysis to assess the level of quality and authenticity.

Based on the student-teachers' observation on family background, she attributed their cultural environment as the main player and source of behavioral influence. The subject's perception toward her students was based on her experience with them. She noted that understanding the students was challenging because of no individual connection during interviews with them. However, she noted that her usual generalization shifted toward perceiving the students as individuals with different needs and personalities. The study indicated gender and ethnic groupings of students; what the preservice student-teacher was teaching, as well as the community structure which provided overview of the classroom context to promote transferability of the study. However, this article did not indicate how the preservice student teacher was assigned to Luft (1997). On the other hand, this article proved credibility based on the descriptive illustration of data gathering and decoding. The subject provided documentation of her observation and by Luft herself, although the study did not indicate the process on how they evaluated authenticity and quality of this data analysis.

This study addressed the issue of enhancing teachers' orientation on multicultural science and the importance of giving attention to quality training for teachers for several reasons. First, because of how it can impact the relationship with students of color, which in this context is a very sensitive point. Second, because without the connection it is hard to evaluate, detect, and oversee students' needs. Third, and most importantly, if the teacher is culturally different from students quality training is especially important. This article illustrates the importance of teachers' orientation to diverse fields of experience to help them understand their students and in bringing science to their attention, interest, and understanding with ease. Furthermore, an established connection will enhance student-centered teaching approach.

In their qualitative research study, Tobin et al. (1999) explored how high standards can be attained by all learners across geographical areas in the United States over different socioeconomic strata. They also explored how it is attainable even when there are many differences in social, cultural, and monetary resources to support students' education. They conducted their study in a school with 180 to 230 students where there was a high population of the African-American ethnic group. The school initiated a program called Enactment, which constructed Small Learning Communities (SLCs) with 180 to 230 students enrolled. Enactment created a learning community center providing a working experience for students within a small learning community to establish family comfort in their environment when introducing students to an interest-based curriculum.

Tobin et al. (1999) gathered data taken from a ten-week unit lesson in chemistry. They gathered artifacts such as digital pictures of students at work, document-written proof of class work, homework, test results, and videotapes covering teaching-student responses from questions posted. Students that are enrolled in learning class service attended the sessions at the end of the day. The team selected eight students to provide diverse perspectives on teaching and learning, and interviewed these eight students to extract information on the current lesson. Furthermore, the team gathered perspectives from another set of students for contrast in the study.

The process narrowed the selection to a particular student named Nicole, who was interviewed extensively for this study. The research team identified patterns and issues of social dedifferentiation into social class and the disadvantaged group whose data was obtained from analysis on teaching and learning. The team took notes on Nicole's perception on how the teacher's lack of sensitivity towards students' problems and how the institution's structures and policies handicapped the student's chance of success. The study also noted the faculty's lack of caring and empathetic ethos that reduced even possibilities for learning, as well as the teacher's failure to give enough attention to young African-Americans. However, the study established that resistance to high expectations is a potential source of discrepancy in a learning community.

Tobin et al.'s (1999) study was centered on the socioeconomic status of the subject; selections were thoroughly defined and included actual scripts of interviews. However, the study used only one gender subject, which was male. Furthermore, aside from sharing a common geographic area, the studies did not have enough qualifying information on the subject to reflect common grounds with fellow classmates to ensure the representation of the whole student body. The research team applied triangulation in confirming data and interpretation.

Tobin et al. (1999) addressed issues on the effects of emphasizing multicultural-based training for teachers. The research proved some negative effects on students' attitudes toward science, with teachers limited orientation to cultural philosophy and practice. The study underscored the importance of multicultural diversification in science to minimize the lack of interest by students of color.

In a national survey study, Catsambis (1995) evaluated eighth grade students on how performance and attitudes in science varies according to ethnicity. This was a two-stage stratified study covering 1,052 schools and 24,500 students; the study obtained its data from the 1988 National Educational Longitudinal Study (NELS). The study included a survey plan for students at two-year intervals. They gathered information on socioeconomic backgrounds, perceptions on self-schooled life and educational experiences, and the aspirations of these students. To evaluate their attitudes toward science, the researcher used questionnaires to ask these students how they look forward to science, what their uncertainties and fears of science are, and about students' future career aspirations. To delve further on students’ social backgrounds, the researcher conducted an inquiry on the students’ parents’ educational backgrounds and dates of birth, gender, and ethnic identitiesy.

Analysis showed little gender heterogeneity across different racial ethnicity. Catsambis (1995) stated that Latino students had a moderate gender-related difference on grades and showed that females received higher marks on grades than males among minorities in general. Furthermore this study noted that there were no gender-based differences of grades among students reluctant to ask questions in class. However, Catsambis (1995) noted that Latino students, male and female, were more hesitant to ask questions than other students of different ethnicity. The study also showed that females of African-American and Latino decent showed less interest in pursuing careers in science; the rest of the minorities showed positive attitudes toward science regardless of their performance. Catsambis (1995) also noted that success in careers and academics has been emphasized more than attitudes in science in the Latino community.

Catsambis’ (1995) study recognized other possible factors that may contribute to the rate of enrollment on high-ability and low-ability classes. Though Catsambis (1995) acknowledged that other sources of data presented in the study were questionable according to significant p-values, statistics showed that there were few data collected on white students that were statistically greater than 0.001. She provided good statistical explanations on her findings that p-values were statistically significant only for white students. For the regression coefficients of the gender-levels of ability groupings in science, Catsambis (1995) reported one datum statistically significant with a coefficient of 0.01. Catsambis (1995) also reported values for interest and attitudes toward science by gender, race, and ethnicity with a coefficient greater than .05 and .01.

The study illustrated issues of inequality of race in terms of attitude toward science. The students addressed the knowledge of limitations in the distribution of students' interest in science across different cultures and how orientation to science can contribute to the cultural aspects that will determine the distribution of interest.

Effects on Teachers

In a correlative study, Haukoos et al. (1995) investigated the integration, retention, and persistence in the implementation of inquiry-based and hands-on student-centered strategies with Native American teachers. The studies also established the teachers' own experiences as nonconstructivist learners as having a powerful influence on their teaching practice.

Based on the collected data, Haukoos et al. (1995) stated that the shift of preference from 1.73 to 2.78. In culturally related group, data showed that teachers see the value and the impact of incorporating multiculturalism in their classes. After a year, the assessment declined to near the preassessment level taken a year ago. These results implied that the teachers' experiences educating students in a nonconstructivist learning environment and then coming back to an environment that does not provide support for alternative strategies disintegrated their momentum in implementing the instructional strategies.

Although Haulkoos et al. (1995) furnished statistical data for the study, the credibility of the study is questionable. Haukoos et al. did not emphasize the teaching experiences of these educators to confirm their preassessment value or to verify the influence on the teachers' preferences over the inquiry-based methods. They did not include age and gender distribution of the subjects. Furthermore, they did not indicate the process selection for this sampling. They did not specify the teachers' background in education, which can play a very significant role on teachers retaining the inquiry approach. In addition, Haukoos et al. pointed out that there were no distinctions made between the Native and Non-native teachers in the sample.

This study suggested that the teachers' attitudes towards culturally oriented science curricula were positive. They suggested the effects of incorporating cultural aspects in science curricula had a minimal role on teachers' indifference to the new approach. Furthermore, they tended to state that teachers declined to use the approach due to other factors, such as lost of momentum from lack of support.

In a qualitative study, Chinn (2007) examined the teachers' perspectives toward incorporating indigenous knowledge after undergoing a professional development program that will touch on decolonizing methodologies and indigenous knowledge. In the study, which included 19 secondary mathematics and science teachers from Asia and United States, Chinn found shifting perspectives among Asian educators towards indigenous science. These perspectives ranged from negative to positive perspectives. The study consisted of 19 mathematics and science educators; eight females and 11 males with demographic distributions as follows: three from Japan, five from Malaysia, one from Indonesia, one from Thailand, two from Korea, two from the Philippines, and five from the United States.

Chinn (2007) conducted a ten-day professional development program called Thinking in Math and Science: Making Connections with the Subjects in Honolulu. Chinn (2007) presented an indigenous Hawaiian cultural practice that focuses on sustainability directed to help teachers reflect their views toward indigenous knowledge and its role and place in Hawaiian society. Chinn (2007) noted how the study included science and mathematics pedagogy overview, inquiry-based laboratory observation, hands-on experience, a two-hour presentation from two former teachers on middle school science, and a tour. She established a comfortable environment to coax teachers to disclose their personal views and provided a research activity. After the workshop training, Chinn (2007) and the participants did not meet for two days. During this interval period, the participating teachers tried the new approach in their classes.

This study recruited the administrators and school personnel to video tape the teachers in action. In addition, Chinn (2007) interviewed the educators about their experiences and their new views about decolonizing indigenous knowledge.

Chinn (2007) found that in a collaborative discussion with individual interviews and video-tape reviews, the teachers' perspectives and application shifted toward inquiry using indigenous knowledge in the curricula. The study initially showed that most of the teacher-participants viewed indigenous knowledge and science as distinct from each other. After the workshop, Chinn (2007) noted that the majority of participants formulated their lesson plans engaging activities with hands-on experience.

This study showed credibility by way of presenting methodology of sample selections. Chinn (2007) outlined the subjects' involvement in the study as to gender and socioeconomic distribution. He also provided the number of teachers representing each country with little emphasis on sample selections. She provided step-by-step methods and programs used in the study of the subjects, the use of tangible instruments in gathering data, data information, and the process of interpretation. Confirmations of the study affirmed her use of subjects from various countries, minimizing partiality by varying ethnic presentations. She also substantiated its dependability and transferability.

Chinn (2007) provided a descriptive and theoretical views from other authors, thereby establishing the position of her study. She had an excellent descriptive methodology and cited other authors' works that paralleled her theoretical position relating to the study. Furthermore, she did an expository work on decolonization with indigenous knowledge citing different authors and different perspectives.

This study suggested that professional development that promoted decolonizing methodologies and indigenous knowledge kept teachers up to speed with their current community status and conditions, consequently promoting successful communication on issues with students. This study also showed teachers possessed receptive attitudes toward culturally-oriented curricula and indigenous-based knowledge, as well as promoting current awareness on community issues with their students and the students' understanding of science. The study showed the teachers' active engagement with an approach perceiving science in different contexts, which allowed for the promotion, integration, and application of indigenous knowledge.

