

# In Pursuit of a Computing Degree: Cultural Implications for American Indians

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While a number of challenges contribute to the American Indian population's disconnect from information technology (IT), the most glaring is the low number of American Indian students pursuing computer science (CS) studies — a degree essential to IT's entry into and diffusion across communities. Yet, research is scant on factors that contribute to the low number of American Indians pursuing CS. This article employs cultural relevancy theory as a framework for defining the role of culture among the American Indian population and its impact on enrollment, retention, and degree completion in CS. Using data derived from in-depth interviews of 50 American Indian students at six Hispanic-serving Institutions (HSIs) and Tribal colleges and universities (TCUs), this article examines these students' experiences in CS programs. It shows slightly more than half of the students experienced different types and levels of conflicts between their culture and a career in CS. This was the case more with American Indian students attending HSIs than TCUs. The study suggests that increasing the number of American Indians attaining a CS degree hinges on (1) the expansion of CS programs at TCUs, (2) HSIs embracing and responding to American Indian cultural knowledge, perspectives and responsibilities, and (3) greater collaboration between TCUs and HSIs.

The dimensions of the Information Revolution and its limitless possibilities are widely accepted and generally understood. ...But to make the most of it we must also acknowledge that there are challenges, and we must make important choices. We can extend opportunity to all Americans or leave many behind. We can erase lines of inequity or etch them indelibly.... We can reap the growth that comes from revolutionary technologies and use them to eliminate, not to widen, the disparities that exist.

— *Remarks by President William Jefferson Clinton at the  
Massachusetts Institute of Technology Commencement Ceremony,  
June 5, 1998*

Since the late 1990s, information technology (IT) has improved the well being of Americans, changing how individuals live, learn, work, and play (Atkinson & Castro, 2008). Today, IT is bonding with the social and physical sciences to not only contribute to discovery and innovation, but to solve complex social issues (Denning, 2000). While research and reports extol the benefits of IT on society, the American Indian population continues to experience fewer or little benefits when compared to other minorities (Davis & Trebian, 2001; O'Donnell et al., 2003). Further, a comparison of the access to IT among American Indians reveals a great divide between those living on reservations and in urban settings (Bissell, 2004). A recent study found that broadband penetration in Indian Country is estimated at less than 10 percent (Morris & Meinarth, 2009). Facing continued socioeconomic disparities, American Indian tribes must deal with a number of obstacles that hinder IT's integration into and diffusion across their communities (U.S. Commission on Civil Rights, 2003).

One of the most glaring challenges is the low number of American Indian students attaining degrees in computer science (CS), a degree essential to IT (Varma, 2009a, 2009b). For instance, in 2007, American Indians nationwide earned 249 bachelor's degrees in CS (National Science Board, 2010), a trend that continues to affect the small number pursuing a career in CS. The CS field includes the study of algorithms, designing and building systems, cutting-edge developments in robotics, computer vision, intelligent systems, bioinformatics, and other exciting areas (ACM & IEEE Computer Society, 2005). With a CS degree, individuals can continuously update their skills since IT changes rapidly. A CS degree contributes to the knowledge needed to build the infrastructure for IT, skill sets for its utilization and computational thinking which contributes to new knowledge, technologies, and applications that connect people, information, and resources across government/institutional, social, cultural, geographic, and economic boundaries (Wing, 2006). These are elements essential to improving economic, educational, social, health, and political disparities facing tribes (O'Donnell et al., 2003). While little research exists on why few American Indians pursue and attain a CS degree, Ortiz and HeavyRunner (2003) and Varma (2009a, 2009b) have identified economic and social factors as possible determinants. To our knowledge, none have examined the role of culture in inclusion and exclusion of American Indians in CS.

Despite U.S. policies to assimilate American Indians into mainstream White society, Indigenous cultures remain vibrant and strong forces in the lives, education, and communities of American Indians (Kelly, 1983; Ah Nee-Benham & Mann, 2003). Distinguished by a number of historical factors, the distinct cultures and lifeways of American Indians threatened the growing European influx as evidenced in early federal Indian policies (Havighurst, 1957; Thompson, 1957). While American Indians continue to face the challenges of assimilation, tribal colleges and universities (TCUs) have become vanguards for American Indian cultural integrity and sovereignty through missions that merge cultural knowledge with mainstream curricula, preserving and strengthening

tribal cultures (Stein, 1992). Additionally, TCUs play a critical role in the education pipeline.

This article focuses on the cultural factors that affect the enrollment and retention of American Indian students in CS programs and subsequent degree completion. Specifically, it investigates the following questions: (1) What challenges do American Indian students face in pursuing a CS degree in institutions of higher education? (2) What role does the American Indian students' culture play in enrollment and retention in CS study in institutions of higher education? (3) What can be done to recruit and retain American Indians in CS study in institutions of higher education?

