# Chapter 5
# Opening STEM Careers to American Indians

**Abstract** This chapter provides an account of science and technology education for American Indians. It begins with a section on the history of higher education for American Indians and is followed by a section on American Indian higher education today. Both of these sections include material about the tribal colleges and universities. The chapter closes with sections on science and technology education for American Indians, and on computing at the tribal colleges.

This chapter provides an account of American Indians, the third of the three underrepresented minorities in STEM covered in this book. The number of American Indians is smaller than the number of Hispanics or African Americans, and the challenges they face are greater than those of the other two minority groups. This chapter begins with a section on the history of higher education for American Indians and is followed by a section on American Indian higher education today. Both of these sections include material about the tribal colleges and universities. We close with sections that discuss STEM education for American Indians and computing at the tribal colleges.

The tribal colleges play a central role in this story. They are typically much younger than the Historically Black Colleges and Universities or the Hispanic-Serving Institutions.[1] The first tribal colleges were formed in the late 1960s as an outgrowth of the civil rights and American Indian self-determination movements. Today there are 37 tribal colleges, spread across 14 states.[2] They are members of the American Indian Higher Education Consortium (AIHEC), described in Chap. 7. An important goal of the tribal colleges has been to provide higher education without the need to assimilate into White culture. While enrollments at the tribal colleges more than doubled between 1990 and 2005, still less than one-fifth of all American Indians enrolled in college attend tribal colleges. Most of the students enrolled in

[1] For a general history of American Indian education, see AIHEC (1999), Deloria (1991), Freeman and Fox (2005), Goulding (1995), Huff (1997), and Nee-Brenham and Stein (2003).

[2] The tribal colleges often play more than a higher educational role on the reservations. For example, the libraries and computer labs are often open to all members of the reservation, and the tribal colleges serve as a locus for community activities such as business incubators and events to promote good health to the entire population.



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tribal colleges are from the first generation in their family to attend college. The average age of these students is 31, significantly older than at most U.S. colleges. Many of these students work and attend school part-time, and a significant number are single parents. About two-thirds of these students are female. Some of the tribal colleges offer only certificates and 2-year degrees, but an increasing number of them offer bachelor's degrees and a few offer masters and doctoral degrees. (NAE 2006; Varma 2009a, b)

The tribal colleges face a number of challenges. The reservations on which they are typically located have high levels of unemployment and low average income, and the tribal colleges are underfunded. Congress first passed the Tribally Controlled College or University Assistance Act in 1981, appropriating $2831 per Indian student for the operation of the tribal colleges.[3] But the actual federal appropriation must be negotiated each year, making it difficult for tribal college administrators to engage in long-term planning. Some programs on the tribal college campuses are also funded out of other federal agencies. Despite significant improvements over the past quarter-century, preparation for college among American Indians is well below the national average in terms of K-12 reading and mathematics proficiency; and American Indian students take fewer advanced science and mathematics courses in high school than Whites, Asians, African Americans, or Hispanics. When American Indian students reach college, they have the lowest recruitment and retention rates of all minorities. However, the tribal colleges are somewhat more successful than other colleges at retaining and graduating American Indian students, especially when the students enter college directly out of high school. It has also been difficult to recruit faculty to teach at the tribal colleges. There are limited numbers of American Indians themselves prepared to teach at the college level, and it is difficult to attract others to teach there. Salaries are low. Teaching and counseling loads are heavy (often five courses per semester). The schools are mostly located in remote places, making it difficult for the faculty to gain additional training to advance their academic credentials beyond the bachelor or masters degree that these faculty members typically hold. (NAE 2006; Varma 2009a, b; Boyer 2014)

[3] In 1994, Congress passed a law making the tribal colleges and universities land-grant colleges, similar to the Morrill Acts of 1859 and 1890, which created the land-grant colleges in many states. Under the 1994 act, some of the tribal colleges (e.g. Salish Kootenai and Turtle Mountain) received funding for their initiatives in e-learning through the Tribal Colleges Equity Education Grants Program administered by the US Department of Agriculture. In 1996, President Clinton signed an executive order for federal agencies to do more to support the tribal colleges and universities.

## 5.1 Higher Education for American Indians – A Brief History

For context, we will briefly discuss the history of higher education for Americans Indians since the first settlements of Europeans in the United States.[4] The story of European-style higher education for American Indians begins soon after the first permanent European settlement is made in Virginia. In 1611 a settlement was opened in Henrico, on the James River near the present-day city of Richmond. A Royal land grant was given in 1618 to form the first European-style higher-education institution in America, and by 1622 a school for American Indians had opened on the site. However, much of the Henrico settlement was destroyed in a battle between the settlers and the American Indians that same year, and the following year the British government closed the college and re-appropriated the land and remaining assets.[5]

Between the 1620s and the American Revolutionary War in the 1770s, a few major colleges opened on the eastern seaboard, and several of them included the education of indigenous people as part of their charters. Harvard College was founded in 1636 and opened an "Indian college" on its campus in 1654. Of the 20 American Indians enrolled in the Latin grammar school that was the feeder program into Harvard, only two graduated with a bachelor's degree.[6] In 1693 the College of William and Mary opened, with one of its founding goals being to Christianize American Indians. In 1769 Dartmouth College was founded, and funds were raised in both Britain and New England for the education of American Indian students. By the time of the Revolutionary War, however, only 47 American Indians had matriculated in these colleges and only four had graduated. There was a high price to be paid by those few American Indian students who attended these colleges, for

[4] There is a sizable body of literature on the history of American Indians and higher education. For general purposes, this section pulled material from Monette (1995), Pavel et al. (1998), Machamer (2000), Martin (2005), and McClellan, Fox, and Lowe (2005). On the history of tribal colleges and the politics of establishing them, see Olivas (1981), Stein (1988), Pease-Windy Boy (1994), Young (1998), and Pease-Pretty on Top (2003). Some examples from the large literature on the history of K-12 education for American Indians, see Adams (1971), Szasz (1977), and Belgarde (2004). Also see Fischbacher (1967), Adams (1971), Boyer (1989), DeJong (1993), Carney (1999), Hale (2002), Reyhner and Eder (2004), and Klug (2012).

Native American Studies programs were established at Cornell, Dartmouth, Michigan, Stanford, and other universities. These programs sometimes had significant value in enabling American Indian students to persist in principally White institutions. On the history of Native American studies programs, see Cook-Lynn (1997), Nelson (1997), Champagne and Strauss (2002), Krupat (2002), and Kidwell (2005).

[5] The College of William and Mary argues that it is, in fact, the college that was supposed to be built at Henrico.

[6] The low graduation rate was apparently caused in part by death to European diseases, loneliness, and cultural issues. To add further indignity, one of the two graduates died in a shipwreck on the return to campus for the graduation ceremony.

afterwards they had trouble being welcomed into either European or American Indian society.

The 1790 Trade and Intercourse Act brought all business transactions with American Indians under federal rather than state or private control. Between 1794 and 1871, the federal government signed treaties with various American Indian nations for support of American Indian precollege education, often in exchange for land. Perhaps the most significant development in American Indian education prior to the Civil War was the establishment in 1825, with federal and missionary funds, of the Choctaw Academy in Kentucky. It provided the most advanced education offered to American Indians at the time, including both liberal arts and vocational training, with a heavy dose of Christianity. While the majority of students were Choctaw, students attended from eight Indian nations. In an 1830 treaty, the federal government agreed to pay for school buildings and provide scholarships for up to 20 Choctaw youth to attend college. However, forced removal of Choctaw Indians began the following year as part of the plan to relocate all indigenous people to places west of the Mississippi. In 1842, when enough Choctaws had been relocated to Oklahoma, the Choctaw nation severed its ties with the Choctaw Academy and established six boarding schools in Oklahoma.

In 1860 the federal government established the first boarding school for American Indians, on the Yakima Reservation in Washington. In 1879 the federal government opened the Carlisle Indian School in Pennsylvania, the first federal boarding school for American Indians not located on a reservation. The school taught mostly industrial and agricultural arts. By the 1880s, there were more than 80 American Indian boarding schools. As a means of assimilation and control, federal law passed in 1893 allowed the government to withhold food supplies from American Indian families who would not send their children to boarding schools or day schools on the reservation; and many families, facing hunger, reluctantly complied.