In a mixed-method study with 18 secondary school teachers, Luft et al. (2003) investigated impacts of different programs on teaching beliefs, practices, and experiences of first time secondary-science teachers. These are teachers exposed to inductive programs–a science support program–that practiced student-centered inquiry methods.

Luft et al. (2003) conducted the study on sixth through 12th grade secondary teachers. In the first part of the study, ten teachers were selected to conduct the workshop, while the assistant researchers handled field trips. The second part of the study involved 18 teachers divided in three groups: those with university-based support programs; the general-based support program group; and those with limited access to induction programs. The research team gathered teachers according to grade level and subject area. The first group went into a workshop program that focused on science instruction through management, planning, instruction, and assessments. The second group went through follow-ups on various curricula and workshop. The third group circulated and socialized with teachers in schools.

Based on the analytical study, Luft et al. (2003) showed that educators who received science-focused support, general support, and peer support had different results. Teachers in the science-focused support program who implemented a student-centered inquiry curricula benefited more compared to other groups.

The Luft et al. (2003) study, which was constructed in a mixed-method approach, illustrated credibility. The first part was a pilot study that explored, selected, and refined the method data collection and analysis. The second part of the study was at an 18-month interval. Luft et al. stated that the finalization of the study involved continuous documentation, observation of classrooms, follow-up interviews, and the participation of several research assistants in data collection. Luft et al. provided a descriptive and thorough process of gathering data for each individual in a group; individuals were selected from various districts in one region. This study showed indications of limitation, though it provided a descriptive rationale for the research project. The research team gave information on the relevance of the project by describing issues related to the condition of first-time teachers inside and outside the United States, which provided external validity of the research project.

This research addressed the concept and definition of teachers' positive responses toward support programs. This study showed that teachers under the science-focused support program used student-centered inquiry methods. The analysis and its findings suggested that university programs and other institutions should incorporate and implement induction programs to promote inquiry and student-centered education in teaching practice.

Barton (2000) studied how preservice science teachers were involved in community-service learning and how this involvement influenced multicultural-science education in theory and in practice. The qualities of community-service learning made multicultural-science education a realistic objective that can foster understanding of United States' preservice students about what an inclusive and liberating multicultural-science teaching practice will accomplish. The study found that service-learning experiences provided preservice students the opportunity to reflect their knowledge in science, in teaching, and on students from the standpoint of schooling.

Barton (2000) provided first an overview on current efforts to promote multicultural-science education and service learning in United States' teacher education. She conducted a case study to address questions on her research of preservice students and used the findings on her theoretical position. The study showed a positive result on preservice students in a way that it challenged their pre-existing understanding of science, culture, and experience in student teaching. Barton (2000) reported that preservice students were given a chance to manipulate and question their current understanding based on their observation in the service-learning experience. She pointed out that one of the advantages was developing the skills to work with children collectively; another advantage was that teachers developed flexibility in applying their skills and honed their understanding of science and culture. Barton (2000) also identified other challenges like exposure of preservice students in unfamiliar populations.

Although Barton (2000) provided literature and illustrations of her theoretical position, she did not emphasize the process of selection, gender distribution, or socioeconomic status of the subjects. Barton (2000) did not explain how these demographics influenced their knowledge on multicultural science.

The Effects of Diversifying Faculties

This section analyzed four studies that perceived the effects of cultural ethnicity and orientation of educators on students' performances and attitudes toward science. Tobin (2004) examined the effects of common cultural practices between students, and teachers on students' performance and attitudes toward science. Tobin, Roth, and Zimmermann (2001) discussed the effects of common cultural orientation between students and teachers. Ramanathan (2006) examined Asian educators' contribution to students' academics. The study also examined the support and resources that Asian educators received. Khine and Fisher (2004) evaluated students' attitudes and performances toward science academics facilitated by Western and Asian educators.

In a case study, Tobin (2004) investigated how social and cultural factors mediated the teaching and learning of science through an intense research that involved longitudinal program in the tenth grade Australian high school and pointed out that students of color and females were often alienated from the enacted science curricula.

The research team participated with the researcher/teacher, Ms. Horton, as part of the subject in the study. They indicated her personal experience and that she was a descendent of immigrant parents was the reason she participated, as well as her suitability in teaching diverse students. This study covered 31 students, one-third of which were ethnic minorities that included New Zealand Maoris, Turks, Italians, and Asians. Ms. Horton selected these students from her five-week chemistry class for the study. She taught the students in a way that encouraged success in learning and understanding science. She used materials and laboratory equipments in the classrooms and showed support in building up students' positive attitude toward science. Additionally, she encouraged community learning to a frame enacted science curricula.

The research team used edited videotape segments on teacher/student interactions, student activities, and discussions on school assignments, including a twenty-minute class discussion on data interpretations and adjustments necessary for the study to gather data. They also took digital photographes and artifacts obtained from research sites to document the results, transcripts, and field notes. This study showed that interpersonal experiences, including sharing social functions and cultural histories influenced the teacher's interactions with students, and her connection and understanding with her students. The sharing of common experiences brought her closer to her student and effectively addressed their needs.

This study showed credibility by providing information on the process of sample selections, instruments for data gathering, and the decoding process. The study used triangulation to confirm interpreted and decoded data. However, it did not indicate evidence of external validity. Furthermore, it did not include socioeconomic and gender distribution to provide classroom context for transferability.

This study addressed the question on how a diverse faculty can influence students' performance and attitudes toward science. This article suggested that similar cultural experience benefited students of color and that diverse faculty had an influence on student's performances and attitudes.

In an ethnographic study examining how teachers and students in an urban school collaborated to identify potential sources of hegemony, Tobin et al. found that teachers learned to enact curricula that produced cultural reforms that were potentially transformable. Tobin et al. (2001) took this study by investigating students from City High School.

This study involved close examination of two new teachers (both from middle-class backgrounds) at City High School and their goals of becoming culturally relevant for their ninth grade African-American students. The research covered a large urban high school with 2,300 enrolled students divided in ten Small Learning Communities (SLCs). Out of 2,300 students, 97% were African-American and only 43% were students that graduated within four years.

This study gave student-teachers the opportunity to evaluate each other on their student-teaching experiences. This exercise was done in a three 90-minute block period. Each lesson contained closure, which transitioned from the previous lessons to help students refer to their previous lesson.

The research team collected data taken from videotaping collaborations with co-op teachers, student-teachers, supervisors, and the research team. The analysis process involved reviewing videotapes, recorded debriefings, videotapes of the analysis sessions, journals, and other forms of interactions. They introduced segments of the recorded conversations and elaborated on each one. The research team summed up critiques and descriptions to highlight the strength and the weakness of the study. They established the learning environment rather than giving that opportunity to the students. They also acknowledged their doubts on their teaching education and curricular reforms as to whether this would intensify, promote, or suggest hegemony and oppression to students. One of the things they acknowledged was that the approach compromised the learning environment in a way that students could no longer establish their own learning environment and that the collaboration had dominated or ruled over the voice of the students in class.

In addition to their findings, the team discussed studies that paralleled the findings and theoretic ideas. Though the study was done in an urban setting, these students were able to transfer to other schools because the investigation preserved the classroom demographics. Tobin et al. (2001) preserved dialogues that occurred during the class, though it did not indicate triangulation in the study.

The study suggested that identifying and connecting with students' social and cultural resources enhanced the effectiveness of the teachers' delivery of the curriculum. Furthermore, the study suggested that identifying and connecting with students provided the teachers with an overall view of the students' various social status' this enabled teachers to adopt a curriculum that silhouettes the students' needs, rather than bringing the curriculum to the minority students.

In a sample survey study of Ramanthan (2006) covering 96 Asian-American educators, the study investigated the positive impact that teachers have on the curricula and their students' academic experience. The Ramanthan (2006) study also indicated some of the problem areas related to minority teachers, such as the balance of support that was given.

Based on the analysis, this study showed that Asian-American educators were merely curricula deliverers when it comes to making decisions on the curricula. Furthermore, since these subjects did not had a strong voice in defining curricula, the subjects limited their opportunity to influence either the curricular structure or the people in their working environment. In terms of support, the respondents claimed they received it from both administrator and their peers. This study showed that these educators had positive interactions with others whether or not their ethnicity was explicitly noted. The study showed that one-third of the educators indicated that their ethnic identity did not impinge their interactions with the students. Many respondents stated that in general, their students engage with them as source of information on multiculturalism. They reported that this fostered a good relationship with their students by sharing cultural information and experiences similar to professional support groups.

The strength of this study stands in the conscientious process of conducting experiments in order to reflect the character of the samples by keeping track of participants through constant communication by phone and mail. The study established an excellent description of sample selections and reasons for sample selections. Furthermore, Ramanthan (2006) showed good descriptions of the items evaluated in the survey. However, data from the survey was presented with no analysis or processing of interpretations of the results.

In this study, Ramanthan (2006) established that ethnicity had a strong influence on students' appreciation and awareness of cultural differences rather than academic achievements. He acknowledged that a shortfall of Asian-American educators had minimal influence on academics. Similarly, the ethnicity of Asian-American educators had a minimal role on students' academic achievements. In addition, this article did not show strong implications between teachers' ethnicity and students' performance in science, both belonging to a dominant and minority groups.

A correlative study conducted by Khine and Fisher (2004) covered the cultural backgrounds of teachers from Brunei with 1,188 enrolments. This study established relationships between the students' perceptions of interpersonal behavior and enjoyment as along with attitudes toward scientific inquiry measured by the Question on Teacher Interaction (QTI), in addition to the measuring tool subscales of the Test of Science-Related Attitude (TOSRA).

Khine and Fisher (2004) took the subject sampling from Brunei. The total number was 1,188 consisting of 543 males and 645 females. These students came from 54 science classes that were chosen across ten secondary schools. The study consisted of 50% of 11th graders. Each class size ranged between 11 and 32 students, averaging 27 students in a class. The mean average age of the participants were 17. In addition, the study involved forty-seven teachers, 24 Asians, and 23 Westerners.