This research is situated within the theoretical framework of cultural relevancy (Ladson-Billings, 1995; Gay, 2002; Ah Nee-Benham & Mann, 2003; Gipp, 2003; Howard, 2003). This theory employs the term "culture" because it encompasses the behaviors, beliefs, customs, history, traditions, and values of diverse American Indian peoples. The word "relevancy" is used because it suggests integrating knowledge about American Indians into specific attitudes and policies of educational institutions to produce better academic and personal outcomes. Cultural relevancy is understood as a set of attitudes, behaviors, and policies that are an integral part of the educational institutions which enables the institutions to work effectively with American Indians. Cultural relevancy theory is based on the assumption that not only do American Indians have a culture to assess, but educational institutions embody a culture as well. If educational institutions are not open to the American Indian culture, both will face challenges in delivery and receiving of learning.

### Methodology

The study is based on primary data collected from 50 American Indian students from six institutions that granted four-year undergraduate degrees in CS in 2005. Five institutions were designated as Hispanic-serving institutions (HSIs; Hispanic enrollment must be at least 25 percent of the total enrollment) and one was a TCU (American Indian and Alaska Native enrollment must be 50 percent of the total enrollment). HSIs were selected on the basis of concentration of American Indian population, geographic location, and enrollment of American Indians in CS. Our own institution, which is an HSI, was excluded from the study. TCUs were selected if they offered a four-year bachelor's degree in CS. Since there was only one such TCU in 2005, it was selected. All CS programs at HSIs were accredited by the Accrediting Board for Engineering and Technology (ABET), the recognized accrediting body for college and university programs in applied science, computing, engineering, and technology. The CS program at the TCU was not accredited by the ABET, but this institution was included because it seeks to provide a CS program that is culturally appropriate for its students.

The total sample size was 50 American Indian students, which was considered appropriate since the total population of American Indians students in CS is small; for instance, American Indians earned only 249 bachelor's degrees

in CS in 2007 (National Science Board, 2010). Purposive sampling was used to identify student participants. Since HSIs had very small numbers of American Indians in their CS programs, academic advisors contacted an equal number of male and female students who were in their second or more years of study. No student declined to participate once contacted. At the TCU, CS faculty asked students to voluntarily participate in the study. The recruitment process ended once the desired number of female and male students was achieved. Out of 50 American Indian students, 26 (13 female and 13 male) came from HSIs and 24 (12 female and 12 male) came from the TCU.

An interview instrument consisting of 65 questions was designed and piloted on two American Indian students at our university; the pilot interviews have not been included in the study. The technique of in-depth interviews was used to acquire primary data on the subject, allowing for topic exploration from the student's point of view. The interviews were based on structured and unstructured formats. The structured format allowed for specific issue coverage while the unstructured format supported dialog as an outcome of a private conversation. This process encouraged in-depth responses from students while the interviewer managed control over topics, investigated supporting direction, and explored relevant leads. Each interview was recorded and lasted anywhere from an hour to over two hours. Information was collected under conditions of complete confidentiality and anonymity.

All interviews were transcribed and inserted in the NVivo 7 software system for data management. A content analysis coding scheme was developed to analyze interview data. Students' responses were coded only once in a single category; their statements or examples could not logically fall into two categories at the same time. Two independent trained coders coded the interviews to ensure consistency and objectivity (Lombard, Snyder-Duch, & Bracken, 2002). The findings are reported by using respondents' comments to show the construction of concepts and descriptive statistics to show the strength of each concept. Both subjects and their respective institutions are not identified in reporting the findings, to comply with the Institutional Review Board (IRB) that granted permission to conduct the study.

Out of the 65 questions posed to each student, the following six questions were relevant to cultural relevancy and thus contributed to the findings of this paper:

- (1) Why are there few American Indian students pursuing a degree in CS?
- (2) Do American Indian students experience a conflict between their cultural values and a career in CS? If yes, how? If no, why not?
- (3) Do American Indian students encounter obstacles in pursuing a CS degree which other students do not?
- (4) What is it like to be an American Indian student in this CS program?
- (5) How do people in CS view American Indian students in CS?
- (6) If you could change some things about your current CS program to make it more attractive to American Indians, what would they be and why?

## Theoretical Framework

### *Relevancy of Culture*

Prior to 1970, scholars did not take into account race/ethnicity or cultural factors as reasons behind American Indian students' dropout from higher education. For instance, Tinto (1975, p. 119) saw "race as an independent predictor of dropout (independent of both ability and social status)." According to him, it is the interactions between a student and a higher education institution's academic and social systems, established overtime, that influence their persistence to stay in school or drop out. The greater the integration, the greater the student's commitment to staying in school and attaining a degree.

While Tinto's (1975) lens of social integrationist theory views college students as a generic or general population with a "one-size-fits-all" theory, Tierney (1992) took a more discriminating lens by looking at the distinct and unique backgrounds of students. Seeing value in the cultural characteristics of the American Indian population, he questioned the social theory that claims student retention occurs by integrating them into the culture of mainstream academe, a predominantly White system. For him, the sociocultural characteristics of the American Indian population must be taken into account within the learning environments of mainstream academe. While Tinto (1975) viewed student departure as an individual process, Tierney (1992) connected student departure to the collective identity inherent in American Indian cultures. The integration of students within the higher education learning environment must be inclusive of different realities, which are formed by different cultural backgrounds. Because diversity impacts learning outcomes, cultural differences need to be viewed as strengths rather than deficiencies (Deyhle & Swisher, 1997).