In the late nineteenth century, three educational institutions were formed that eventually brought higher education to American Indians. In 1878 the Sitka Industrial and Training School opened in Alaska for Alaskan Natives. It received early funding through the efforts of a Presbyterian Minister, Sheldon Jackson, and was renamed in his honor in 1910. In 1880 Almon Bacone, a Baptist missionary teacher, opened an American Indian School in Oklahoma, and in 1885 it moved to Muskogee, Oklahoma, where the Creek tribe had donated land for the school. In 1910 it was renamed Bacone College, and it is still one of the few private colleges focused on American Indian education. In 1887 the North Carolina state government funded the Croaton Normal School for students from the Cherokee Nation. It began granting 4-year degrees in 1939 and is now part of the state university system and known as the University of North Carolina at Pembroke.[7] Hampton Institute in Virginia, a Historically Black college founded by the American Missionary

[7] The school went through a number of name changes: Indian Normal School of Robeson County (1911), Cherokee Indian Normal School of Robeson County (1911), Pembroke State College for Indians (1941), Pembroke State College (1949, which began admitting White students in 1953), and Pembroke State University (1969); and then it was made a part of the University of North

Association in 1868 to teach freed slaves, admitted American Indians from 1878 to 1923. Throughout the nineteenth century, however, all of these schools were primarily for secondary and vocational education rather than higher education.

The Rockefeller Foundation funded a study entitled *The Problem of Indian Administration*, better known as the Meriam Report after its principal author. The report, prepared by an organization that later became the Brookings Institution, was delivered to Congress in 1928. It was the first Congressional study of American Indian affairs since the Schoolcraft study in the 1850s.[8] Among many other indictments of the Interior Department for its management of American Indian affairs, the report criticized the boarding schools and missionary schools catering to American Indians for their poor education, harsh living conditions, and coerced enrollments. The Meriam Report was influential during the Hoover and Roosevelt Administrations. The federal government passed the Indian Reorganization Act in 1934, which provided tribes with many rights of self-government.[9] The bill included provision for loans for American Indians to attend college. Two years later, Congress passed the Johnson-O'Malley Act, which authorized federal contracts to states to provide higher education to American Indians.

The Second World War had a significant impact on education for American Indians. 25,000 American Indian GIs returned to their reservations after the war, either from the war fronts or from urban areas where they had relocated during the war to work in war-related factories. This experience gave the veterans a wider view of the world, expectations that the federal government would support them (rather than control them as the Bureau of Indian Affairs typically tried to do), and a regard for education as a principal way to achieve a better life for themselves and their families. Some American Indians took advantage of the GI Bill of Rights (Veterans Readjustment Act, 1948) to attend college or vocational school. The Bureau of Indian Affairs started a scholarship program that same year. By the late 1950s, more than 20 tribes offered college scholarships to their members. Even so, there were only about 2000 American Indians in college in the late 1950s and only about 3500 in college in the late 1960s.[10]

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Carolina university system in 1972. It may be the only Historically Indian college that is now minority American Indian.

[8] It was not, however, the last federal report on American Indian education. Another report with similarly critical things to say as the Merriam Report was the Kennedy Report of 1969, *Indian Education: A National Tragedy – A National Challenge* (U.S. Senate Committee on Labor and Public Welfare 1969). For a discussion of the Merriam and Kennedy reports, see DeJong (1993).

[9] College scholarships for American-Indian students became available in 1948 through a Bureau of Indian Affairs scholarship program. The Bureau of Indian Affairs had taken over federal responsibility for higher education of American Indians in 1921 with the passage of the Snyder Act.

[10] One might have thought that the civil rights movement of the 1960s would be highly supportive of American Indian needs, including educational needs. However, civil rights legislation was driven principally by the demands of the African American community; and the legislative goal of integration of Whites and Blacks ran counter to the desire of the American Indians to create segregated educational institutions. For a comparison of American Indian and African American education, see Carney (1999, Chapter 5).

In the 1950s and early 1960s there were a few new venues offering higher education to American Indians. Arizona State University opened the Arizona State Indian Education Center in 1954, providing both undergraduate and graduate instruction. The Santa Fe Boarding School renamed itself the Institute of American Indian Arts in 1962 and began offering college-level instruction in the arts. But other than the handful of schools mentioned so far, most American Indians had to attend majority institutions if they wanted a higher education.

The tribal college movement began with the Navajo nation, which owned the largest amount of land and had the largest population of any tribe. There had been talk of self-control over both pre-college and college education on the Navajo reservation since the early 1950s. The first major action was taken in 1963, when Navajo leaders applied for grant funds to take over the Bureau of Indian Affairs school in Lukachuki, Arizona. This attempt failed, but it led to the creation by the Navajos of the Rough Rock Demonstration School in Rough Rock, Arizona for precollege education of their children. The same individuals who were involved in founding the Rough Rock School led the effort in 1968 to create Navajo Community College (today Dine College) in Tsaile, Arizona. The federal government provided support for both capital and operating expenses through the Navajo Community College Act of 1971.

The creation of Navajo Community College showed the way for the creation of a number of other colleges under tribal control. In 1970 the Haskell Institute, which had been founded in 1884 as an off-reservation boarding school in Lawrence, Kansas, changed its name to Haskell Indian Junior College (now Haskell Indian Nations University) and began offering postsecondary education. Other early colleges were Turtle Mountain Community College (North Dakota), Fort Berthold Community College (North Dakota), Standing Rock College (now Sitting Bull College, North Dakota), Oglala Lakota College (South Dakota), and Sinte Gleska College (now University, South Dakota). The numbers steadily grew, and today there are 37 tribal colleges and universities. There are more than 10 times as many tribes as colleges, however, so there is opportunity for growth in the number of tribal colleges in the coming years.

Many of these schools received federal support under Title III of the Higher Education Act of 1965. One funding requirement was that these institutions be accredited. None of the early tribal colleges were accredited, so the tribal colleges formed working partnerships with accredited majority institutions, which typically were the grant holders.[11] However, since the passage of the Tribally Controlled

[11] Efforts to achieve regional accreditation at the tribal colleges began in earnest in the 1970s, with efforts to accredit Navajo Community College, Oglala Sioux Community College, Sinte Gleska College, Turtle Mountain Community College, D-Q University, and Standing Rock Community College. In 1976, Navajo Community College was the first tribal college to receive accreditation to offer associate degrees. In 1983 Oglala Lakota College and Sinte Gleska College were the first two tribal colleges accredited to offer bachelor degrees. In 1989 Sinte Gleska was the first tribal college accredited to offer masters degrees. Today, most of the tribal colleges are accredited as institutions to offer 2-year degrees and many are also accredited for 4-year degrees. These early relationships between the tribal colleges and mainstream colleges and universities have developed over time to

College Assistance Act in 1978, most of the tribal colleges have received their funding directly from the federal government.[12]

In the 1990s there was ongoing federal concern about both precollege and college education for American Indians. In 1991 the U.S. Department of Education released a report entitled *Indian Nations at Risk: An Educational Strategy for Action* (U.S. Department of Education 1991), which identified many problems with precollege education on the reservations and presented various solutions. A White House Conference on Indian Education resulted in 114 recommendations. At the college level, in 1994 Congress granted land grant status (created under the Morrill Act of 1862) to the tribal colleges, which provided them with substantial ongoing funding. In 1996 President Clinton signed an Executive Order calling upon all the federal agencies to provide better access for American Indians and the tribal colleges to the various educational programs operated by federal agencies.

## 5.2 Higher Education for American Indians Today

American Indians[13] face many challenges in their higher education.[14] They are approximately twice as likely to live below the poverty line as other Americans. Many American Indians, especially the one third who live on reservations, grow up

include many other types of programs such as articulated agreements for transfer from the tribal college to complete a baccalaureate, distance learning programs, and access for tribal college students to certain kinds of science and technology facilities and faculty that are typically stronger at the mainstream college or university.

[12] There was a slew of federal legislation concerning American Indian education in the 1970s. In 1972 Congress passed the Indian Education Act, which recognized Indian culture and provided grants to support its incorporation into the curriculum; this Act also provided support for Indian teacher training and Indian adult education. In 1975 Congress passed the Indian Self-Determination and Education Assistance Act, which (in order to enhance self-governance over educational matters) authorized the federal government to contract with tribes and Indian organizations for the tribal operation of programs. The most important of these laws was the Tribally Controlled Community College Act (1978), which provided legal recognition to and funding for the operation and improvement of the tribal colleges.