Khine and Fisher (2004) found that students from Brunei perceived Western educators as friendlier, more approachable, and as having better leadership skills than their Asian counterparts. They pointed out that the leadership scale value of Asian teachers were 2.71, while the Western teachers were 3.12. The standard deviation for Asian teachers was .70, while the Western teachers had a standard deviation of 0.60. The mean differences on the leadership scale were -0.40, and 10.76 for the t-value. The understanding scale values for Asian teachers averaged 2.62, while the Western teachers averaged 3.09. The mean difference on the understanding scale was -0.47, while the t-value were 12.14. The standard deviation for Asian teachers was .72, while the Western teachers' standard deviation was .61. For uncertain scale values, Asian teachers received 1.40, compared to the Western teachers received 0.97. The standard deviation for Asian and Western teachers was .68. The mean difference on the leadership scale was 0.42 and the t-value was 10.76. The admonishing scale value of Asian teachers was 1.55, while the Western teachers' admonishing scale level was 1.12. The standard deviation for Asian teachers was .77 and for the Western teachers it was .60. The mean difference on the admonishing scale was .42 and the t-value was 10.72. For the helpfulness/friendliness scale, Asian teachers received 2.68 and Western teachers recieved 3.24. The standard deviation for Asian teachers was .78; the standard deviation for Westerners was .66. The mean difference on the helpfulness/friendliness scale was –0.55, and the t-value was 13.16. For the student responsibility/freedom scale, Asian teachers received 1.68; Western teachers received 1.71. The standard deviation for both Asian and Western teachers was .56. The mean difference on the student responsibility/freedom scale was –0.02, and the t-value was 0.64. For the value of the not-satisfied scale, Asian teachers received 1.52; Western teachers received 1.10. The standard deviation for Asian teachers was .76, while Western teachers had a standard deviation of .68. The mean difference on the nonstratified scale value was .41, and the t-value was 9.87. For the strictness scale, Asian teachers received 2.10, compared to Western teachers receiving 2.06. The standard deviation for Asian teachers was .55, while the Western teachers had a deviation of .58. The mean difference on the admonishing scale was .04, and the t-value was 1.45.

As for the students' enjoyment of science, Khine and Fisher (2004) pointed out that students enjoyed science more when taught by Western teachers compared with Asian teachers. In addition, students' responded more positively with inquiry-based science. Khine and Fisher (2004) found the scale-item mean for enjoyment of science lessons for Asian teachers was 3.75 and 3.90 for the Westerns. The standard deviation for Asian teachers was .68 and .60 for Western teachers. The mean difference for this scale item was -0.15 the t-value was 4.06. Khine and Fisher (2004) noted that it is statistically significant on the basis of the p-value of less than .001. As for the attitude on the scientific inquiry scale, Asian teachers received a mean score of 3.53, compared to the Western teachers receiving 3.49. The standard deviation for both teachers is .54. The mean difference for this scale item was .04 and the t-value was 1.30.

Khine and Fisher (2004) saw a less positive response on learning and appreciation of science curricula with Asian teachers, whereas Western teachers were receiving positive feedbacks from their students. The researchers suggested that students reflected interpersonal decorum with more positive imputes on Western teachers than on their counterparts. Furthermore, Khine and Fisher (2004) observed that students appreciated inquiry-based science curricula more with Western teachers. Khine and Fisher (2004) observed that Asian teachers way of teaching is more rigid, objective, and stringent compared to their counterparts. In other words, the students had the tendency to gravitate toward Western ways of teaching.

Khine and Fisher (2004) used an excellent illustration of statistical support for their correlation. They used the mean average comparing both groups for its scale items with the probability value kept below 0.001, with the exception of the student responsibility/freedom scale item where the Western teachers' mean item value is 1.171, which fell within one standard deviation of 0.50 for Asian the teachers. Khine and Fisher (2004) reported a p-value of less than 0.001, which they indicated to be a score significantly different. In addition, Khine and Fisher (2004) reported a scale mean difference that ranged from 0.42 to 55.

As with sample characteristics, Khine and Fisher (2004) mentioned the gender distribution, ethnic identity, mean age grouping, and geographical origin of the participants. In addition, they provided external validation and use of the QTI from Germany, Australia, and the United States. They agreed this process illustrates cross validation of the QTI. Khine and Fisher (2004) introduced and explained thoroughly their theoretical position. Kline and Fisher (2004) presented a clear illustration of how cultural orientation relates to the type of teaching approach; they also explain that in practice, the teacher's cultural orientation correlates with students' positive responses toward interpersonal decorum. In addition, they presented a clear correlative illustration between inquiry-based approach and students' positive inputs in science class. Conclusion in leadership approachability understanding and helpfulness that Western educators scored on QTI scale was linked with students' positive responds to a sound learning environment and their enjoyment of the curriculum. This article implied that the educator's cultural ethnicity did not necessarily have a positive influence on students with a similar ethnicity. Furthermore, a good teaching practice per se had a strong influence on students' academic achievement rather than a common ethic origin.

The analyses of this section suggested that the educators' racial identity, ethnic origin, and cultural orientation had little influence on students' performance and attitudes toward science. These analyses addressed the question on how diversifications of faculty influence the students' understanding and performance in science class. Ramanthan (2006) illustrated the Asian educator's role and influence on student's performance and attitudes in science; the analyses showed that educators have a strong influence on student's cultural awareness. Khine and Fisher (2004) pointed out that Brunei students' academic performance and attitudes toward science with Western educators' approach had a strong relation compared with their Asian counterparts. It tends to say that racial diversification of faculty may have little influence on students' academic performance, though it may have strong influence in students' multicultural awareness.

Other Forms of Reflecting Indigenous Knowledge in Science

The following analyses discussed how indigenous knowledge is incorporated in science curricula and the effect of incorporating indigenous knowledge into science curricula on students' performance and attitudes in science. Rodriguez et al. (2004) discussed programs and their effects on students' performance and attitudes. Cogan et al. (2001) and Ninnes (2000) discussed the integration of textbooks and its effect on students' performance and attitudes in science. Kearsey and Turner (1999) and Ash (2004) explored the used of native language as a form of student-centered strategies in understanding science.

Culturally Oriented Programs for Students

Rodriguez et al. (2004) studied how university outreach programs can promote academic and cultural-identity development among culturally diverse tenth grade students and how they can meet the goals of advancing students' competency in mathematics and engagement with science and academic development. The studies found a positive relationship between resources provided by the program and students' performance and attitudes.

This study covers 193 adolescent students with a gender ratio of 53% female and 46% male. These studies included a breakdown of ethnic identity: 45% Latino/Mexican-American; 17% Pacific Islander/Native Hawaiian; 21%

African-American; 12.25% Native American; and 4% unclassified. Across this population, 40% speak English as secondary language (ESL).

Using the same subjects, the team evaluated the effectiveness of the program meeting the goal of enhancing students' performance in mathematics and science. They used the Test of Integrative Process Skills (TIPS) that assessed five specific academic skills that focused on mathematics and science competency. The team collected the pre- and post-assessment study over a four-year period, and the overall score increased from 20.21 to 24.00. In 1999, the overall score increased from 20.16 to 25.30; in the year 2000, the score increased from 20.34 to 24.66. The study showed improvements in mathematics and the sciences based on the pre- and post-assessment TIPS scores. Furthermore, this showed that outreach programs had a positive effect on students of color learning mathematics and science.

This article provided outcome data for internal validity on previous studies covering its first four years of study. The team also provided socioeconomic and gender distributions for the study. They acknowledged that further study and investigation should be carried out to reevaluate the quality and effectiveness of the program. They did not provide steps or what types of instruments were used for data collection.

The study concurred that the structure of the program was culturally-oriented and therefore is culturally responsive and should promote success. These studies evaluated the program structure and its curriculum before its integration in order to address attendant issues influencing the enhancement teacher-candidates' may experience in science class.

The study addressed the question regarding the influence of indigenous knowledge on students' perspectives and academic performance. According to the analysis, the integration of indigenous study in the program influenced the students' perspectives toward science and, more importantly, students' performance in science.

Incorporating Indigenous Aspects in Textbooks

A similar study from Cogan et al. (2001) covered eighth-grade level curriculum from 40 countries. It explored how the cultural context of the curriculum policy relates to what was being taught in the classroom and in turn examined how curriculum relates to textbook contents and the subjects taught.

The research team ran an i-depth analysis on the Third International Mathematics and Science Study (TIMSS) that conducted a survey of teachers and school administrators. The research team derived its analysis from content standards, textbooks, and classroom instruction surveyed in the TIMSS. The TIMSS framework organized the evaluation based on the three major areas in science.

In the content, standard Cogan et al. (2001) found that energy handling (specifically, electricity), organs, tissues, sensory, response systems, and reproductive systems were the most common topics covered in the textbooks across the 40 countries. and electricity for the most covered topic area. Based on the analysis, the research team confirmed that these common topics are expressed across many cultures.. The study showed that different cultural approaches were illustrated in textbooks and from teacher's instructions. The study demonstrated a very descriptive data resource. The research teams furnished all kinds of questions, sections, and levels of complexity for all the topics.

Based on this analysis, they implied that science can be communicated in various cultures in many different ways using standard textbooks, lesson plans, and classroom environment. This study also suggested that Western classrooms can be adapted to a more culturally-oriented curriculum in addressing science for all students.

In a qualitative study, Ninne (2000) explored ways that indigenous knowledge can be represented in science using textbooks like Australian and Canadian textbooks. Research showed these texts reflected signs of indigenous concepts. Ninne (2000) selected textbooks that fell under two series; the Dynamic Science series and the Science Probe series. Four books were assigned to the Dynamic Science series and contained the following initials: DS1, DS2, DS3, and DS4. There were three texts assigned in the Probe Series, each have the following initials: SP8, SP9, and SP10. The author chose to pick the above texts from Australia and Canada to preserved the authenticity of Eurocentric perspective considering that European settlers with less marginalized groups predominantly occupied these two countries.

Ninnes (2000) used two methods of analysis. The first method involved a set of terms and collective statements, graphs, and other forms that reflected indigenous knowledge. It was a whole archive of collective statements of indigenous knowledge taken from the textbooks. The second form of analysis involved identification of textual grammatical and ideological features. The analysis of ideological textual features on these archive statements sorts out aspects that reflected references of what was indigenous and what was considered not indigenous. Furthermore, the analysis showed that Australian and Canadian science textbooks contain considerable amounts of information that reflect indigenous knowledge like myths, legends, and taboos. Aside from biology, the study also showed indigenous knowledge integrated in the physical sciences, including chemistry, physics, and earth science.