Mainstream institutions of higher education are generally aware of the cultural nuances of American Indian students, but are hesitant to build on that cultural knowledge. Tierney (1992) noted that a university president saw acculturation among American Indian students as a problem since they lacked the attributes of individual competition that mainstream colleges and universities see as necessary to academic success and completion. University administrators identified the pull of the student's American Indian culture as a problem. They believed that American Indian students' full acceptance of and participation in the mainstream institution's culture is required to ensure academic success and degree completion. This belief infers that American Indians who value their culture cannot succeed in mainstream colleges and universities. Borrowing from Durkheim's theory of suicide, Tierney (1992) equates this to American Indian students having to choose between cultural and intellectual integrity versus cultural and intellectual suicide.

Given the high dropout rates among their youth attending mainstream colleges and universities, tribal communities and their leaders believe that tribal culture is the link to improving the educational outcomes of their people (Stein, 1992). In the 1960s, tribal communities fought for the right to determine their own

destinies through the development of a higher education system unique to tribal cultures. The emergence of the tribal college movement signaled cultural rebirth and the implementation of self-determination strategies by tribal communities. As the first TCU established in 1968, Navajo Community College (now Diné College) in Arizona introduced cultural relevancy through a curriculum that blended tribal knowledge and wisdom with mainstream academia. The establishment of TCUs has led to a cultural rebirth and opportunities for American Indian students to achieve parity through education, inclusive of technology, defined by cultural traditions, values, and beliefs (Barden, 2003). Today, the development of curricula at TCUs begins with cultural relevancy where the learning environment reflects the student's cultural identity.

### *Cultural Relevancy Theory and Education*

A primary focus of TCUs is to provide a quality culturally relevant education (Gipp, 2003). The TCU Language and Culture Relevancy Model addresses three principles (Ah Nee-Benham & Mann, 2003):

- (1) Learning that leads to sovereignty, engagement, and empowerment begins with an individual's spiritual, cultural, emotional, physical and cognitive strength and self-esteem.
- (2) An individual's learning must embrace interrelated disciplines, including the humanities, professions, social sciences, and natural sciences; thereby, learning is balanced, equitable, and develops high ethical standards in Natives for living in a contemporary world.
- (3) The learner, with a strong inner core, can then be challenged to design solutions or actions that address social, political, cultural, and economic issues that affect wellness, the family and tribe/clans, and the land, water, and natural resources that sustain life.

This model is comprised of concentric circles that reflect the interrelatedness of the individual/learner, extended family and tribal community members, natural resources (land and water), and external communities (regional, national, and international). It begins with a strong individual/learner reaching out to these elements (Ah Nee-Benham & Mann, 2003, p. 173). For TCU students transferring to mainstream higher education institutions, the TCU experience prepares them for the cultural mismatch they are likely to experience upon entry. The model encourages education leaders, teachers, and policymakers to think inclusively about students' learning experiences and the content of their experiences.

Rather than focus on the negative characteristics that describe disparities in American Indian students' academic achievement, cultural relevancy theory directs teachers to focus on students' potential to learn and to utilize cultural nuances in the teaching process to address the different realities that students experience outside of the classroom setting (Ladson-Billings, 1995). Culturally responsive teaching is more engaged in American Indian students' cultural knowledge and experience. It includes student "characteristics, experiences, and perspectives" which are used as conduits for more effective teaching as

knowledge and skills are expressed through students' "lived experiences and frames of reference" (Gay, 2002, p. 106). Ibarra (2001) uses the term "multicontextuality" to address diversity and low minority student enrollment, retention, and graduation rates in science, engineering, and math at higher education institutions. He advocates defining higher education strategies that welcome students' cultural backgrounds through special programs and services. Multicontextuality theory recognizes that the varied and diverse experiences of students derived from their cultural communities impact their performance and experience in higher education.

Studies have shown that teaching practices that engage the culture of the students result in improved academic achievement and self-confidence while building leadership capacity among students (Howard, 2003; Ladson-Billings, 1995). American Indian students have greater academic achievement in learning environments when education is grounded in cultural knowledge from their communities, an accomplishment highlighted in the U.S. Department of Education's *Status and Trends in the Education of American Indians and Alaska Natives* (DeVoe, Darling-Churchill, & Snyder, 2008). Contextualizing teaching to American Indian students' natural environment (home and community) allows them to feel comfortable and familiar in their learning (Lipka, 1991). Bowman (2003) attributes American Indian students' success in higher education to the tenets of culturally relevant teaching. By addressing multicultural education, employing multiethnic research, valuing cultural capital and competencies, and pushing for policy changes influenced by cultural contexts, cultural relevancy in the learning environment allows for the engagement of cultural knowledge, experiences, and perspectives of diverse student populations.