Three schools received funding directly from the Bureau of Indian Affairs through the Snyder Act of 1923: Haskell Indian Junior College, the American Indian Art Institute, and Southwest Indian Polytechnic Institute.

Generally speaking, the state governments did not provide support for the tribal colleges.

[13] There are sizable social science and policy literatures on American Indians and higher education. Fuchs and Havinghurst (1972), and Larimore and McClellan (2005) provide general overview material. Pavel et al. (1998); Institute for Higher Education Policy (2000, 2007); DeVoe and Darling-Churchill (2008), and AIHEC (2009) provide general statistical information on the topic. More specialized studies include ones on persistence [Jackson et al. (2003); Mosholder and Goslin (2013–2014)], cultural issues [Kirkness and Barnhardt (1991), Frey and Pewewardy (2004), Lundberg (2007), and Tippeconnic and Tippeconic Fox (2012)], and policy [NAS (2011)].

[14] This paragraph, like those of so many other researchers, dwells on the challenges for American Indian students. It should not be forgotten that there are many excellent American Indian students.

in isolated areas where educational and employment opportunities are limited. While educational attainment of American Indians has increased markedly over the past 40 years, Indians trail behind the White population and most other minority groups in educational attainment. More than a fifth of American Indians do not graduate from high school and less than half pursue a college education. As of 2002, only 13 % had attained a college or higher educational degree. Of the small number of American Indians who pursue advanced degrees, few study in STEM disciplines. As of 2007, approximately half of the master's degrees earned by American Indians were in the fields of education or business, and approximately half of the doctoral degrees were in education, history, or the social sciences.[15]

American Indian students have a different demographic profile from American college students overall. They are more likely to be older (more than a third are over age 30), they are more likely to be financially independent, and approximately two-thirds of them are women.[16] About half of them attend 2-year colleges, and they are most likely to attend a public community college or public 4-year college, followed by a tribal college. Less than 10 % attend private colleges. Child services, public transportation, and scheduling flexibility are particularly important to the large number of American Indian students who work and have a family while they attend college. More than 70 % of American Indian students receive financial aid, most commonly federal grants; this group is particularly vulnerable to reductions or delays in financial aid or increases in tuition.

Where do American Indians attend college? In addition to the 37 tribal colleges and universities, there are three religiously affiliated schools (Bacone College, Nazarene Indian Bible College, and American Indian College) and three colleges under federal control (Haskell Indian Nations University, Southwestern Indian Polytechnic Institute, and the Institute for American Indian Art). However, the majority of Indian students attend one of 85 colleges and universities with only small Indian student populations. Only a handful of these colleges have more than 500 Indian students enrolled.[17]

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The National Native American Honor Society, created in 1981 by Frank Dukepoo, challenges American Indian students to achieve academic excellence and gives recognition to those – from fourth grade through graduate school – who do. (Dukepoo 2001)

[15] For more detailed statistical information, see DeVoe and Darling-Churchill (2008).

[16] For information on male American Indian college students, see Stuart (2012).

[17] While there is a vast literature on students who attend tribal colleges, the social science literature on American Indian students attending predominantly White institutions is thin. One example (Makomenaw 2012) discusses the experiences of American Indian students who transfer from tribal colleges to complete their undergraduate degree at predominantly White institutions. These students, Makomenaw found, sought out meaningful interactions with other American Indian students, faculty, and staff but were indifferent to their interactions with other populations on campus. Academic advising and financial aid were the university services most often mentioned as important to these transfer students, but their experiences with these services were less than uniformly positive. The students experienced ignorance or stereotypes both in the classroom and elsewhere on campus, and this contributed to a feeling of alienation. Also see the personal stories of American Indian students at predominantly White institutions as told in Huffman (2008).

Jackson et al. (2003) have identified factors and characteristics important to the persistence of American Indian students in higher education. While their study is only a small qualitative study (n = 15) of students who grew up on reservations, their findings are consistent with the wider social science literature. The authors identify nine factors that have an impact on American Indian academic persistence in college. Support from a parent, grandparent, or other relative is "almost an imperative to be academically successful." Participation in structured social activities, such as multicultural offices or clubs for American Indians, is regarded as beneficial, even though several of the students hesitated before joining them. Students are motivated by warm interactions with staff and faculty members because these interactions provide a support network and make the students feel more a part of the community. Exposure to college-level programs, e.g. Upward Bound, or college-educated professionals prior to entering college makes the students feel more comfortable about the college and career path they are planning. Every student these researchers interviewed had experienced some form of racism, and this was universally acknowledged to be a demotivating force. Every one of the students in this study also tracked a nonlinear path through their education, in every case involving at least three colleges and often accompanied by gaps of a year or two when they were out of school. Several of the students reported tension between the student's aim to be a good student and the aim to be a good member of his family or community – even when the family and community were supportive of his education.

An older study focused on a cultural understanding of persistence (Kirkness and Barnhardt 1991) points out that blame is generally placed on American Indian students for "high attrition, poor retention, weak persistence, etc." However, these issues, the authors argue, can be viewed from an alternative perspective:

> From the perspective of the Indian student, however, the problem is often cast in more human terms, with an emphasis on the need for a higher educational system that respects them for who they are, that is relevant to their view of the world, that offers reciprocity in their relationships with others, and that helps them exercise responsibility over their own lives.

Cultural explanations abound for the reasons that American Indian student persistence in tribal colleges is higher than in majority colleges, such as a more culturally relevant curriculum, less isolation, more personalized attention, and no pressure to assimilate into a mainstream culture.[18]

[18] Here are some other examples of cultural issues related to the higher education of American Indians: in a national study (n = 643) of American Indian students (Lundberg 2007), the students reported higher levels of learning when the school had a strong commitment to diversity; through a qualitative study of the Commanche tribe, Tippeconnic and Tippeconnic Fox (2012) analyzed how tribal values shape teaching, learning, research, and educational governance; Pewewardy and Frey (2004) have shown the problems (what they call "ethnic fraud") that arise when colleges allow students to self-declare as American Indians according to their own definitions; and Boyer (2008) discusses the cultural issues that arise when an intertribal college attempts to support various individual tribal cultures. Guardia and Evans (2008) lists core values of American Indians: sharing, cooperation, noninterference with others, present-time orientation, being versus doing, extended family orientation, respect, harmony and balance between humans and their environ-

Students who attend tribal colleges and universities generally have a strong positive sense of their institution.[19] They praise the faculty, staff, and curriculum.[20] They value the small class size, the affordability, and the availability of such services as daycare and transportation. They are less satisfied with the quality of the laboratory and library facilities on campus.[21] They believe that college will lift them from a life as a minimum wage earner or welfare recipient.[22] Compared to American Indian students attending a principally White institution, the students at tribal colleges and universities score higher on tribally linked variables. There is some evidence that attending a tribal college (compared to another type of college) slightly increases associate's degree attainment levels but moderately decreases bachelor's degree attainment, especially for males.

A number of the students who attend tribal colleges are not prepared for college as measured by traditional metrics such as standardized test scores and high school grade point averages. Several social science studies have examined programs intended to help prepare students with weak high school academic records and poorly defined academic and vocational goals to succeed academically at tribal college and transfer successfully into a 4-year degree program at a majority institution. One model program that has been adopted at six tribal colleges is called Breaking Through, designed by two advocacy groups: Jobs for the Future and the National

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ment, spiritual causes for illness and problems, decision-making by consensus, and importance of the tribe.

[19] For general overview material on tribal colleges and universities, see Oppelt (1990), Boyer (1997a, b), Machamer (2000), AIHEC, the Insitute for Education Policy, and Sally Mae (2000); Benham and Stein (2003), Campbell (2003), Institute for Higher Education Policy (2006), Reyhner (2006), and Abelman (2011). For general statistical information, see AIHEC (2008). For an extended case study of one (government-controlled) school for American Indians (Southwestern Indian Polytechnic Institute), see Khachadoorian (2010); for a case study of a church-related Indian school (Bacone College), see Neuman (2013). Various studies address specific topics related to tribal colleges and universities: accreditation (Putnam 2000); student persistence (Kicking Woman 2011) and attainment (Reese 2011; Wright and Weasel Head 1990), American Indian male students (Stuart 2012), transition from secondary to postsecondary education (Brown 2003; Gonzalez 2012), Intertribal colleges (Boyer 2008), tribal colleges and universities and their relations to private foundations (Boyer 2000), local economic development (American Indian Higher Education Consortium and The Institute for Higher Education Policy 2000), and policy (Olivas 1981).