In this study, Ninnes (2000) acknowledged the problematic effects of this study. She stated that incorporating indigenous knowledge does not necessarily counteract the problems of stereotyping, racism, and prejudice. In fact, she said that depictions of indigenous knowledge would put some risk on students of indigenous culture to be identified based on what has depicted on the textbooks. Furthermore, Ninnes (2000) stated that authors might run the risk of imposing definitions just to preserve the authenticity. She also pointed out that this could manifest as another way to drive the integration of indigenous knowledge in science curriculum.

This study illuminated elements that the reflect integration of indigenous aspects that manifest overcoming ethnocentricity. This study examined how science curricula can reflect indigenous aspects using textbooks and other resources used in science curriculum. This study promoted a student-centered approach in teaching, and inclusion of students of color in the class.

Use of Native Language

A correlative study conducted by Kearsey and Turner (1999) figured out difficulties and advantages for bilingual students in comprehending science language for students from United Kingdom schools.

This study involved the use of the science text called *Nuffield Co-Ordinated Sciences* biology textbook. Kearsey and Turner (1999) noted that this text covered 20% of the curricula time available for teaching students ages 14 through 16. The study focused on six schools retrieved from the initial inquiry in the Nuffield Chelsea Curriculum Trust database of 37 schools. These six schools contained less than 10% bilingual pupils. The selection process of the subjects was based on the usage of textbook. Kearsey and Turner (1999) referred to schools with students using textbooks from different schools and some selected schools. They focused on schools that were state schools, independent schools, and international schools. Gender distribution of bilingual students from the school 1018 has 24 boys and 40 girls. The distribution is overlooked since two of the six schools, 1021 and 1031, were single-sex boy school. Although Kearsey and Turner (1999) included schools from overseas, their study did not include students enrolled in a course teaching English as a second language.

Kearsey and Turner (1999) used the context of the textbook in the study drawn from the faculty's interpretation of interviews and policy documentation. These interviews and documentation report on the textbooks, reviews of schools participating in the study, and other review sources. For this purpose, they made appointments for interviews to preserve the consistency of the data collected. In addition, the research team formulated a school case study profile to frame the context of the school. Furthermore, the team assessed the accessibility of the textbook study by analytical approaches such as questionnaires, cloze task data, readability formula analysis, and interviews.

Some of the questions included in the questionnaire were open-ended. They questioned students about languages spoken at home and in school. The close-ended questions, on the other hand, focused on where they used the textbooks.

110 pupils in five schools were included in a pilot study and were plotted in the spreadsheet for data collection. In addition, Kearsey and Turner (1999) gave the follow-up questions to a small number of pupils from schools 1018 and 1031. These items questioned when and where the students' languages belonged in the eighteen most common situations provided. The purpose of these follow-up questions was to look at other instances where they use their language outside the confine of academics and what language was used.

Kearsey and Turner (1999) uncovered that bilingual students' degree of textbook comprehension was more or less at the same level as their monolingual counterparts. In addition to this finding, they found a small distinction between school 1018 and 1020. Kearsey and Turner (1999) noted that there were similarities based on the case study profile. Furthermore, there was no distinction between mixes of bilingual students' social classes. About 23% of bilingual students in school 1020 and 24% in school 1018 used English in at least half the situations they encountered. In addition, 60% of the students used English in 28% of the situations presented to them in school 1020 while school; 1018 showed 81% students. Kearsey and Turner (1999) pointed out that most of the students in school 1018 used their secondary language. School 1030 showed a lower number of bilingual students who used English, at only 28% of the situations presented.

Analysis showed that bilingual students do not perform quite as effectively as students who were monolingual in cloze tests considering that they had access to resources such as textbooks, small work groups, and peer approval. Kearsey and Turner (1999) pointed out that there were smaller portion of bilingual students who responded to the follow-up questions, which indicated that these students were comfortable with the English language. The average cloze score for bilingual students was lower than their monolingual students. Kearsey and Turner (1999) noted that based on the questionnaire data, bilingual students and monolingual students had similar perspectives on textbooks from the same school. In addition, they indicated that most of the bilingual students can perform better or the same as their monolingual peers in simple tasks.

Kearsey and Turney (1999) provided statistical illustration of the findings. In addition, they implemented an internal validation that was implemented in the study, using F-test, and the T-test. Though these tests ensured the data collected were not influenced by external factors, the study failed to provide any explanation of sample selections in schools 1018 and 1031. The follow-up question was conducted on a small number of students from school 1018 and school 1031.

This study showed how the use of bilingualism could bring students close to their learning. The use of native languages as a form of student-centered strategies tends to address the application of incorporating indigenous knowledge in science curriculum. This study tends to address issues on how students can use the approach of bringing science to students.

In a case study, Ash (2003) explored the collaborative social interactions, conversations, opportunity dialogues, and making meaning within family groups as a source of exploring, learning and understanding scientific ideas among Spanish-speaking families. It was found that this particular family group used mediation techniques and crossovers of cultural boundaries in exploring science concepts.

This study involved Spanish-speaking families from Head Start, a group underserved by science education. Ash (20003) selected six families to visit the Splash Zone exhibition in the experiment. The selection of the families involved voluntary participation based on their interest, the age of their children, and the time commitment. Children involved in the study were between the ages of three and nine.

The study involved observing family conversations, actions, and the meaning-making process of science at home and at museum. This set took place in aquariums, museums, and at families' home. The study constructed a flowchart for an analytic frame that preserved the natural flow of the conversation. Ash (2004) obtained data from the interviews, aquarium visits, post- interviews, and reflective prompts. In addition, Ash (2004) documented events, gathered data, reviewed videos, and other documented interviews to select significant events. Ash (2004) based her selection on four items and used it as a frame for her analysis.

This study found that Latino families used mediation techniques including adults asking questions to initiate knowledge-gathering from the source. The subjects also showed crossing over cultural boundaries between their daily lives, and science conversation flowing between Spanish and English in their home and recreational sites.

Ash (2004) provided a well-described experiment design. She provided dialogues of the conversation between the subjects with translations and actions associated with the conversation. She indicated where she obtained the subjects, and elaborated on the selection of these subjects. She also discussed her theoretical position and supported it with authors and other studies related to her theoretical point.

This study inferred the possibility of using native languages as a form of student-centered teaching approach. This study illuminated the potential use of cultural aspects in learning science. In this case, the use of native languages enforced science conversations in the family and helped students of color engage and learn science.

Contradictions Regarding the Idea of Multicultural Science Education

This section analyzes five studies that perceived multicultural science to be less effective or relevant on students' attitudes and learning in science. Sweeney (2001) investigated teachers' perspectives about multiculturalism in science education. Kesamang (2002) evaluated the influence of cultural beliefs and sociocultural backgrounds on students' achievement and their attitudes toward science. Carr and Klassen (1997) examined teachers' beliefs about incorporating antiracial education and awareness. Brok, Fisher, Richards, and Bull (2006) evaluated factors in learning environments that had a significant influence on students' learning and understanding of science. Dxama and Osborne (1999) examined the effects of traditional beliefs and attitudes of students in Malawi on their performance and attitude towards science.

A quantitative study conducted by Sweeney (2001) examined ways an involved preservice science teacher in community service influenced views of multicultural science education, with a focus on both theoretical views and views on practical application. Sweeney (2001) investigated undergraduate students and found that many elementary and secondary students had little knowledge of multicultural education in general science.

The study took place at the University of Central Florida (UCF), a four-year university with 2,500 undergraduates and 1,300 graduate students enrolled in the college of education. The study used five undergraduate-level science classes and three forms of data: analytic memoranda from classroom discussion, students' reflections focusing on their reaction, and documentation of conversations between authors and students. The teacher instigated a class discussion by introducing the analytic memoranda that focused on the relevance of the science-technology society (STC) in teaching and learning. Most discussions touched on issues related to HIV/AIDS, preteen/teen pregnancy and sex education, obesity, the theories of evolution and creationism. The research team sent the students' written responses to the authors to reflect the answer as to why they agree or disagree with their reading. Grading process was based on the rubric. These responses were evaluated by the authors, and returned with the authors' reflections and responses.

Most of the subjects refused the idea of politicizing the classroom. According to Sweeney (2001), typical comments made in the discussions were, "It's more watering down of the science content, isn't it?" (p. 19). Other comments reported were, "There's a danger of reverse racism if you take this too far," or "It's discrimination against the White mainstream" (p. 20).

In addition, Sweeney (2001) provided excerpts from a verbatim response. This study showed that most of the subjects believed that multicultural education had little relevance towards science curricula. Huge resistance from these subjects stated that they are very content with their ability to teach the subject. Others believed that incorporation of multicultural education leads to introducing political issues that do not belong in the class.

Although the study focused directly on postsecondary students, Sweeney (2001) did not elaborate on the characteristics of the subjects aside from the number of the participants. There was no information about the gender, class, or age that could have influenced perceptions toward incorporation of multicultural education. Sweeney (2001) did not include any information related to the subjects' age or the subjects' community experiences—both of which could have an important contribution to the study. However, Sweeney (2001) acknowledged that the findings represented white females from a middle class group. The study also acknowledged the absence of minority groups in the study. This explained the lack of descriptions regarding the subjects' characteristics.

This study introduced the theoretical framework of the science-technology society (STS), which Sweeney (2000) defined as "teaching and learning of science in the context of human experience, including the technological application of science" (p. 5). In addition, there could be principles that may have evolved over the years that may reference an important focus on the integration of multicultural education in science curricula.

This study was based on the subjects and candidates involved, and showed great partiality. As mentioned in the findings, Sweeney (2001) acknowledged the absence of individuals of color. In addition, these perspectives, responses and reflections are gender biased–there were no male subjects included in the study. The process of evaluation also reflected biases of the study outcome wherein their instructor evaluated responses and limited the interpretations to one perspective. This study omitted triangulation because there was no second interpretation from other sources.