### *Culture and Technology*

The debate continues on whether IT changes cultures and whether this may be a factor in IT's limited existence across tribal communities and thus the low number of students pursuing a CS degree (Varma, 2009a). American Indians have developed their own technologies, which have gradually transformed their culture. IT, on the other hand, has been developed outside American Indian communities, which can suppress the space for Indigenous innovation. IT can disrupt culture via "24/7" exposure to the dominant culture. IT can provoke reluctance because it mimics assimilation tactics posed by federal policies which supported "loss of identity and traditions" (Bissell, 2004, p. 143). Generally, the cultural discontinuity experienced by American Indians in institutions of higher education is seen as creating obstacles for them to do well in science and engineering fields, including CS (Erickson, 1987; Martin, 1991; Philips, 1993).

IT can also stimulate cultural rebirth through information dissemination, protection and preservation mechanisms. Tribal and TCU leaders voice the need for IT as a path to economic growth and building tribal member skill sets necessary for employment, and the means to communicate with the broader community. They do not necessarily see IT as a threat to their lifeways; rather,

they see its potential in building stronger and healthier communities and view it as an opportunity to add to the knowledge it contributes (O'Donnell et al., 2003). Understanding concerns regarding the impact of IT on culture and language, they embrace dialogue with community members to determine the shape that IT must take to fit their needs and define boundaries to ensure cultural integrity. For instance, the Salish Kootenai College developed a 10-year goal for technology implementation as early as 1986 since they believed a TCU could accept technology and still keep its culture (Ereaux, 1998). They investigated all technologies to identify those appropriate in meeting tribal community needs, and engaged in dialogue with community members to ensure an understanding of technology's potential impact on the community. Similarly, the Tewa Language Project was one of many cultural preservation initiatives supported by technology — CD ROM (Jacobs, Tuttle, & Martinez, 1998). While the project sought to revive and preserve the language for the Pueblo communities that speak Tewa, other advantages included recordings related to cultural life and sacred use areas (Jacobs et al., 1998).

Despite the fact that TCUs and tribal communities (governance) are involved in a number of projects related to technology, the level of technology varies across communities, including available workforce. While there is interest in IT by tribal communities, overcoming the digital divide — the gap between those with and without access to information technology — is a critical first step (Twist, 2002). Equally important is the readiness of communities. Little research exists regarding the preparedness of all 564 federally recognized tribes and integration of technology within communities may be dependent upon tribal leaders' acceptance of technology, which is often determined by their own use of it within tribal governance. This can impact the pace and process of engaging technology, including resources (Benton Foundation, 1999). Readiness is also impacted by the number of members in tribal communities. Only eight tribal groupings within the U.S. 2010 Census have over 100,000 persons each, and four tribal groups have populations of at least 50,000 each; most tribes have populations of less than 10,000 (U.S. Census Bureau, 2010). Without IT resources, however, American Indians' readiness will not be fomented.

## Findings

### *Why So Few American Indians in Computer Science?*

In response to the general question, "Why so few American Indian students study CS?" students identified a number of reasons, which were grouped into three categories: digital divide, socialization bias, and cultural values. The digital divide category incorporated students' statements which showed lack of computer and other IT resources at the family, community, and school levels, a shortage of qualified teachers on reservations, and a dearth of job opportunities on or close by reservations. The socialization bias category consisted of students' remarks which highlighted a limited motivation to pursue higher education overall and of CS in particular; a lack of encouragement for technical education at home and



in schools; and an absence of role models. The cultural values category consisted of students' comments, which emphasized tribal customs, cultural traditions, and Indigenous worldviews.

As Table 1 shows, almost half of the students (48 percent) pointed to the digital divide as a prevalent factor in the low number of American Indians in CS education. The majority of students from the TCU (54 percent) and a significant number of students from HSIs (42 percent) identified the digital divide as a contributor to American Indians' unequal participation in CS. According to these students, the digital divide creates marked impediments for them that other minority students do not encounter. As one TCU student said, "Most people here lack access to information technology. If they do have a computer, they do not have the Internet." Another explained, "It is extremely expensive for us to have a computer and maintain it." One alleged, "In [high school on the reservation], they do not really put CS on the board, they don't even mention anything about it. So, American Indians are not sure what CS is really all about." A HSI student said, "A lot of our people must get a job after high school to take care of families. So, CS is not in the picture." This is further complicated by the "perception that there is no work for someone with a CS degree on the reservation," noted this HSI student.