[20] For example, in one study (Institute for Higher Education Policy 2006) 86 % of students were satisfied with the course in their major field of study; 83 % were satisfied with their contact with faculty and administrators; 82 % were satisfied with the overall quality of instruction; and 78 % were satisfied with the curricula on tribal culture. Another study of Montana's seven tribal colleges offered consistent findings. (Wright and Weasel Head 1990). Although focused more on persistence, a different, independent study of Montana's seven tribal colleges (Kicking Woman 2011) found similar results concerning student satisfaction.

[21] The severe infrastructural problems faced by tribal colleges and universities, and possible policy remedies, are discussed in The Institute for Higher Education Policy (2000).

[22] This belief was largely true. Many tribal college students found jobs related to their studies on the reservation, enabling them to have employment and give back to their tribe. (AIHEC et al. Survey of Tribal College Graduates 2000)

Council for Workforce Education. This program provides comprehensive academic support services, remedial work in math and English that is embedded in required courses, and accelerated learning so that students are back in the workforce more quickly, given the pressure to support their families. While these programs are primarily targeted at vocational training in fields such as carpentry or electrical construction, the same characteristics have proved useful in giving students a strong foundation for transferring to a 4-year program at another institution.[23]

## 5.3 American Indians and STEM Education – A Brief History

One of the reasons there are few American Indians engaged in STEM education and careers[24] is because of the poverty at home and the low quality of many of the schools in which they are trained at the primary and secondary levels.[25] Math and reading scores at the fourth and eighth grades, percentages of families with 25 or more books at home, and percentage of homes with computers are all below those of Whites, Asians, Hispanics, and African Americans. By percentage, only half as many American Indian students achieve the ACT math and science readiness benchmarks compared to the national average. In 2010, only 51 % earned a regular high school diploma – the lowest of any demographic group. At the college level, the 6-year postsecondary graduation rate for American Indians is 39 % – the lowest of any group. While college attendance and college graduation numbers for American Indians have increased slowly over the past quarter century, graduation numbers in engineering remain stubbornly low: approximately 300 bachelor's degrees, 100 masters degrees, and 10 doctoral degrees per year for more than a decade. (NACME 2013)

Carroll et al. (2010) conducted a set of interviews with American Indian students in South Dakota, a state with a significant American Indian population. Three salient

[23] On Breaking Through, see Gonzalez (2012). On the success rate of transferring from a tribal college to a 4-year degree at the University of North Dakota, see Brown (2003).

[24] American Indians comprise 0.7 % of the population but only 0.4 % of engineering bachelor's degrees and only 0.3 % of the engineering workforce.

[25] There is a modest literature on American Indians and STEM education. For general information, see NACME (2013). Some of the more narrowly focused topics include student characteristics of American Indians studying STEM disciplines (Schmidtke 2010), recruitment of American Indians into STEM fields (McNeil et al. 2011; Popovics et al. 1974), K-12 STEM education (Richardson and McLeod 2011; Carroll et al. 2010; Kafai et al. 2014), educational attainment of American Indian students in STEM disciplines (James 2000), the tensions between science and Indian culture (James 2006; Garroutte 1999; Murry et al. 2013), culturally agreeable science curricula for American Indians (Riggs et al. 2007; Kostelnick et al. 2009), stepping out and persistence of American Indian STEM students (McAfee 2000), STEM doctoral education for American Indian students (Oguntoyinbo 2014), engineering programs at tribal colleges and universities (NAE 2005), and attracting American Indian students to computing (Varma 2009a, b).

points emerged from their study. First, many students select subject areas to study that will enable them to help their reservation. Thus many of the students choose to study education or nursing in college. Often, the high school students could not see how the study of science or mathematics would prepare them for a career that either they could pursue on the reservation or that would help their people. Second, there was rapid turnover in teachers and administrators in the reservation schools. The lack of administrative continuity led, for example, to difficulties with plans for adequate technological infrastructure for the schools and local communities.[26] Many of the teachers in the schools were supplied by Teach for America; and while these (mostly) young teachers were enthusiastic, they were generally not experienced teachers.[27] Third, a number of programs had been put in place to try to interest American Indian and other high school students in math and science, give them hands-on experience with math and science, or provide support services such as counseling and tutoring.[28]

The South Dakota study found that, at the college level, most of the American Indian students who majored in science or engineering fields:

- took a non-traditional pathway through college that involved learning technical skills, serving in the military, or working and starting a family before they entered college;
- were often reserved in character, which was sometimes mistakenly interpreted by faculty as disinterest;
- exhibited strong personal drive to succeed;
- faced a dual cognitive load of learning a new culture at the same time they were learning STEM material;

[26] Richardson and McLeod (2011) call for high school administrators at American Indian schools to step up to the role of technology leaders if they want their students to succeed in the modern world. James (2000) also discusses the poor technological infrastructure in American Indian schools.

[27] James (2000) points to the particular difficulties the Indian schools have in staffing math and science faculty positions with qualified instructors and how many of these schools do not teach any advanced courses in these areas. He also points to the lack of role models, not only among family and friends, but also among teachers; most American Indian students never took a class in which the teacher was an Indian. He also points out that stereotypes are common "that native children are less capable than Euro-children, especially in science and mathematics," and "that Indian children are more inclined toward arts and crafts than intellectual pursuits. Such condescendingly positive stereotypes can lead to lack of intellectual challenge and stimulation that helps mitigate against intellectual interest" and also to the Indian student's lack of self-confidence.

[28] Programs that attempted to interest American Indian (and other) high school students in math and science included the Todd County math contest, Girls Day at South Dakota School of Mines, the Knowledge Bowl held at Sinte Gleska College, the Build a Computer program at Central High School, and the Math & Science Initiative run by the University of South Dakota. American Indian high schools students were given hands-on math and science experience through the Build a Computer program at Central High School, as well as through activities coordinated by the AISES chapters and by the Math & Science Initiative Program at the University of South Dakota. Support services were provided through federal TRIO and state GEAR UP programs, the Academic Café at Central High School, and transition counselors at Todd County high school.

- performed best academically in small-group, hands-on learning environments and worst in large lecture classes; and
- commonly experienced racism.

When enrolled in a large, majority university, the authors found, the students did better when they participated in smaller communities on campus where they felt comfortable, and that the college AISES chapter often played that role for the science and engineering students. (See Chap. 7 about AISES.)

There is a small body of literature about recruitment, retention, and attainment of American Indian students in undergraduate STEM studies.[29] McNeil et al. (2011) looked at a program at the South Dakota School of Mines and Technology called Tiospaye (the Lakota word for extended family), which was designed to enhance recruitment, retention, and graduation of American Indian students in STEM disciplines. The program includes professional, cultural, and social as well as academic activities. The students are encouraged to enroll together in the same large math and science lecture courses as well as in the same recitation sections, so as to build a cohort.[30]

A graduate student is employed as both a mentor and tutor for the students. The mentor meets weekly with each student during the freshman year until both mentor and protégé agree that meetings can occur less often. The mentor provides academic advising to each of the Tiospaye scholars and also provides tutoring sessions in some of these early core math and science courses (e.g. calculus and introductory chemistry) that many of the scholars are taking. The students are also encouraged to make regular use of the Tech Learning Center, which is free and open to all students.

The program director meets monthly with the Tiospaye students and holds regular office hours to deal with other problems that arise, such as financial aid issues or problems with an individual faculty member. The program director also communicates with the Tiospaye scholars regularly about the availability of career development seminars, scholarships, and other opportunities that might interest them. Twice a month, the students meet with faculty for an informal meal; and professional development seminars are often attached to these meals – on topics such as communication skills, resume writing, career planning, and graduate school. The Tiospaye students are required to hone their professional skills by writing a resume

[29] Popovics et al. (1974) is an interesting artifact of an earlier era. It is remarkable for how early it appeared in trying to recruit American Indian students into engineering education and careers. The article was written by engineers, for an education journal of engineers (*IEEE Transactions on Education*). It is not well informed by social science research, and in some ways it is not culturally sensitive. It takes the position, often expressed by engineers, that engineering is inherently interesting and that American Indians (and others) would necessarily feel the same way if only the barriers for its study were removed.