This study touched on the issues of teachers' perspectives toward multicultural science. This analysis tends to imply that the use of indigenous or culturally structured science-oriented curriculum will have little effect on students. Furthermore, the study tends to suggest that structuring science curricula with indigenous and cultural practices or beliefs will bring political and social issues that will interfere with science learning. This study exposed suggested tendencies that this approach might stereotype students of various cultures.

In a correlative study, Kesamang (2002) examined the influence of the sociocultural background of Botswana's secondary junior high on worldviews, the relationship between the students' sociocultural background and attitudes toward science, and the differing attitudes of the mean science achievement score in the low and high sociocultural students.

The study involved 11 randomly selected Botswana secondary schools. They were selected within a 120 kilometer radius of one another. The stratified random sampling technique ensured that both the urban and nonurban schools were included. From across the 11 schools, Kesamang (2002) randomly selected 395 students for the study. The sample included 179 boys and 216 girls whose age average was 14.

Kesamang (2002) used three instruments to address the seven target questions in the study: the sociocultural scale, the attitudinal scale, and science achievement mean score. The team collected data early in the first month to avoid the impact of tuition fees on students. The first two questions dealt quantitatively, while questions three through seven were analyzed qualitatively. From a total item of 20, the students' mean score in science achievement test was 8.80 with standard deviation of 2.61. From four multiple-choice questionnaires and a science test of 20-items, the chance mean score in science achievement was 5.00, which were subjected to T-test.

Based on the data analysis, Kesamang (2002) concluded that the Setswana mythologies did had an effect on student's worldviews. He also concluded that even though their cultural orientation exerted some influence on their beliefs, these students showed a positive disposition toward science. He also noted the negative relationships that existed between Botswana's socio-cultural background among students and their attitudes regarding science and between sociocultural ethnic enclaves and their achievement in science. They also found that students with low sociocultural backgrounds scored a more positive disposition toward science than their counterparts. Furthermore, Kesamang (2002) noted students from low sociocultural backgrounds scored higher in science than those in high sociocultural ethnic enclaves.

Kesamang (2002) also illustrated a thorough process of selection where a stratified random sampling was used. He noted gender, ethnicity, age, and geographical location in the study. Since the study focused on a specific influence of cultural background and science knowledge, Kesamang (2002) narrowed down the subjects to one ethnic group. This study did not emphasize external validation, although he provided a description from internal validity instruments in used for the study.

In addressing the first target question of the study, Kesamang (2002) provided elaborate descriptions of the conditions and factors that account for the influence of cultural practices on students' perceptions of science. Kesamang

(2002) presented the average mean and the standard deviation of the sociocultural scales to illuminate the cultures' influence on their perception of the world. The conclusion regarding the relationship between sociocultural background and attitude toward science was -0.144, which supported the conclusion. However, statistics showed a positive relationship, though the value for the r coefficient was equals to 0.363.

This study addressed issues on students' socioeconomic backgrounds, their achievements, and attitudes toward science. This study implied that students' academic achievements and attitudes toward science did not necessarily correspond to students' ethnicity, and socioeconomic status. Without the element of a positive relationship, teaching from multicultural perspectives will not have any positive influence on students' performance. Similarly, teacher's orientation toward students' cultural backgrounds will have no effect on students' attitudes in learning science because their learning is independent from their own cultural awareness.

In a quantitative questionnaire, Carr and Klassen (1997) studied the views of minority and white teachers among 352 secondary school teachers. They examined how these views affect the implementation of a system needed in education that would be free of racial biases. They pointed out that diverse needs were required in racial and ethnic cultural groups to promote bias-free influences.

Only 70 of the 352 teachers responded, which is a 20% representation of the sample. The researchers also sent 119 questionnaires that specifically addressed teachers belonging to minority groups; 25 teachers participated, constituting about 21% of the sample. They also conducted in-depth interviews with 22 of the minority teachers. Each interview was conducted with open-ended questions tol draw each participant into provide elaborate responses.

In the first distribution of questionnaires, the research team mailed questionnaires to randomly selected secondary teachers from the rolls of permanent teachers who were employed in the school year 1994–1995. Of the teachers that responded, 86% were Caucasian and 14% were from minority groups. Carr and Klasson (1997) increased the number of minority teachers in the study by using targeted sampling from the list of minority teachers created by the board in 1990. Ultimately, 24% of the participants in the study were teachers from minority groups.

This article was inclined to go against the necessity of teaching science in a multicultural perspective approach and against multicultural context in preservice teaching education. This paper disagreed with the fact that antiracism and anti-monoculturalism do not belong to science classroom. Furthermore, this study implied that multicultural contexts were not relevant in schools and do not promote understanding of science—therefore it is unnecessary to emphasize diverse cultural teaching, according to the study.

Similarly, Brok et al. (2006) examined factors that influence students' perceptions of their learning environments and pointed out that gender had a stronger influence on students' perception toward science. This finding was based on responses from 655 students from 26 eighth grade science classes. These science classes were picked from 11 California schools in Monterey

County. Brok et al. based the selection on the time required for the fourth author of the study to travel. Each of the 18 middle schools received phone calls and letters from the principals and science teachers. Out of 18 middle schools, 11 decided to take part of the research study. Some of the science teachers received a mandate to participate and others volunteered to participate. Each participant was asked to select a course they prefer to teach.

The ethnic compositions were as follows: 20.7% of the students considered themselves Latino/a; 15.9% African-American; 0.9% Native American; 14.2% Asian-American; 35.0% Caucasian-American and 13.4% unclassified. In terms of representations in percentage, it’s important to note that of the total population in the samples, Latino/a makes up 43.2% of the population; 8.4% of the population for African-American, and other ethnic groups make up 0.6% of the overall population. Given the number of candidates, 48.7% were males and 11 out of 18 were female teachers.

The study provided statistical illustrations and evidence of the findings. The probability value of the study was less than .001. The population for people of color falls between 81 to 100%. Reduced price meals were provided to 46.3% of the students. The t-test generated a coefficient of .44 and the p-value of .667 for the free meal reflected the value for the state of California. The sample class size average was 25.8%. The state’s average class size for eighth grade was 26.9%, and the state class size average for science was 29.3%. These t-values for the sample and the state class average size did not coincide.

According to the research team, Asian-American students had more favorable perceptions of their learning environments compared to other ethnic groups. Although gender had a strong correlative relationship with science class perception, Asian-Americans showed a positive relationship with students' attitudes towards science.

Aside from providing socioeconomic backgrounds and breakdowns, the researchers also provided gender breakdowns for students and teachers who participated in the study. They presented the selection process of these subjects and the factors that they considered when deciding who gets to be included in the study. They included the origin of the geographical location of these samples. The study based the sample selection on convenient sampling and the study showed inconsistency in the number of samples representing the state.

This study tends to suggest that students' performance and perspectives on science are not entirely driven by or dependent entirely on ethnicity and students' gender. Furthermore, the study tends to imply that incorporation of indigenous knowledge and establishing culturally oriented curricula in science based on gender consideration is not relevant.

In a correlative study, Dzama and Osborne (1999) established the extent of traditional beliefs and their effects on students' performance in science. They also established how much the total variance in students' science scores indigenous beliefs account for. The study uncovered a negative correlation between students' traditional attitudes and with what was proven by the science test.

The research team selected 160 secondary students from four classes, including 120 boys and 40 girls from five different schools in Malawi. The study population distributions were as follows: four students aged seventeen and below; 12 students who were eighteen years old; 15 students who were nineteen years old; 32 students who were twenty years old; 26 students who were twenty-one years old; 35 students who were twenty-two years old; 19 students who were twenty-three years old; 12 students who were twenty-four years old; and five students who were twenty-five years old and above. The team administered three tests: the first was based on basic electricity; the second was a rational thinking task; and the third was a questionnaire about traditional beliefs. The team designed the questionnaires composed of twenty-six items that measured the level of commitment toward their beliefs and attitudes.

The study showed that the mean percentage for the electricity test was 35% with a standard deviation percentage of 18; 23% mean percentage for reasoning task with a standard deviation percentage of 20%. The mean average for traditional attitudes and beliefs was 31% with 11% standard deviation. The mean percentage for level of confidence in response was 65% with a standard deviation of 17%. Looking at the mean percentages, the reasoning task was lower while the electricity test scored the level of confidence in response to all the tests was higher (Dzama & Osborne, 1999, p. 399). The research team acknowledged that the high standard deviation and the low mean, which was noticeable in the reasoning task, was due to the large distribution of scores between 100% and zero.

The correlation between age and the reasoning task was -.29. The correlation between age and the electricity test was -.12. The correlation between the age and the confidence level was -.03. The correlation between the reasoning tasks and electricity test was .54. The correlation between age and the traditional attitudes was .23. The correlation of the electricity test and confidence level was .56, while the correlation between traditional attitudes and electricity was -.42. The correlation coefficient between students' confidence and traditional attitude was -.28.

Dzama and Osborne (1999) also pointed out that casual reasoning was not influenced by their traditional beliefs and attitudes. Furthermore, they stated that traditional beliefs were not a factor influencing the outcome of the electricity test. In their final statements, Dzama and Osborne (1999) concluded these Malawian students and students in other developing countries had low performances that were not due to their worldviews. Rather, low performances were due to the lack of support students received. They concluded that lesson plans should be in keeping with what was relevant to students lives which would benefit them and enhance their understanding of and performance in science.

The external validity of the study was based on the narrative Dzama and Osborne (1999) provided on students' science performance in Japan and England. Internal validity was tested repeatedly using the T-test. They also provided mean values for electricity tests, reasoning tasks, traditional attitudes and beliefs, and levels of confidence. They also noted the standard deviation and provided an explanation for the distribution. The ages of the subjects were noted in the study along with gender and socioeconomic breakdown. This study, however, did not emphasize the process of selection. There was no discussion or illustration on how and why these subjects were chosen.

This study tends to state that traditional beliefs had no influence on students' performance and critical thinking. The study stated, however, that lack of support had a strong influence toward their performance. The study tends to imply that constructing culturally-oriented science curricula by the integration of indigenous and cultural practices has little influence toward students' performance.

Summary

The first section discussed analyses that addressed one of the questions about the effects of incorporating indigenous knowledge in science curricula on students' performance and attitudes toward science. Herbert (2004), Klos (2006), Chiu, Chow, and Mebride-Chang (2007), Odom, Stoddard, and LaNasa (2007) discussed analyses of the effects of this approach on students' performance. Barton and Yang (2000), Feinstein (2004), and James (2006) discussed analyses of the effects of this approach on students' attitudes toward science.