**Table 1.** Reasons given by students for the low number of American Indians in computer science education, by analytical category

Reasons	TCU Students	HSI Students	Total Students
	% (N = 24)	% (N = 26)	% (N = 50)
Digital divide	54 (13)	42 (11)	48 (24)
Socialization bias	25 (6)	39 (10)	32 (16)
Cultural values	21 (5)	19 (5)	20 (10)

About one-third (32 percent) of students cited socialization bias for the lack of American Indian students in CS education. More students from HSIs (39 percent) than the TCU (25 percent) pointed to this as the case (Table 1). As one HSI student stated, "I just don't think American Indians have the determination, the discipline, or even the encouragement to do well in the sciences." Another said, "There is a lack of self motivation and probably a lack of support from the family." Students further pointed out that a lack of proficiency in mathematics pushes American Indian students toward non-technical fields. As this TCU student acknowledged, "A lot of American Indians are studying, but they all are doing different degrees. ...Some of them I talked to think CS is too hard for them to handle." Another said, the "mathematical aspect of computer science is too hard." Some students from HSIs believed the CS environment was an unfriendly place for American Indians. As one student mentioned, "Sometimes there is over

sympathy...and sometimes too much appreciation just for the fact that you are an American Indian in computer science. There is never a middle ground.” Among students from the TCU, females felt that they were being somewhat pushed out by their male peers. As one student noted, “It is a challenge because you have to struggle with the stereotype that you are not as skilled as men, you are not as knowledgeable as them.”

One-fifth of the students (20 percent) specified cultural values as a barrier to pursue education in CS. Students from both the TCU (21 percent) and HSIs (19 percent) mentioned cultural conflicts (Table 1). One HSI student generalized, “There is a resistance to adapt. Because of history, we lost that identity and we do not want this identity to get caught up into the white man’s world. ...So we do not know where to go.” Another student from the TCU said, “I would say some of it would be the upbringing and the ideology of nature of controlling forces as the divine force and a lot of American Indians might see computers as a conflict of nature so they would want you to stay away from them as a profession.”

#### *Culture and Career in Computer Science*

In response to the specific question on whether American Indian students experience conflict between their culture and career in CS, slightly more than half of the students (27 or 54 percent) said yes (Table 2a). They gave multiple reasons that were coded into three categories: cultural traditions, cultural values, and reluctance towards technology. In the cultural tradition category, students identified tribal ceremonies and community activities. The cultural values category consisted of students’ statements that showed individualism, competition, collectivism, and cooperation. The reluctance towards technology category incorporated students’ comments that highlighted specific features of computers and IT.

Table 2a shows that of the 54 percent of students (n=27) who responded affirmatively to conflict between culture and a career in CS, almost half of them believed American Indian traditions were somewhat making them choose between participation in tribal ceremonies or community activities and university responsibilities. More HSI students (56 percent) than TCU students (36 percent) singled out cultural traditions as a conflict. For students attending the TCU, attendance at and participation in traditional activities did not necessarily pose conflict due to proximity of event, whereas, students at HSIs have to consider transportation and time related to distance. As one HSI student said, “I am far away from home, I am not so close. To finish this degree, I do not want any interference with whatever is going on at home. But, I still want their support. It means I have to go back home to attend whatever is going on. It takes a lot of time and you lose your focus.”

About one-third of the students (33 percent) identified cultural values as differing from values present in their lives as CS students, contributing to conflict. More HSI students (38 percent) than TCU students (27 percent) believed this to

**Table 2a.** Students who responded “yes” to conflict between culture and career in computer science

Reasons for “Yes” to Conflict	TCU Students % (N = 11)	HSI Students % (N = 16)	Total Students % (N = 27)
Cultural traditions	36 (4)	56 (9)	48 (13)
Cultural values	27 (3)	38 (6)	33 (9)
Reluctance towards technology	36 (4)	6 (1)	19 (5)

**Table 2b.** Students who responded “no” to conflict between culture and career in computer science

Reasons for “No” to Conflict	TCU Students % (N = 13)	HSI Students % (N = 10)	Total Students % (N = 23)
Utility of computing	69 (9)	20 (2)	48 (11)
Value of education	0	50 (5)	22 (5)
Assimilation into mainstream	0	30 (3)	13 (3)
Others	31 (4)	0	17 (4)

be the case (Table 2a). Generally, students saw the CS field as encouraging individualism and competition among them, whereas, American Indian cultural values focus on collective good and cooperation. As this HSI student explained, “Here we are told to be better than others. But, in our culture, you are told not to put yourself above others. In fact, you are told to put people and community before you.”

Less than one-fifth of the students (19 percent) thought technology itself poses a conflict among some family members and their community because they are reluctant to encourage students to pursue CS. More TCU students (36 percent) than HSI students (6 percent) thought this to be the case (Table 2a). In one TCU student’s words, “Computers make the whole thing rather impersonal. We, on the other hand, are interconnected with community.” Another said, “American Indians place higher value on nature and not being in a rush to do technological things or incorporating technology into their lives.”

In response to the question of whether American Indian students experience conflict between their culture and a career in CS, slightly less than half of the students (23 or 46 percent) said “no” (Table 2b). They gave multiple reasons that were coded into four categories: utility of computing, value of education, assimilation into mainstream, and others. The utility of computing category comprised students’ statements that emphasized employment opportunities and economic well being. The value of education category consisted of students’

remarks that focused on family members inquiring about their school performance, showing appreciation with their grades, and making them attend school. The assimilation into mainstream category incorporated students' comments highlighting integration, catching up, and not being left behind with non-American Indians. When students did not specify why they did not see a conflict, they were placed into the "other" category.