[30] A cohort approach is also being used in the doctoral program in the School of Social Transformation at Arizona State University, in which two cohorts of Pueblo Indians were established to study together through online courses and in-person classes in their community. Topics included issues concerning cultural preservation and economic development in their community. (Oguntoyinbo 2014)

and attending the annual career fair, even before they are at a stage when they are entering the job market.

The fact that American Indian students do not follow the traditional pathway through college, i.e. attending college immediately after high school and graduating 4 years later, is often seen by critics as a shortcoming of either the American Indian students themselves or of the higher educational system. However, McAfee (2000), in a qualitative study of 76 American Indian STEM majors and 33 faculty members and administrators from nine colleges and universities, addressed this phenomenon not as a failure but simply as a pattern known as "stepping out." Students might take absences from college and change schools – times of stepping out – but they would eventually return to school with determination and perhaps a better understanding (called "progressive discovery" in McAfee's paper) of who they are and what they can get out of college. One of the students interviewed stated:

> It seems like every time I went back to school I was clearer about what I wanted to do. It was hard though, because every time I went back my life was more complicated with a bigger family and more debt and less money. But I always felt like I knew myself better. Finally I got a good hold of what I wanted to do so I just went for it.

Moves to enroll, spend time away from school, or change colleges were motivated by various factors including cultural identity, academic preparation, financial resources, family needs, motivation, and interaction with the "institutional interface." These students showed remarkable persistence, McAfee noted, in their long-term pursuit for an education.

One of the common approaches used by STEM educators to reach out to American Indian students is to teach them about topics that have cultural relevance to them.[31] For example, Purdue and several other universities organized the Sharing the Land program. It provides a way for precollege students to learn about Earth science through a Young Native Scholars summer bridge program and an Explorers Club outdoor education program for primary school students. (Riggs et al. 2007) Another example is a geographic information systems curriculum that has been established at Haskell Indian Nations University in partnership with the Center for Remote Sensing of Ice Sheets (an NSF-funded center at the University of Kansas), the U.S. Geological Survey, the Kansas Biological Survey, the geospatial technology company Western Air Maps, and the Kansas City Area Transportation Authority. (Kostelnick et al. 2009)

However, some scholars – notably including the sociologist Eva Garroutte and the psychologist Keith James – believe that there are fundamental tensions between

[31] In 2005 the National Academy of Engineering held a two-day workshop on the campus of Salish Kootenai College in Montana. The purpose was to provide advice to 11 tribal colleges and universities that offer engineering programs. The report of this workshop (NAE 2005) reflects the importance of making the engineering curriculum culturally relevant to students. The examples given in the report, however, were weak at integrating cultural relevance into the engineering, science, and math courses being taught in these engineering programs: "(1) using Native symbols in school logos and campus designs; (2) offering, and in some cases requiring, courses on tribal culture and language…; (3) involving tribal elders in classroom teaching; and (4) providing facilities that can be used for adult education, boys and girls clubs, health clinics,….

American Indian culture and mainstream science as it is generally taught in Europe and the United States; and that this tension undermines, or at least makes more difficult, the efforts to attract American Indians to STEM disciplines through programs that select content for cultural reasons. For example, James (2006) points out that some American Indians are distrustful of science because of the ways it has undermined the culture and livelihood of Indian peoples:

> US and Canadian history reveal instances when science has been intentionally used against Native peoples. In other cases, science has put itself in the service of achieving ends valued by the mainstream culture even when those ends have injured Indian people directly or violated their cultural values: the actions of anthropologists and archaeologists in removing and exploiting the cultural and spiritual materials and remains of Indian ancestors contributed to negative views of mainstream science in particular, as did psychologists and social workers who participated in efforts to break down Indian cultures or who assisted with programs that promoted adoption of Indian children by non-Indian parents. Engineers, chemists, and other scientists supported relatively frequent expropriations of Indian lands for resource extraction, dam building, and other purposes and failed to defend Indians against pollution of their lands and other health-damaging actions, all of which added more support for the impression that science did Indians more harm than good.

James goes on in the same article to argue that there is an "incompatibility" between American Indian cultural values and scientific values.[32] American Indian cultures share this set of values:

[32] In a different paper, James (2000) discusses ways in which science is not value free. He writes: "Scientists and engineers are socialized and trained to value objectivity, but there are at least two problems with how this value is generally put into practice. First, the norm of being objective in gathering and evaluating information related to developing scientific understanding of a specific issue or problem is often unnecessarily and destructively extended to mean that the resulting knowledge should be applied without regard to consideration of anything other than its scientific or technical accuracy. Second, whereas few would argue with attempting to consider information objectively as a worthwhile ideal, scientists and engineers often invoke this ideal as a talisman to confer a veil of sanctity on their work despite abundant evidence that the human mind, even when possessed by a scientist, is inherently subjective in all its operations….

"Subjectivity creeps into science in many subtle ways. For instance, the problems that scientists and engineers address, far from being the universal want of some amorphous general society, more typically reflect the issues that particular groups possessed of significant economic and political power desire to have addressed. Not surprisingly, the benefits of addressing those problems typically go more to those powerful groups, and the costs typically fall more on less powerful social groups. Scientists and engineers, far from being objective in this process, are often part of the very elites that benefit and, conversely, outside of the groups that pay the costs. A substantial body of research indicates that judgments of the relative merit of a particular course of action do tend to be significantly, typically, unconsciously distorted by the social group memberships and the relative social statuses of the judges, of those who will benefit, and of those who will bear the burden of costs…"

Another value in science that Keith identifies is *technological fix* mentality: "Technology is seen by many as capable of solving anything, and technical virtuosity is admired in and of itself. These values are so strong among many scientists and engineers that problems are often immediately defined in technological terms and technical solutions are sought regardless of the true nature of the issue."

The third and last of the science values that Keith describes here is specialization, compartmentalization, and reductionism, which he argues can be useful but is harmful in their extremes: "But

> (1) an equal respect and valuation of nonhuman and human beings; (2) a belief that inevitable bonds exist between the well-being of humans and the well-being of nonhumans; (3) an emphasis on the importance of place and the uniqueness of each locality; (4) a perception that the spiritual and the material are in harmony with each other; (5) a belief that there are multiple ways of knowing, including the scientific and the spiritual, that are equally valuable and equally required for complete understanding; and (6) an orientation toward extended time frames for analyzing phenomena and weighing potential outcomes of actions.

On the other hand, science (or at least scientific education) holds a set of values that are incompatible with those of American Indians:

> …scientists are oriented toward mastery of nature, priority to the technically advanced, progress (a better future), independence, and personal prestige and achievement. Science and science education are also inclined toward reductionistic approaches that treat topics and applied issues in isolation from each other.

Garroutte (1999) claims that the epistemology of mainstream science teaching differs from indigenous epistemologies. She argues that mainstream educators trying to present culturally relevant education to American Indians are not really adopting an indigenous mindset but instead are stripping away certain fundamental indigenous assumptions and placing other aspects of American Indian understanding into a nonscientific thinking category (given lower status), where it cannot conflict with scientific thinking. This, the author argues, is harmful to preserving indigenous ways of thinking.

Similarly to Keith, Garroutte contrasts the epistemology of science teaching with the American Indian understanding of the natural world. Describing the science teacher first, she states:

> The conventionally trained science teacher is carefully schooled to impart to her students a model of inquiry – what I have referred to as "classroom science" – in which knowledge is generated only through intersubjectively verifiable, replicable, sensory observations. These observations are ideally capable of expression in laws that are causal, universal, and impersonal and that allow for the prediction and control of the natural world. This natural world is separate from and unaffected by the language used to describe it, and its exploration is separate from the domain of ethics. A central value governing descriptions of this world is the reduction of explanatory complexity. The results of inquiry yield knowledge, while the ability to apply scientific methods frequently equates with rationality, thought, and intelligence.

Later in the paper, Garroutte describes, by contrast, the very different American Indian ways of knowing:

> In American Indian models of inquiry into the natural world, knowledge tends to be received from a variety of observations. Information is not necessarily excluded from consideration if it is gained from sources other than the five senses, from an unrepeatable experience, or

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the skewed values of modern science (and of some societies) and the structures and systems of sciences as professions tend to inhibit integration and coordination. This has two mutually reinforcing negative outcomes. Practical problems result because analyses and judgments tend to have very narrow foci regardless of the breadth of the issue(s) at hand; and those whose values tend more toward integration and synthesis tend to be driven away from scientific and technical fields."