The second section addressed the issue on the effects of accentuating multicultural science education in preservice programs on students and teachers. The first part of this section focused specifically on how emphasizing multiculturalism in preservice teacher training programs influences students' performance and attitudes toward science. Fisher and Waldrip (1999), Glasson et al. (2006), Luft (1997), and Tobin et al. (1999) conducted analyses to see the effect of incorporating an emphasizing multicultural science education in preservice. Haukoos et al. (1995), Chinn (2007), Luft et al. (2002), and Barton (2000) discuss teachers' perspective toward this approach and how this can influence the implementation of indigenous knowledge in the classroom and students' learning.

The third section analyzed four studies that focused on the effects of the cultural ethnicity and orientation of educators on students' performance and attitudes toward science. Tobin (2004) examined the effects of common cultural practices between students and teachers in students' performance and attitudes toward science. Tobin, Roth, and Zimmermann (2001) talked about the effects of common cultural orientation between students and teachers. Ramanathan (2006) examined Asian educators' contribution to students' academic achievement. The study also examined the support and resources the Asian educators received. Khine and Fisher (2004) evaluate students' attitudes and performance toward academic science facilitated by Western educators and Asian educators.

Section five reviewed studies on how indigenous knowledge incorporated into science curricula influenced students' performance and attitudes in science. Rodriguez et al. (2004) discussed programs and their effects on students' performance and attitudes. Cogan et al. (2001) and Ninnes (2000) discussed the integration of textbooks, and the effect of integrating textbooks on students' performance and attitudes toward science. Kearsey and Turner (1999) and Ash (2004) explored the sued of Native language as a form of student-centered strategies in understanding science.

The last section analyzed five studies that perceived multicultural science to have less effect or relevance on students' attitude and learning in science. Sweeney (2001) investigated teachers' perspectives about multiculturalism in science education. Kesamang (2002) evaluated the influence of cultural beliefs, and sociocultural backgrounds with the students' achievement and attitudes toward science. Carr and Klassen (1997) examined teachers' belief about incorporating antiracial education and awareness. Brok et al. (2006) evaluated factors in learning environments that had a significant influencing on students' learning, and understanding of science. Dzama and Osborne (1999) examined the effects of the traditional beliefs and attitudes of Malawian students on their performance and attitude.

Chapter four will revisit the common themes of the findings from literature analyzed in chapter three. Chapter four will discuss these themes and their implication in classroom practice. The chapter will look at the weaknesses and areas that need further research.

CHAPTER FOUR: CONCLUSION

Introduction

Chapter one discussed how Western perspectives dominated the science field. The chapter also discussed how classroom science emphasized a Western-based approach. Furthermore, the chapter introduced the idea of using approaches that expand the spectrum of looking at science concepts from different perspectives. In addition, chapter one also addressed the issues of a shortage of minority educators in science field, including the shortage's influence on the science classroom. Chapter two covered a brief description of Eurocentric perspectives. This chapter briefly discussed historical perspectives in science, including philosophical views from scientists in the early millenniums of human history, and in turn looked on how current times perceive science. A section that acknowledges the importance of other cultures' contributions to science, and the importance of multicultural perspectives in science followed this discussion. Chapter three reviewed and critically analyzed literatures that addressed the question of this paper. Herbert (2004), Klos (2006), Chiu, Chow and McBride (2007), and Odom et al. (2007) explored the influence of integrating and using indigenous knowledge in addressing science to students. This section discussed research analysis that critically reviewed how using indigenous knowledge in teaching science affects students' understanding and performance in science. On the other hand, Barton and Yang (2000), Feinstein (2004), and James (2006) investigated the effects of bridging indigenous knowledge and science curricula on students' attitudes toward science.

In the second section of chapter three, Fisher, and Waldrip (1999), Glasson et al. (2006), Luft (1997), and Tobin et al. (1999) examined the effects of emphasizing multicultural science education in teachers' training and the students' perspectives toward science. Haukoos et al. (1995), Chinn (2007), Luft, Roehrig, and Patterson (2003) addressed the effects of multicultural science curricula on educators' perspectives. Tobin (2004), Tobin et al. (2001), Ramanthan (2006), and Khine and Fisher (2004) explored studies that focused on educators' cultural and ethnic orientations and how these influencing perspectives impact the students' performance and attitudes in science. The following analysis discussed how indigenous knowledge in science curricula relates to students' performance and attitudes in science. Rodriguez et al. (2004) discussed outreach programs and its effects on students' performance and attitudes. Cogan et al. (2001), and Ninnes (2000) discussed the integration of textbooks and its effects on students' performance and attitudes in science. Kearsey and Turner (1999), and Ash (2004) explored the sued of Native language as a form of student-centered strategies in understanding science. Chapter three also the examined works of Sweeney (2001), Kesamang (2002), Carr and Klassen (1997), Brok et al. (2006), and Dzama and Osborn (1999) in emphasizing how little effect multicultural science has and questions its relevance on students' attitudes and learning science.

Chapter four will conclude this paper through revisiting the questions, results, and findings of the literature that was critically reviewed in chapter three; the implication of these results in actual classroom practice, and recommendations for further research. This chapter will revisit the questions addressed in this paper on (1) ways and means of faculty diversification; (2) teaching from a multicultural perspective; (3) questions on enhancing and emphasizing multicultural science on preservice programs and training-teacher candidates; (4) and how it affects students' (a) on their understanding and performance in science; (b) on their attitudes toward science; (c) and on the effects of an enhanced multicultural science curriculum on teacher-candidates' perspectives in science.

Summary of Findings

How teaching from a multicultural standpoint affects students' understanding and performance was one of the questions addressed in chapter three. In his response to this, Herbert (2004) showed an interesting result from his exploratory studies in his quantitative study. Herbert (2004) established that when students were confronted with certain scientific issues, they used both traditional knowledge and conventional scientific approach—complementing solutions on scientific issues with both viewpoints.

In addition to Herbert (2004), Klos (2006) examined the influence of integrating indigenous knowledge and science curricula on students' writing and reading skills from South Africa and found positive results in learning scientific concepts. This study showed that students whose ethnicity is native to South Africa benefit from using their own cultural knowledge in making sense of scientific concepts. However, this study did not provide a preassessment to verify level of skills.

Chiu et al. (2006), Odom et al. (2007), and James (2006) gathered findings that highlighted the relationships between cultural and indigenous-based science curricula and students' attitudes toward it. Chiu et al. investigated the influence of native culture on students' performance in science as brought about by the frequency of resources used in science curricula. Chiu et al, in a stratified sampling, examined 158,848 15-year-old students from 34 countries. Chiu made a quantitative study of how a country's cultural values, per capita income, racial partiality, and learning strategies (including memorization, elaborative perceptions, and metacognitive) affect students' achievements in science curricula.

Odom et al. (2007) explored the relationships between the actual practices and outside influence and how middle school students' performance in science is affected. Their findings showed that students' achievement was improved by a student-centered teaching method. Furthermore, they pointed out that students complement their learning with cultural-indigenous knowledge more than with memorization and technical strategies of learning science.

In a qualitative study on how Native American students' cultural identities and cultural values affect their views on scientific and technological products, James (2006), conducted a survey of tribal college and high school students from urban and reservation high schools. James found that students' cultural beliefs had a strong negative impact on how they view conventional science. James (2006) suggested based on these findings that a strong Native American identity shunned Native American students away from any cultural values that may open to different scientific views.

In an ethnographic case study, Barton and Yang (2000) investigated how the instructional methods of teaching science in schools and how the integration of cultural values and ethnic experiences in the school system influence students' chance and opportunity for success in and out of school. Although they felt that the study was not conclusive they did, however, acknowledge that the role of cultural superiority may have some contribution to the students' low self-esteem. This idea gives credit to the suggestion of cultural integration by redirecting the system toward a more culturally-oriented science curricula may result in ethnic success.

In a qualitative study, Feinstein (2004) determined how bridging indigenous and Western knowledge influences the science performance of students in college and found positive results in their learning. The study showed that creating an environment of indigenous and Western viewpoints will enhance students' understanding of science and influence a shift to include more students' perspectives. They also noted a positive view on students' experience of indigenous culture. Furthermore, the study showed how students developed a self-construct perception of the subjects.

Herbert (2004), Klos (2006), Chiu et al. (2007), and Odom et al. (2007), explored the influence of the integration of indigenous knowledge in teaching science to students. They discussed research analyses that critically reviewed how using indigenous knowledge in teaching science affects students' understanding and performance in science. On the other hand, Barton, and Yang (2000), and Feinstein (2004) and James (2006) investigated the effects of bridging indigenous knowledge and science curricula on students' attitudes toward science. In this section, Klos (2006), studies from Feinstein (2004), Chiu et al. (2007), and Odom et al. (2007) showed strong validities with the analyses. Their studies showed variations of the subjects' ethnicities, cultural orientations, and race. These variations allows for emphasis on the effects of incorporating indigenous concepts on students of various cultural backgrounds.

Although, Herbert (2004), Klos (2006), and Barton and Yang (2000) focused only on one ethnic group, most of these subjects came from different countries and do not represent a Western culture, which establishes an equally strong external validation.

Similarly, Chiu et al. provided external validity grounded on a cross-country experiment. In addition, with a cross-school sampling of the study, internal validity was established. The research team statistically controlled the variables to ensure reliability and guarantee reproducibility of the study. A sample test from Program International Student Assessment was provided via website.

On the other hand, Odom et al. acknowledged their unawareness of the validity and reliability of the instruments that would recommend specific classroom practice in their study. The significance coefficient for each correlation maintained the value of p below .01 or .05, which makes the probability of the correlative relationship somewhat questionable. Nevertheless, they provided socioeconomic distributions that established validation of the variation of the subject. From these analyses, positive attitudes toward science and performance are the main trends of the findings in the section. These tendencies suggest that the emphasis on cultural aspects in learning science will provide students a sense of belonging along with an ease of learning. Most studies that showed external validations and strong statistical layouts tend to show strong illustrations of positive attitudes and performance toward science.