Table 2b shows that out of the 46 percent students (n=23) who said "no" to cultural conflict and career in CS, slightly less than half (48 percent) believed in the use value of a CS degree. According to these students, a CS degree will improve their lives, thus they did not understand why it would be in conflict with American Indian culture. They commented that it was necessary to pursue a CS degree since it would help the community keep pace with the rest of the world. More TCU students (69 percent) than HSI students (20 percent) emphasized the utility of CS (Table 2b). As this TCU student explained, "Things have changed in the last 20 years from being an American Indian and staying at the poverty level to getting a job and coming out of the poverty level." Another said, "With computers, there is no waste, no toxics, nothing like that and it is a good teaching tool for the young ones. ...I really want to help people out, and this is my reason to study CS so I can start a business."

One-fifth of the students (22 percent) believed that since American Indian cultures value education there was no conflict to pursue a CS degree. However, this was noted only by HSI students (see Table 2b). As this HSI student said, "Ever since I have been growing up, people have been telling me, 'Go to school, you are going to need an education.' So, I don't see why any of my values would suffer."

More than one-tenth of the students (13 percent) discussed how American Indian cultures were evolving by engaging in modernity and technology, thus embracing CS. Only HSI students noted this to be the case; none of the TCU students made any remarks to reflect such sentiment (Table 2b). It should be noted these HSI students did not grow up around their tribal communities. As one HSI student said, "Some of us are indeed traditional. But, most of us are fairly assimilated into main-stream culture so we are able to incorporate high technology."

### *Encountering Obstacles*

In response to the question of whether American Indian students encounter obstacles that others do not in pursuing a CS degree, students either said "yes" or "no"; none said s/he did not know or "maybe." As Table 3 shows, over half of the students (60 percent) identified distinct obstacles for American Indians in their CS programs. For those students, 67 percent were from the TCU while 54 percent were from HSIs. The remaining students (40 percent) did not believe obstacles existed for American Indian students. Of those students, 46 percent were from HSIs and 33 percent were from the TCU.

**Table 3.** Student responses to whether American Indian students encounter obstacles that others do not in pursuing CS degrees

Obstacles	TCU Students % (N = 24)	HSI Students % (N = 26)	Total Students % (N = 50)
Yes	67 (16)	54 (14)	60 (30)
No	33 (8)	46 (12)	40 (20)

The majority of HSI students talked about contrasting values as obstacles to pursue a CS degree. According to them, the CS academic culture differs from American Indian cultures which contributes to misunderstandings between students and instructors, making the American Indian student's experience with academe and CS somewhat difficult. They felt that leaving their cultural environments for that of CS was not easy, as they move from being a "majority" to a "minority." As this HSI student explained,

A lot of American Indian students when they start, they are very quiet and shy. It is sort of a value you are taught as an American Indian person. Here a lot of White people are very loud, they get what they want. ...Some of us have a hard time being verbal and loud.

Another said, "When I would give presentations, I would not look at people in the eye. Because I am a Navajo person, you don't do that. That's considered very direct and rude." This student generalized,

Yes, you have to leave a whole value system and a place that you have been comfortable with. You were a part of a community, a part of majority. Now, you come to a different area where you are not a part of a community but you become a minority.

Students from the TCU, on the other hand, contrasted the value system inherent in CS education. As one student said, "We are not a written people, we are oral people. So paper is not that important to use. Initially if you show paper to Indians they would go 'wow.'" For TCU students, a distinct obstacle was lack of exposure to computers and related resources. As one student said,

Where I went to school, we had eight computers in the whole school and the principle had one for himself. So, there were actually seven for everyone else....I did not have good exposure to computers before I came here.

Another said, "We had one instructor and we just got another one. ...Our instructors do everything, they teach all classes. They do the labs. They advise students. It has been hard for both teachers and for us."

Less than half the students (40 percent) did not believe obstacles existed for American Indian students to pursue a CS degree. Of those students, 46 percent were from HSIs and 33 percent were from the TCU (Table 3). Typical responses were: "No," "There is no problem," and "I cannot think of anything." Some students from HSIs also pointed out that those American Indian students in CS receive more support and funding than other students through scholarships reserved for American Indians.

### *Being American Indians in Computer Science*

In response to the question, “What is it like to be an American Indian in CS?” students characterized their experiences in multiple ways, which were placed into three categories: difficult, no difference and positive. The difficulty category comprised of students’ statements showed limited resources, deficiency in high school education in mathematics, lack of social acceptance, feeling isolated and being singled out. The no difference category consisted of students’ remarks that showed identification with their peers in the CS program irrespective of race/ethnicity, gender, and location. The positive category incorporated students’ comments that highlighted feeling honored, reflecting pride and a responsibility to their communities.