> from events which are not, by scientific definitions, intersubjectively verifiable. Indeed, ideas of subjectivity and objectivity may be, in themselves, quite different from those assumed by non-Indian thinkers. Indian models of inquiry often find other patterns in the natural world than the law-governed and causal ones sought in typical science classrooms: a broader, more complex, more personalized order, which is rooted in responsible interrelationship and co-creative activity. Laws do not grind blindly away, and the prediction, control, and manipulation of the natural world are less pronounced expectations. Language may be seen as a powerful, active force in the ongoing process of creation, and seeking knowledge becomes a sacred activity through which inquirers begin to penetrate the fabulous complexity of the world. Native models of inquiry understand the methods they prescribe as means of generating dependable, accurate knowledge about the natural world, but do not require the conclusion that there are no other sources of knowledge.

Both Keith and Garroutte believe that these tensions can be overcome by science education that is truly sensitive to American Indian culture and epistemology. However, both remain skeptical about the simplistic efforts to marry science education and American Indian culture that have generally been attempted.[33]

## 5.4 Computing and the Tribal Colleges

The story of computing in the tribal colleges has several strands: the development of a computing infrastructure (computers and networking), the use of this infrastructure to build a virtual (digital) library used in the tribal colleges and distant education programs operated out of the tribal colleges, and the teaching of computer science and information courses and entire curricula. Although there were some computer courses and even complete programs offered in the tribal colleges as early as the end of the 1980s, computing-related activities in tribal colleges only took off in the second half of the 1990s – with many different activities taking place at about the same time. There may have been multiple reasons for this timetable: dawning recognition of the educational importance of the Internet, increased interest in funding broadening participation activities at the National Science Foundation, new sources of funding from private foundations (especially the Kellogg Foundation), the growing recognition of the importance of the computer as an economic driver and a work opportunity, and the newfound stability of the tribal colleges after they received land-grant status in 1994 and through President Clinton's Executive Order in 1996 requiring federal agencies to make their programs more readily available to the tribal colleges.

This timing is quite a bit later than computing programs at most mainstream colleges inasmuch as the first campus computing laboratories were created in the 1940s and half of the computer science departments operating today were founded in the

[33] Murry et al. (2013) describe a method of Vision Mapping, which they argue can be used to enable scientists and American Indian communities to work together on issues of sustainability.

James (2001) has also edited a volume from a conference that addressed the issue of reconciling science and American Indian culture and values.

10 years between 1965 and 1975. In fact, many tribal colleges did not begin to develop a computing curriculum until after 2000, and many of these programs are taught only at the 2-year level. For example, one computer science department chair remembers (as quoted in Varma 2009a):

> I began by offering a course called Introduction to Computers, which basically used some version of the Apple computer to teach word processing. From there, I worked my way into Microsoft Platform, DOS, and Windows. I created a 1-year certificate program in data processing and a 2-year associate degree program in the late 1980s.

As Varma (2009a) evaluates the state of computing programs in the tribal colleges:

> Most TCUs offer associate degrees and/or certificates in IT-related fields, such as business data processing, business computer operator, CS, computer office skills, computer support technology, e-commerce, information systems, information technologies, integrated office technology, internetworking specialist, graphic arts technology, microcomputer applications in business, microcomputer operations, and microcomputer management. Some have moved from certification and associate's degrees to a bachelor's program in CS.

Let us look back at these intertwined histories of computing-related activities in the tribal colleges. One of the earliest efforts was the Summer Institute in Computer Science. The goal was to encourage American Indian students to transfer from 2-year tribal colleges to 4-year research universities. The program began in 1991, when Lubomir Bic and others from the computer science department at the University of California at Irvine visited the Navajo Community College in Tsaile, Arizona.

The SICS program as it developed was a non-residential program primarily for students in southern California, advertised through local tribal colleges and American Indian community centers. For eight summers, beginning in 1992, American Indian students engaged in an 8-week summer program. It included intensive, 4-week university-level courses in computer science and telecommunications on the Irvine campus. Tuition for the summer courses was paid by industry. The students with the top performance in these summer courses had their school-year tuition paid for the following academic year at their home colleges. The 4 weeks of coursework were followed by a 4-week internship in industry, to learn about the technological workforce and build mentoring relationships. The summer internships in 1998, for example, were held at Boeing North America, Rockwell, Silicon Systems, Toshiba America, TRW, Unisys, and Xerox. Evaluation of the SICS program showed that more than 90 % of the students continued their college education, more than 80 % transferred to a 4-year college to pursue a bachelor's degree, and more than 50 % pursued some type of degree in a computing discipline. The program also included cultural and social events to help build a sense of community and provide opportunities for the students to meet informally with the faculty. (Bic n.d.)

As of 1995, there had been limited progress in developing computing activities on the tribal college campuses themselves. Tom Davis, who has held multiple higher-level administrative positions in various tribal colleges and who was actively

involved in bringing computing to several of the tribal colleges, assessed the situation in the second half of the 1990s: a few schools had computing labs, including College of the Menominee Nation in Wisconsin, Salish Kootenai in Montana, and Turtle Mountain in North Dakota; "[b]ut overall, the programs were pretty weak, not much connectivity, not much of anything."[34] (Davis 2014)

One program that Davis noted as a particular early success was an e-learning program at Bay Mills Community College in Michigan's Upper Peninsula, created by Davis working together with Helen Scheirbeck, the head of the Indian Head Start program in Washington, DC. Scheirbeck was concerned that Congress was going to pass legislation requiring Head Start teachers to have earned at least an associate degree and that this requirement would be difficult to achieve for the teachers in some of the remotely located tribal college Head Start programs. (Indeed, Congress did pass legislation requiring that 50 % of Head Start employees have an associate degree by 2003.) Davis knew Larry Smarr and some of the work being done out of the supercomputer center at the University of Illinois, and he was also familiar with some projects that were being funded at the time by the Sloan Foundation. Based on these models, he built an asynchronous, online associate degree program in early childhood education using an electronic bulletin board, PowerPoint, Java Chat, email, and telephone – with many of the students connecting to the system through America On Line. The program, which became available to students beginning in 1998, was highly successful. In its first 3 years it attracted students in Alaska, Florida, Michigan, Oregon, Texas, Washington state, and Wisconsin. This "virtual college" as it was called, was replicated at other universities. (Davis 2014; Tribal College Journal staff 2001)

Another project, known by some as the AIHEC Virtual Library Project, had its origins at about the same time in the late 1990s. Dan Atkins, a computer scientist who was the dean of engineering at the University of Michigan, was selected in 1992 by the university president James Duderstadt to remake the university's library school so that it had continuing relevance in an increasingly digital world. This effort, which led to the creation of the School of Information in 1996, was funded primarily through a multi-million dollar grant from the Kellogg Foundation, which is headquartered in the state of Michigan. The Kellogg Foundation, and especially one of its officers Gail McClure, built a strong rapport with Atkins.

In 1995 the Kellogg Foundation made a $30 million commitment to support higher education at the tribal colleges, known as the Native American Higher Education Initiative.[35] The Kellogg Foundation grant supported the American Indian College Fund, AIHEC, and AIHEC's Student Congress. But the bulk of the funds

[34] Davis served as president of Lac Courte Oreilles Ojibwa Tribal College and Little Priest Tribal College, as acting President and Chief Academic Officer at Fond du Lac Tribal and Community College, helped found College of the Menominee Nation, and was Provost at Navajo Technical University.

[35] The Kellogg Foundation's $30 million commitment to American Indian higher education influenced the Lilly Endowment's decision to invest $30 million in tribal campus buildings and also positively influenced contributions from the Packard, Fannie Mae, and several smaller foundations. (Boyer 2000).

were intended for some competitive grants targeted not only at individual tribal colleges but also intended to foster collaborations among several tribal colleges or partnerships between tribal colleges and majority institutions. In the end, these funds were used for a wide range of purposes including creation of new courses and programs, purchase of administrative software for student records, and development of a community wellness center.