Fisher and Waldrips (1999), Glasson et al. (2006), Luft (1997), and Tobin et al. (1999) explored the effects of enhancing or incorporating a multicultural approach to science. The second part of the section addressed teachers' perspectives toward this approach and how it can influence the implementation of indigenous knowledge in the classroom and students' learning.

Fisher and Waldrip (1999) examined the quality of Cultural Learning Environment Questionnaire (CLEQ) questionnaires that were used by 3,785 students from Australia in determining relationships between culturally sensitive learning environments with their attitudes in science and their inquiry skills development. They found a positive association in students' inquiry skills and competitiveness in a less-modeled structured lesson.

Glasson et al. (2006) explored the possible influence of a methods class on Malawian teacher educators' views and practices when teaching about place-based ecological sustainability issues in primary grades, specifically focusing on traditional ecological knowledge and the colonial legacy on deforestation. Glasson et al. found that Malawian educators had a good grasp of scientific concepts grounded in indigenous knowledge. Their knowledge of indigenous concepts enriched their understanding of Western conventional science. Glasson et al. demonstrated the used of indigenous knowledge in their approach to conventional science supplementing their students' current understanding of science. Such an approach can be beneficial to students because it afforded them a science-based perception on their prior knowledge and cultural familiarity and orientation.

In the case study, Luft (1997), studied ways to enhance teaching diverse science classes with her preservice science student teacher. She found three factors that would prepare preservice science student teachers in teaching classes that were culturally different from the teachers' cultures. This study addressed the issue of enhancing teachers' orientation to multicultural science. It is important to give attention to the quality of training teachers because teachers and students of color relations depend on it. Without establishing connections with students it is hard to evaluate, detect, and take notice of the students' needs; this is even more important if the teacher is culturally different from their students. This article illustrated the importance of orienting teachers to diverse fields of experience to help them understand their students and bring science to their understanding. Furthermore an established connection will allow further enhancement in developing student-centered teaching approach.

In a correlative study, Haukoos et al. (1995) investigated the integration, retention, and persistence of implementing inquiry-based and hands-on student centered strategies with Native American teachers and found that teachers' own experiences as a nonconstructivist learners have a powerful influence toward their teaching practice.

In a qualitative study, Chinn (2007) examined a shift of teachers' perspectives toward incorporating indigenous knowledge after undergoing professional development that touched on decolonizing methodologies and indigenous knowledge. In 19 secondary mathematics and science teachers from Asia and the United States there was a shift of perspectives among Asian educators from negative to positive perspectives toward indigenous science.

Based on these analyses, common trends tend to show that implementation and emphasis on multicultural preservice programs yield some positive attitudes among educators, which can have an influence on their classroom. However, there are still other factors that may influence their implementation, including availability of resources, budgetary constraints, and staff support as noted in Haukoos' et al. study. Nevertheless, teachers tend to be positive toward the integration of multicultural science in the curricula.

Tobin's (2004) study addressed the question of the effect of teachers' ethnicity on students' performance in this paper. In a case study, Tobin (2004) investigated how social and cultural factors mediate teaching and learning of science through an intense research experiment involving a longitudinal program of tenth grade students in Australian high schools. They found that students of color and females were often alienated from the enacted science curricula. This study showed that personal experience, and sharing social and cultural history influenced teachers' interactions with their students. Sharing similar experiences brought teachers closer to their student and made them more able to respond to the students' needs. This study showed evidence of credibility. It provided information on the process of selecting samples, instruments for data gathering, and decoding process. This study used triangulation to confirm interpreted and decoded data. However, this study did not indicate evidence of external validity. Furthermore, it did not indicate socioeconomic and gender distribution to provide classroom context transferability.

In an ethnographic study on how teachers and students in urban schools collaborated to identify potential sources of hegemony and to enact curricula that produced cultural forms that are laboratory and potentially transformable, Tobin, Roth, and Zimmermann (2001), investigated students from City High school. The school established the learning environment rather than giving the students that opportunity. They also acknowledged their doubts on their teaching education and curricular reform and whether these factors intensify, promote, or suggest hegemony and oppression to students. One of the factors they acknowledge was the approach compromises the learning environment because students no longer establish their own learning environment. The collaboration had dominated over the voice of the students in the class.

In a sample survey study of Ramanthan (2006) covering 96 Asian American educators, the study investigated and pointed out the positive impact they have on the curricula and on their students' academic experiences. They also found some problem areas related to minority teachers, such as the balance of support given. Ramanathan (2006) tended to address that ethnicity has a strong influence on students' appreciation and awareness of cultural differences rather than academic achievements. He acknowledged that the shortage of Asian educators might have contributed a minimal influence on students' academics. Nevertheless, the study showed that the cultural orientation and ethnicity of Asian educators played a minimal role on students' academic achievement. In addition, this article did not show a strong implicating relationship between teachers' ethnicity and students' science performance over both dominant and minority groups. One of the strengths of this paper was the process of the experiment, which was conducted conscientiously in order to reflect the character of the sample. They kept tract of the participants through phone calls and mail. This study demonstrated a well-described sample selection; they described the reason for the sample reduction. Furthermore, Ramanthan (2006) provided a good description of the items he evaluated in the survey. Data results from the survey were presented. However, there were no data analyses or a process of interpreting the results.

The strongest study reviewed in this paper was on the Khine and Fisher (2004) correlation study. The researchers focused on the relationship between students' perceptions on interpersonal behavior as measured by the Question on Teacher Interaction (QTI) and the enjoyment of science lessons. In addition, the subscales of the Test of Science-Related Attitude (TOSRA) measured the attitude toward scientific inquiry. Researchers found that students perceived Western educators to be friendlier, demonstrated better leadership and were more approachable than Asian teachers. Khine and Fisher (2004) established a clear illustration on how cultural orientation in teaching approaches and cultural practices in education correlates with students' interpersonal behavior. In addition, they clearly illustrated a parallel correlation between the inquiry-based approach and the students' positive inputs in science class. They concluded that the leadership, approachability, understanding, and helpfulness that Western educators displayed based on the QTI scale were linked with the students' positive response to a sound learning environment and their enjoyment toward the curricula. This article tends to imply that cultural ethnicity of educators do not necessarily have a positive influence towards student of similar ethnicities. This article tends to imply that the teaching practice itself has a stronger influence toward students' academic achievement over the similarity of ethnicity between students and educators.

The general trends of these analyses for this section tend to suggest that educators' race, ethnicity, and cultural orientation has little influence on students' performance and attitudes toward science. Although they found little support of direct influence on students' performance, their findings showed a strong trend on students' cultural appreciation and recognition of multicultural ethnicity. These analyses addressed the question of how diversification of faculty influences the students' understanding and performance in science classes. Ramanthan (2006) illustrated Asian educators' roles and influence on students' performance and attitudes toward science. The analysis showed that these educators have a strong influence on students' cultural awareness. Khine and Fisher (2004) pointed out that Asian student academic performance and attitudes toward science with a Western approach have a strong relationship compared to Asian teachers. It tends to say that racial diversification of faculty may have little influence on students' academic performance, though it may have a strong influence towards students' multicultural awareness. However, Tobin (2004) showed a positive relationship between a teachers' cultural orientation and students' performance.

Brok et al. (2006) emphasized that ethnicity had little influence on students' perception of their science classes. Furthermore, they noted that ethnicity cannot counter balance a high science achievement across different ethnic groups of female students. Similar to Kesamang (2002) and Carr and Klasser (1997), this article tends to say that students' learning being independent from cultural context creates irrelevance toward using multicultural perspective in teaching science.

Furthermore, the article tends to suggest that enhancing teacher-students' exposure to diverse settings has little influence on students' learning and attitudes toward science. Dzama and Osborn (1999) statistically illustrated the relationship between South African students' traditional knowledge and their performance in science. The study showed that traditional beliefs had little influence on their performance, which seemed to suggest that integrations of their indigenous knowledge would have little influence on students' performance.

Some of these articles showed gender influence or lack of support from the staff and school. In these analyses, Sweeney (2001) somewhat showed the least strength in presenting analyses and data. Sweeney (2001) provided little socioeconomic variation between the samples. White middle-class teachers presented most of the perceptions. Sweeney (2001) acknowledged that white females from a middle-class group represented the findings. The study also acknowledged the absence of minorities in the study; this explained the lack of descriptions regarding the subjects' characteristics. Brok et al. (2006) showed a stronger illustration of the findings; they provided statistical analyses and a complete set of validated data results. Dzama and Osborne (1999) showed statistical results of the findings. Correlational coefficients were stated and provided with reasons and possible sources of error. Furthermore, the study was conducted in South America, which minimized confounding effects on the study. Nevertheless, this analysis tends to suggest that relationships between students' racial and cultural practice with their science performance was weak even if the curriculum was embedded with cultural aspects. Some of these articles showed that gender influence or the lack of support from the staff and the school system was some of the influencing players that dominated the study.

Classroom Implications

Based on the themes from the study, it is clear that teachers should establish a classroom that will promote students' comfort and sense of belonging and connection. In order to insure this, they must recognize and reflect the roles of their own identity to their environment. Herbert (2004), Klos (2006), Barton, and Yang (2000), and Einstein (2004), Fisher, and Waldron (1999), Glasson (2006), Loft (1997), and Tobin, et al. (1999) addressed the question related to the effects of multicultural science on students' performance and attitudes towards science. From these analyses, a positive effect on their attitude in science and on their performance tends to be the main direction of the findings in this section. This trend seems to suggest that emphasis on cultural aspects benefits students in a way that they could learn to appreciate and acquire a sense of belonging as they are learning science in class. Furthermore, these studies tend to show that native indigenous knowledge could be used as a format of prior knowledge that could help students make sense of worldviews through western knowledge. Most studies that showed external validation with strong statistical layouts tend to show strong illustration of positive attitude and performance in science. This is an opportunity to enhance students' awareness of how science can be perceived in various points of views, and bring students of different racial and cultural orientation closer to one another.