Half the students (52 percent) commented on difficulties regarding being an American Indian in the CS program, which had negative consequences for them. Generally, this was the case more with the students from HSIs (58 percent) than the students from the TCU (46 percent) (Table 4). As one HSI student declared, “Quite a minority. Caucasians are more socially acceptable just by the simple fact that there are so many more people who are Caucasian than there are American Indians.” Another elaborated, “In a lot of the classes I am usually the only American Indian student. You could relate better if there were other American Indian students....To maybe, study with, or do something other.” TCU students mostly pointed out difficulties related to lack of exposure to computers as being a limiting factor. As one student noted, “I have a disadvantage because I did not have exposure early on to computers. ...I was not exposed to them in high school either.”

One-third of the students (34 percent), however, commented that their ethnicity or race did not contribute to being treated differently from other students. Slightly more TCU students (38 percent) than HSI students (31 percent) noted this to be the case (Table 4). This TCU student was clear, “I think we can do just as good a job as anybody else can, if not better.” Another said, “I love being an American Indian and getting a degree even makes it better.” This HSI student generalized, “Computer scientists are pretty open ...I don’t think my peers view me as any different from them in terms of my ethnicity.” Another said, “I don’t feel any different being a woman or an American Indian woman.”

**Table 4.** Students’ responses regarding difficulties being an American Indian in computer science

<b>Being an American Indian</b>	<b>TCU Students % (N = 24)</b>	<b>HSI Students % (N = 26)</b>	<b>Total Students % (N = 50)</b>
Difficult	46 (11)	58 (15)	52 (26)
No difference	38 (9)	31 (8)	34 (17)
Positive	16 (4)	11 (3)	14 (7)

Not all responses were negative. One-sixth of the students (14 percent) highlighted their unique, positive experiences in CS. Of those students, 16 percent were from the TCU while 11 percent were from HSIs (Table 4). As one TCU student said, "To me, it is an honor. In today's society and in order for our people to survive into the future, we need to have the knowledge to keep up with the rest of the world. It is great." Similarly, an HSI student noted, "Honored, because not many American Indians go to college and major in engineering."

*Perception of American Indians in Computer Science*

In response to the question, "How do non-American Indians in CS view American Indians in CS?" students characterized their experiences in multiple ways, which were grouped into three categories: treated differently from Whites, do not know, and treated same as others. The category of being treated differently from Whites incorporated students' expressions of feeling looked down upon, seen as out of place, perceived as not as smart and having to prove their technical skills. The category "do not know" included those remarks that conveyed that they did not want to speculate what others may think, or they did not know how others view them in CS. The category of being treated the same as others consisted of students' comments which reflected no differential treatment and acceptance of diversity among students.

Over half the students (52 percent) commented that they are treated differently from Whites. Of these students, 75 percent were from the TCU and 31 percent were from HSIs (Table 5). Generally, students from the TCU commented on the general view of Whites towards American Indians whereas students from HSIs were specific about challenges they face in the CS program. As this TCU student said, "From the start we are never thought to be smart enough. We are not accepted in their society. ... We are what they called 'savages.' We just live simple and they have that image of us." Another said, "White people expect American Indians not to know as much as they do." This HSI student believed, "They do not think of American Indians as computer scientists." Another said, "They feel that they know more than we do to the extent we should not be there. So, they are surprised to see us here." Another HSI student felt that "they [Whites/mainstream] do not expect us to finish the degree."

**Table 5. Students' responses to how American Indians are treated in computer science programs**

<b>Perception</b>	<b>TCU Students % (N = 24)</b>	<b>HSI Students % (N = 26)</b>	<b>Total Students % (N = 50)</b>
Treated differently than Whites	75 (18)	31 (8)	52 (26)
Do not know	13 (3)	46 (12)	30 (15)
Treated same as others	13 (3)	23 (6)	18 (9)

About one-third of the students (30 percent) said they had no idea of others' perceptions of them or of American Indians. Of these students, 46 percent were from HSIs and 13 percent were from the TCU (Table 5). As this TCU student said, "I do not know, honestly." Similarly, this HSI student mentioned, "I really have not heard anybody say anything about us." Another said, "I am not sure. I have not heard any opinions about us."

About one-fifth of the students (18 percent) believed they are viewed the same as other students and that there was no differential treatment. Of these students, 23 percent were from HSIs and 13 percent were from the TCU (Table 5). As this HSI student said, "We are all here to learn and help each other out." Another noted, "They view us just the same, just as any other students." This student explained, "There are a lot of other cultures too. It is a pretty good blending in. The majority is Caucasian, but there are other minorities. ...The majority's view of the minorities is really good." A TCU student echoed the same sentiment, "I went to another university before this one and I was among the five American Indians. I really did not encounter any racial views or anything. In fact, whites were open and curious about my culture."