Unfortunately, there was a clash between the foundation and tribal representatives at their first meeting. Kellogg had had success with the African American community by funding centers of excellence at the most elite Black colleges and universities (e.g. Clark Atlanta, Howard, and Spelman) on mutually agreed upon targeted topics such as math and science education or jazz studies; and the Kellogg staff planned on adopting this same approach with the tribal colleges. However, the tribal college representatives resisted this plan:

> "What's the splash?" challenged [Fort Peck Community College President Jim] Shanley. He meant, how much money are you proposing, and how long will you stay with the colleges? And when Sinte Gleska University President Lionel Bordeaux spoke, he turned the foundation's assumptions about responsible grant-making upside down. "It's all of us or none of us," he said. "That's the way it has always been with us." "Don't pick us off," [foundation officer] Johnson recalls being told. "Don't you decide who the best of us are. If you have $10, spread it among all of us." (Boyer 2000)

In the end, Kellogg backed off, making grants to all but the smallest and newest of the tribal colleges and allowing each college considerable input and latitude in the ways the funds were to be used – although the foundation required that the funds be used on projects within a few broadly specified categories such as curriculum development, development offices, distance learning, or social services.

There were additional problems. Some of the schools were too weak to make effective use of the funds. Assessment was also a point of disagreement:

> The foundation "is really attached to outcomes" Johnson explains. "We plan almost everything. We do external scans, and then we do internal scans, and then we will review all the literature, and then we develop concept papers. We develop goals, strategies, and action plans." Little is purposefully left to chance. The [tribal] colleges take a slightly different approach. "They want outcomes, too," Johnson says, "but they are open to outcomes; they are open to what will happen. They say, 'This is what we hope will happen.' Whereas Kellogg is more machine-like. It's more about predictability and control in its drive for excellence." (Boyer 2000)

One of the values that Atkins instilled in the Michigan information school was to ground and inform research by engaging in real-world problems and trying to do social good. He and his colleagues in the Alliance for Community Technology – a part of the information school – were at the cutting edge in digital library research. McClure wondered whether a digital library for the tribal colleges might be of value to their teaching. However, McClure had a "long history of challenges of actually getting these tribal colleges to work together," so she made the award for this project to Atkins and the University of Michigan to build a digital library for the tribal colleges.

The tribal leaders were unhappy that the grant was awarded to Atkins and the University of Michigan instead of directly to the tribal colleges themselves. Early in the project, when Atkins traveled to scheduled meetings with the tribal leaders, they would sometimes not show up. Atkins was discouraged about whether this project could succeed, but things began to turn around when he began to work through Karen Buller, the director of the National Indian Telecommunications Institute. Buller vetted Atkins with tribal leaders and told them that Atkins was someone they could work with. She helped Atkins to convene a meeting in Ann Arbor, and this meeting seemed to be a turning point in the success of the project. The initial day of the meeting was acrimonious, but at dinner that first evening in a fancy restaurant in Ann Arbor, Atkins saw the first evidence of the project coming together. As he related the story:

> I had been told by Karen and by Gail that when Native Americans start joking with you or even making fun a little bit of you or making jokes about you or on you or with you, that that was a sign that they were accepting you… We were ordering dinner, it was a fairly nice place, and all of the sudden one of the Native Americans said, "Aha, Dan, I see now why you brought us to this restaurant." And I said, "Oh yeah?" He said, "Yes, they have boiled redskins on the menu." Referring to potatoes of course. Everybody laughed and [this] actually lightened things up. That meeting apparently, instead of being the end of the project, was one where we turned the corner on being able to work together. (Atkins 2015)

To build a culturally appropriate digital library presented some challenges. For example, there were questions about how well existing classification systems would fit with the cultures of the various tribes – which themselves were not always in agreement. Atkins's team used a "strong user-centered design approach", working closely with the different tribal colleges in creating the design attributes of the system so that the digital library was culturally appropriate for them. The project was challenging in Atkins's estimation because of difficulties with "logistical support, the ability to work together, and basic technical competence." (Atkins 2015) There were weaknesses in network infrastructure that made distribution of materials online suboptimal; and the grant did not include funds to build better Internet connectivity. Individual variation across the tribal colleges was also an issue. Not only might the materials to be used in the tribal colleges be different from materials used for research and teaching in a majority institution such as the University of Michigan, but there were also variations in needs across the different tribal colleges, such as the language in which the materials were presented and the most effective examples to use in illustrating particular scientific and engineering principles.

The Kellogg Foundation was generally happy with the results of the project. There was cooperation among the tribal colleges, the project provided a widespread familiarity of the value of digital libraries to the teaching and research missions of the tribal colleges, and the project built some human capacity on the tribal college campuses. The success stimulated the Kellogg Foundation to hold an international workshop in Hawaii on the value of digital libraries as cultural repositories, with representation from native peoples of Australia, New Zealand, Sweden, Canada, and the United States.

The virtual library supplemented the meager library resources of most of the tribal colleges. Over time, it was supported by grants not only from the Kellogg Foundation, but also from IBM and the National Science Foundation. (U.S. White House 2000; Billy 2006) As touted by the White House:

> The virtual library homepage will link into a major national database that will catalog electronic books, magazines, journals and Internet documents from around the world. The virtual library will have a reference section, a database section, and local exhibitions for the 32 tribal colleges across the country. There will also be a technical support system which will answer student, faculty and community members' questions interactively. (U.S. White House 2000)

In another effort, in 1999, AIHEC formed a High Technology Committee to consider what to do about the worsening digital divide for American Indians. Jack Barden, one of the founders of Standing Rock Community College (now Sitting Bull College) in North Dakota, and Tom Davis were the co-chairs. The committee created various plans in its first 2 years:

> It has come up with a series of projects and activities designed to increase the number of tribal IT workers and experts, improve higher education IT programs, extend the ability of tribal colleges and universities (TCUs) to serve increasingly larger Native American student populations in tribal communities, build strong partnerships with major higher education institutions and research labs, and generate resources to cover a national effort. Parts of the initiative also recognize the importance of prekindergarten schools as pipelines for TCU students and of introducing technology into the American Indian Program Branch of Head Start. (Davis and Trebian 2001)

Barden and Davis, together with Carrie Billy, who at that time was leading the White House Initiative on Tribal Colleges and Universities working in the Clinton Administration and who is now the President of AIHEC, developed a plan for a Circle of Prosperity Conference held in Silicon Valley in 2000. The plan, which received endorsement and support from the office of Senator Jeff Bingaman (D-NM) and ARPA Deputy Director Lee Buchanan, was designed to bring government and industry leaders together with leaders from the American Indian community to address solutions to the digital divide for American Indians. The conference adopted a prosperity game format, a domestic version of a strategic war game produced by Sandia National Laboratory. It involved:

> interactive simulations that encourage creative problem-solving and decision-making. This "game" format explored the challenges and opportunities of the new information age economy as it relates to Indian country.
>
> During the conference, the attendees spent two days playing by a predefined set of rules that specify teams of players, allowed interactions, forced group reporting periods, and a method of assessing outcomes. Different interest groups were layered into teams and given objectives that ensured intense discussion and debate. Over the two days, teams adopted strategies and then interacted with competing teams' "moves" based on those strategies, leading to outcomes that may or may not have been consistent with individual attendees' goals but that led toward a plan with a high probability for real-world success. (Davis and Trebian 2001)

Davis was pleased with the high-level attendance at the conference and the fact that it gave "Carrie Billy and [me] a lot of fodder for going after the Clinton

Administration and getting them … to support increasing the amount of money going into STEM programs of the tribal colleges and universities, [funded through] the National Science Foundation." (Davis 2014) Davis credits this as an important influence in motivating the National Science Foundation to create the Tribal Colleges and Universities Program (TCUP, see below).[36]

At about the same time, two existing NSF programs, AN-MSI and EOT PACI, came together to help bring better connectivity to the tribal colleges. In 1997 the National Science Foundation created a program known as EOT PACI in computational education, outreach, and training that brought together all of the education, outreach, and training programs that were being carried out by the National Computation Science Alliance (those institutions working with the supercomputer center at the University of Illinois at Champaign) and the National Partnership for Advanced Computational Infrastructure (those institutions working with the supercomputer center at the University of California at San Diego).[37] In 1999, NSF initiated a major program with Black and Hispanic-Serving institutions as well as tribal colleges, through its Advanced Networking Project With Minority-Serving Institutions project (AN-MSI). This project involved a $6 million award to Educause, a non-profit association whose mission is to advance education through educational technology. It was part of NSF's strategy to take advantage of its national supercomputer centers to advance educational opportunities across the nation.