Fisher, and Walrus (1999), Glasson et al. (2000), Luft (1997), and Tobin et al (1999), Haukoos et al (1995), Chin (2007), Luft et al (2002) explored the effects of enhancing or incorporating multicultural approach in science. In addition to the tendency to address students' performance in promoting specific training programs that focuses on incorporating science curriculum with cultural aspects, these studies also reflected the teachers' positive attitudes in multicultural sciences. These researches tend to imply that a good follow up of supports to a fellow educator in regards to their assimilated approach would influence the implementation of the curriculum resulting to acceptance and encouragement of student-centered strategies in the classroom. Teachers especially those conducting cooperating teaching positions must recognize the importance of providing support and encouragement on implementing a multicultural science as part of their role in supporting the preservice program and the teachers training. The focus is to help future teachers establish a frame of reference that will facilitate decision-making in their classroom. Examining ways to discuss and introduce topic-issues that will not instigate stereotyping and partiality; evaluating student's progress with due consideration and benefit of the doubt; these are attributes of a rich backbone of objective cultural orientation that transcends cultural barriers for the betterment of the educational system and students' education.

Tobin (2004), Tobin et al. (2001), Ramanthan (2006), and Khine and Fisher (2004) addressed the question on the effects of teachers' ethnicity on students' performance. The general trends on these analyses for this section tends to suggest that educator's race, ethnicity, and cultural orientation had little influence towards students' performance, and attitudes towards science. Although they found little support of direct influence on students' performance, their findings showed a strong trend towards students' cultural appreciation and recognition of multicultural ethnicity. This tends to imply that any educators of different race can have an impact on students' academic performance in science regardless of the ethnicity and race. This should not discourage teachers of different colors in educating students that is ethnically different from them, and it should not be perceived in such stereotype perspectives. Referring to Gordon (2000) from chapter one, he noted that cultural ethnicity is not the main key to a successful educator. He quoted one of the teachers that were interviewed stating, “You don’t have to be Black to teach Blacks. Every teacher has to be versatile: you do what is best for different groups of students” (Gordon, 2000, p. 71). Similarly, a Latino teacher Gordon (2000) pointed out that teacher’s ethnicity or race is independent from their ability to connect to students of color. She explained it is not valid to make the assumption that a minority teacher can handle minority students well (Gordon, 2000, p. 74).

Rodriguez et al (2004), Cogan et al. (2001), Ninnes (2000), Kearsey, and Turner (1999), and Ash (2004) addressed other forms of indigenous knowledge incorporated in science curricula and its relationship with students’ performance and attitude in science. These findings illuminated elements that reflected integration of indigenous aspects that would overcome ethnocentricity. The study examined how science curriculum reflects indigenous aspects through textbooks and other resources. These studies promoted student-centered approach in teaching and inclusion of students of color in the classroom. As an educator, it is important to recognize and use resources that would benefit students’ performance in the classrooms, this will give students the opportunity to reflect themselves in the classroom community and these will encouraged learning other cultural perspectives that would bring appreciation and respect towards their fellow students of different culture. This is an opportunity for students to learn the impacts and contributions of other cultural ethnic groups representative of their peers in the class by means of historical figures, scientist in the past and the relationship of the concepts brought by these scientists.

Although majority of these analyses promotes multicultural science, it is important that teachers should be careful not to emphasize cultural aspects that would lead to labeling or stereotyping. Ninnes (2000) acknowledged that the problematic effects in her study of incorporating indigenous knowledge do not necessarily counteract stereotyping, racism and prejudice. In fact, she pointed out that depiction of indigenous knowledge exposes the student that is culturally and ethnically different to be label based on what is depicted on the text. Second, Ninnes (2000) stated based on her evaluation of the textbooks that the author runs the risk of imposing definition for the sake of preserving the authenticity. Although some resources may provoke racism, or stereotyping and biases, teachers should take control of these in the classroom science to avoid distractions.

These findings should be perceived as a resource and supportive principles that will serve as guidance. It is an opportunity to acknowledge students from different cultural background utilizing these resources especially in today’s society and the increasing number of minority. Establishing a student-teacher relationship by getting to know students outside academic can be a form of acknowledgement of the students in the classroom. Teachers could direct their curriculum in a more constructive learning to help students create the sense of ownership of their education. It is important to equipped students’ not only with knowledge of science but awareness of cultural differences. Furthermore, it is vital that educators will develop science field by enriching diverse perspectives through encouraging students to pursue science. Exposing the role of culture in science can attain this approach. As an educator it should be a privilege to be able to give students the opportunity to explore the field of science in various ways. Furthermore, this is an opportunity to provide further enrichment of ideas to science.

Suggestions for Further Research

Feinstein (2004) was consistent with tracking student's personal reflection through the number of questions asked. He also indicated gender and socio-economic status. This study provided background information on the students' education. This study provided a good description of theoretical position. The study conducted two interviews, which ensured the quality of the data. Questions were not open-ended however, the students' provided journal and observation field notes. The questionnaires contained pretest and post-test concept. A shift of role allowed him to see the condition of the candidates. These samples were well selected and very diverse.

Fisher and Waldrip (1999) provided a well descriptive procedure of constructing the Cultural Environment Questionnaire, CLEQ, and the Questionnaire on Teacher Interaction, QTI. They also provided evidence that validated these questionnaires. Research team provided external validity by sending the questionnaires to multinational corporate working in forty countries. They also provided internal validity, consistency and reliability of the QTI test. They used selected questions for the Test of Science- related Attitudes, which generated an alpha reliability of .79. Aside from providing validation of the instrument they also indicated the alpha coefficient for this study, which ranged between .67 and .88 for the QTI. For the students' attitude towards science, the reliability of this measure was 0.69.

As for Glasson et al. (2006), one of the strengths of this study consisted of a strong description of the methods class. Glasson et al used a clear ethnographic approach to the research by using multiple methods of data collection. The connection of indigenous knowledge and themes of the teachers was clear and well substantiated. At the same time, the authors fail to provide a clear picture of the demographics of the participants. No information was provided regarding the years of teaching. Glasson et al. acknowledge factors that need further investigation, which may have problematic effect on the study. One of these factors was lack of trained teachers, and resources.

Luft (1997) on the other hand used thorough descriptive illustration of the data gathering and decoding that showed credibility. The subject made documentation of their own observation and Luft (1997) made her own. This study did not indicate the process of how they evaluated the authenticity and quality of that data analysis. The study conducted by Luft (1997) used uniformed socio economic parameters in illustrating the teachers' cultural awareness. How will the student-teacher persona be affected if the student body was more diverse rather than limited to one cultural ethnicity?

Although they provided a statistical illustration of the study, there is a question on Haukoos et al. (1995) credibility of the study. The study specified the use of pre-assessment value, however, did not emphasize the content. When using current perception of teaching on students-centered approach and inquiry; did they question the teachers' background experience? If so, how can these factors affect the fluctuations of the number of teachers using the approach in their experience? They did not consider the teaching experience of the educators in their pre- assessments in order to evaluate the influence on their preference over the inquiry based. They did not question the gender distribution of the experiment and how this distribution impacts the outcome. In addition, Haukoos et al pointed that there was no distinction made between the Native and Non-native teachers in the sample. They did not include age and gender distribution of these subjects. Furthermore, they did not indicate the process selection for their sample.

Rodriguez et al. (2004), Cogan et al. (2001), Ninnes (2000), Kearsey, and Turner (1999), and Ash (2004) addressed other forms of indigenous knowledge incorporated in science curricula and its relation with students' performance and attitudes in science. Rodriguez et al. discussed programs and its effects on students' performance and attitudes. Cogan et al, and Ninnes (2000), discussed the integration of textbooks, and its effect on students' performance and attitudes towards science. Kearsey and Turner (1999), and Ash (2004) explored the sued of Native language as a form of student-centered strategies in understanding science. These analyses showed positive relationship between students' attitude and appreciation of science.

In addition, the study showed evidence of its dependability and transferability. Chiu et al. (2007) provided a description and theoretical views from other authors, which established the basis of the study. She provided an excellent descriptive methodology and cited other authors that confirmed her theoretical position related to the study. Furthermore, she illustrated the use of indigenous knowledge from different authors and their perspectives.

Although majority of these analyses promoted multicultural science, it is important that teachers do not emphasize cultural aspects that will lead to labeling or stereotyping. Ninnes (2000) acknowledged that the problematic aspects in her study of incorporating indigenous knowledge did not necessarily counteract stereotyping, racism and prejudice. In fact, she pointed out that textbook depiction of indigenous knowledge runs the risk of exposing students to indigenous culture labeling. There is still a question of the authenticity of delivering and using these resources to promote cultural awareness in science. Second, Ninnes (2000) stated based on her evaluation of the textbooks in her study that author runs the risk of imposing definitions for the sake of preserving authenticity. This post a questions on how to balance between reliance with the text and preserving the learning experience

Conclusion

Chapter one presented the rationale for studying the questions of how using Traditional Ecological Knowledge and western modern science approach in teaching science can affect minority student performance and enrollment numbers in science. This chapter introduced two conflicting sides regarding the effects of diversifying faculty in high school towards student’s performance in the class. In this chapter, Gordon (2000) proposed caution on making assumption of bridging between race and the ability to relate to minority students. This chapter introduced and discussed the terms universalism, Western modern science, indigenous and Traditional Ecological Knowledge. This chapter also discusses implications and relevance of multicultural perspectives in the approach of natural science.

Chapter two explored the historical trends of how science was interpreted and viewed over the centuries from different cultures, and how the term science has evolved through different era. It briefly discussed the historical development of the philosophy of science, and how it was derived through philosophers in the early century. Chapter two also discussed how current decade perceived science. It showed how the euro-centric approach dominated the science community over the century. Finally, this chapter discussed the importance and role of other culture and its contribution to science.

Chapter three critically reviewed the research literature concerning the teaching of science from different cultural perspectives and its influence on students' learning and attitudes in science class. Chapter three also explored the effects of having a more diverse staff on students' learning and attitudes in science. Finally, chapter three critically reviewed the literature concerning the influence and effects of improving teacher education in student's learning and teachers' perspectives in science.

Chapter four concludes this paper through revisiting the questions, the results and findings of the literatures that was critically reviewed in chapter three and the implication of these results to classroom practices and suggestions for further research. This chapter revisited the questions addressed in this paper on

(1) establishing a diverse faculty, (2) teaching from a multicultural perspective, and (3) how enhancing, and emphasizing multicultural science in preservice program and training teacher candidates affects students" (1) understanding and performance in science, and (2) attitude towards science, and the effects of enhancing multicultural perspectives on teacher candidates in science.

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