AN-MSI was a joint venture between Educause and EOT PACI, with Dave Staudt from Educause as the project leader. The goal was to improve "Internet connectivity, campus networks and their technical support, and advanced use of the networks." (Davis and Trebian 2001) By early 2000, 100 minority-serving colleges and universities had signed up to participate in AN-MSI. AIHEC's High Technology Committee took the lead role in working on the tribal college component of AN-MSI. Davis had some reservations about whether the program would achieve the stated aims of Educause and NSF officials – to bring the African American, Hispanic, and American Indian institutions closer together.[38] He pointed out differences: the American Indian schools were more remote than most Black and Hispanic-serving colleges and universities; the American Indian community was slower to reach consensus but more resolute in following that consensus once it was attained; the tribal colleges and universities were generally much smaller than the Black and Hispanic-serving institutions, which meant that they could not offer as many innovative programs; and the American Indian community had stronger

[36] For a summary of Clinton Administration efforts to address digital divide issues in the American Indian community, see U.S. White House (2000).

[37] On the impact of EOT-PACI see Alexander and Foertsch (2003).

[38] The summative evaluation of the project by Foertsch (2004) was more positive about the collaboration gained between the three minority communities through this project. On the other hand, as Foerstsch notes, given the substantial networking infrastructure needs at these institutions and the large number of participating institutions (100), and the small amount of funding available when $6 million was split so many ways from the beginning, there were concerns about how far any individual institution would be able to advance on funding from this project.

cultural issues to face than the Black or Hispanic communities.[39] But Davis was bullish about the impact this program could have on the tribal colleges and universities themselves.

In the end, Davis was right on both counts. While there were some useful connections made through the program, such as quarterly meetings of the technical support staffs of these various minority-serving institutions, the initiative did not lead to deeper connections between the institutions serving different minority communities. The tribal colleges faced the greatest challenges of these three types of minority-serving institutions: "distrust of specific new technologies, geographic remoteness, weak economic bases in tribal communities, lack of private investment on tribal lands, poor targeting of specific government policies for improving technology infrastructures in Native American communities, and lack of protection of Native American intellectual property rights over the Internet." (Davis and Trebian 2001)

Nevertheless, Davis's assessment of the long-term outcome was very positive:

> …what that money really did was it allowed us to bring all of these technicians from Hispanic and Black and Tribal colleges together in quarterly meetings, … And we developed a number of different programs all over the country with that [funding], trying to build technology infrastructure. Now, in Tribal college country, of course, it really worked. I mean, today I don't think you'll find a Tribal college in the country (even some of the really, really small ones) that [does not] have a pretty good technology curriculum as well as pretty decent networking, pretty decent Internet connectivity, and quite a bit of expertise in

[39] Regarding these cultural issues, Tom Davis (2014) stated: "…some of the differences have to do with culture within Indian country. I mean, just to try to give you an example, … Carol Davis at Turtle Mountain, who was the Chief Academic Officer up there for a long time, wrote her doctoral thesis upon what the medicine people and the Anishinaabe community in the northern tier of states in the United States where the Anishinaabe are, what they thought of information technology because there's a lot of controversy about that. Really, should you give it sort of a violation of what Indian people are about and have historically been about in Indian culture, in Indian spirituality? And Carol's thesis was pretty interesting. And what it basically showed is that, yeah, there's a lot of concern about it. You don't want certain information to get out about Indian culture on the net, for instance. You want to make sure that women stories are told properly, winter stories are told properly, that sort of thing. But, overall, the medicine people, I think, said, "Okay, this is a new way that our people can make money and make a living for their families, so go ahead, go do it". And I think, so you have that element in all of the communities."

Davis (2014) also reported a story about cultural issues concerning Navajo Tech: "At Navajo Tech, one the most interesting things was that there's a lot of trouble bringing technology labs to communities and then one of the librarians had this idea of getting the Navajo rug-weavers, some of the elders in New Mexico together, where some of the finest of the rug work is happening around Crownpoint, and she introduced them, I think, … to [the software program] Paint to help them design patterns for their rug. And it was sort of difficult to get a group of them to come to that meeting, of these elderly women, primarily, from all over, the elderly women. But they came, we sent out a bus to pick them up or the group that brought them in sent us a bus out to pick those ladies up. They all came in and they got introduced to it and then the truck driver got into trouble because he couldn't get them to leave. They got so deeply involved in it. And were talking about the cultural aspects and how cool this was and all that kind of stuff. And so, in the end, it's a wonderful story. So you have some barriers within Indian country that I don't think you have with any of the Hispanics or the Black communities, at least, that I know of."

> information technology.[40] And a lot of them have developed a pretty sophisticated e-learning program of one kind or another…. So anyway, we managed to pull off AN-MSI, which was sort of an important marker along the road as we tried to develop, strengthen, especially the tribal colleges and universities' performance in the whole area of information technology. (Davis 2014)

Another important NSF program, the Tribal Colleges and Universities Program (TCUP), was initiated in 2000 with funds specifically earmarked by the Clinton Administration.[41] The program continues today, and to date it has awarded approximately $150 million in grants. The TCUP programs aim to build capacity in the STEM disciplines. TCUP funds have been used for "upgrading technology, purchasing lab equipment, strengthening core courses, building partnerships with mainstream universities, and promoting K-12 outreach." (Boyer 2014) A theme running through these grants is the support for information technology to leverage STEM education. (Varma 2009a, b) Another common theme is building a research experience for undergraduates, often on projects of value to the reservation such as reservation water supplies, as a means to enhance student engagement. Although TCUP has had a significant impact, major facilities shortcomings remain in the tribal college classrooms and laboratories (Boyer 2014; Nee-Benham and Stein 2003; Varma 2009a, b; CEOSE 2004)

In 2009, the Obama Administration created the Broadband Technology Opportunities Program (BTOP) as part of the American Recovery and Reinvestment Act, operating through the U.S. Commerce Department's National Telecommunications and Information Administration. The objective is to accelerate broadband diffusion to underserved areas so as to create jobs and do other public good. Two BTOP projects are having an impact on American Indians. BTOP funds are allowing the Computer Center at the College of the Menominee Nation to provide Internet access – and training programs – to the entire local community, not only to the college. Under the ZeroDivide Tribal Digital Village Broadband Adoption

[40] However, this does not mean there was Internet connectivity in student homes. There is no economic incentive for the telecommunications companies to provide service in remote areas such as on Indian reservations. The federal government has funded connectivity infrastructure to some of these remote areas, such as through the Internet to the Hogan Project of the mid-2000s, which sought to increase connectivity to the Navajo Nation, a project of the San Diego Supercomputer Center with funding from NSF's TerraGrid program. The first stage was to build a fast Internet connection from Albuquerque to Navajo Technical College, and from then "Through an extended mesh of wireless broadband towers that will be built by students, faculty and community members, NTC will offer broadband connectivity to 31 community centers, and later to schools, clinics, hospitals, police departments, fire houses and homes." (Mueller 2007, also see Davis 2014).

[41] These were not the first NSF grants to the tribal colleges. Several grants were given as early as the 1970s, for example to Turtle Mountain Community College to build and equip laboratories for basic science courses. In the mid-1990s, NSF had provided funds through its Rural Systemic Initiatives Program to strengthen K-12 education in a number of poor communities, including various Indian reservations. Other major funders of STEM activities at tribal colleges and universities have been the Ford, Iannan, Kellogg, Gates, and Bush Foundations as well as the federal departments of Education, Agriculture, Interior, Housing and Urban Development, and National Aeronautics and Space Administration. (Boyer 2014; AIHEC 2014)

Program, 19 tribal communities in southern California are receiving Internet access and digital literacy training.[42]

The early success of Bay Mills Community College in distance education set the tone for future efforts by the tribal colleges. By 2013, 29 tribal colleges and universities were providing distance education. For example, as of 2011, Northwest Indian College in Washington State was teaching 75 % of its students through distance learning. United Tribes Technical College in North Dakota, which was the first tribal college to offer complete degree programs online, now provides eight associate of applied science degrees through distance education. Salish Kootenai College in Montana offers 125 courses through distance education. (Hampton 2013)

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[42] For a revealing, earlier example of the positive impact that telecommunications infrastructure can create on an Indian reservation, see the story of Oglala Lakota College and Pine Tree Reservation as told in James (2000). For a profile of the IT infrastructure at various individual tribal colleges and universities, see AIHEC (2009).

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