#### *Attracting American Indians to Computer Science*

In response to the question, "What changes should be made in the current CS program to make it more attractive to American Indians?" students made recommendations that were placed into four categories: recruitment, support services, early exposure, and no change. The category of recruitment consisted of students' statements regarding providing information to tribes on the benefits of having a CS degree; advertising the CS program; and organizing talks by American Indians to help students understand and overcome the challenges they might face in CS. The support services category included students' recommendations for mentoring by American Indians who are successful in CS so they can serve as role models; tutoring or help with coursework to retain and support success for American Indian students in CS; and establishing clubs or organizations specifically for American Indian students. The early exposure category included students' comments emphasizing exposure to computers and other IT resources in high schools; strong training in mathematics; and the use of computers for technical knowledge rather than for playing games or for word processing. The category of "no change" comprised students' sentiments suggesting they did not know what could be done, had not thought about it, felt no change was needed, or that their institutions were doing a good job to recruit and retain American Indian students in CS (Table 6).

A significant number of students (38 percent) discussed aggressive recruitment strategies to attract more American Indians to CS. An almost equal number of students from HSIs (39 percent) and the TCU (37 percent) suggested recruitment strategies (Table 6). As one HSI student said, "When I was in school I did not hear a lot about CS. So, there should be more exposure, more information about the program." Another said, "I would go to the American



**Table 6. Students' recommendations to attract American Indians to computer science**

Actions	TCU Students	HSI Students	Total Students
	% (N = 24)	% (N = 26)	% (N = 50)
Recruitment	37 (9)	39 (10)	38 (19)
Support services	29 (7)	23 (6)	26 (13)
Early exposure	21 (5)	23 (6)	22 (11)
No comments	13 (3)	15 (4)	14 (7)

Indian schools on the reservations and try to get them to come to [university]. Make them visit the CS department." A TCU student said, "CS programs need to catch the attention of American Indians that basically will make it attractive to American Indians as a whole. Tell them the added benefits and in the end what can happen when you are done." Another said, "Put posters with the American Indians doing computer stuff in the community." This HSI student believed in "[b]ringing in American Indians who studied and worked in the CS field and have them give a talk."

One-fourth of the students (26 percent) suggested support services. Slightly more students from the TCU (29 percent) than from the HSIs (23 percent) suggested support services (Table 6). As one HSI student said, "Bring some senior American Indian students who are CS majors and make them give a talk on how they have dealt with challenges. They need to convey that if they can do it, you can do it, too." This TCU student suggested having "American Indian instructors and tutors because American Indian students relate more with each other, they understand each other a lot better."

About one-fifth of the students (22 percent) thought early exposure to computers is a must to generate interest among American Indians. An almost equal number of students from HSIs (23 percent) and the TCU (21 percent) suggested early exposure (Table 6). As this HSI student said, "You would have to start somewhere in high school and have them develop their mathematical abilities more and see that they are good at it." Another said, "I would implement programs in schools to explore computer science. Not just surfing the Web, not just doing word processing, not just playing games, but knowing what makes computers work and to introduce that early in academics, before college." A TCU student said, "The thing that needs to change is in the high schools themselves. Not at the college level. The college level is trying really hard. It is the high schools that are doing a really crappy job preparing the students."

The rest of the students (14 percent) believed no changes were needed. There was little difference between students from HSIs (15 percent) and the TCU (13 percent) (Table 6). As one HSI student said, "[This university] has a lot of programs for American Indians. So, no need to do any additional thing." A TCU student said, "We could not change anything. It is our people. If they want to study CS, they will do it. If they do not want to, nothing can be done."

## Conclusions

While a number of challenges contribute to American Indians' disconnect from IT, the most glaring is the low number of American Indian students pursuing CS studies. This article employed cultural relevancy theory as a framework in defining the role of culture among the American Indian population and its impact on recruitment in CS. Using data derived from in-depth interviews of 50 American Indian students at five HSIs and one TCU, this study examined students' experiences in CS programs. Findings identified two major themes. First, culture is a necessary component to American Indian student success in CS. Second, the lack of exposure to and familiarity with computers and technology is a major obstacle to student interest in CS. Both factors contribute to the low number of American Indian students pursuing a degree in CS.

This case study supports scholars and practitioners who emphasize cultural relevancy in educating American Indians. As evidenced in the student data presented here, to the American Indian population, beliefs, language, and culture are the lifeblood of existence. Participation in ceremonies strengthens cultural identity and community member status. While connection to home remains important to many, it can interfere with and interrupt focus on school work. Having to choose between participation in cultural activities and school responsibilities poses conflicts for students attending HSIs since time imposed by distance can disrupt studies. Because of proximity to tribal communities, TCU students experience fewer conflicts. This study shows that students from tribal communities or those possessing a strong affinity to their tribes attending HSIs experience a strong pull to participate in or attend ceremonies, but must consider the impact on their CS studies. Because cultural identities differ from the practices of CS, students were obligated either to sacrifice values for or adapt to CS in order to succeed in the program.

Equally important is the digital divide. The geographically remote and often isolated locations of tribal communities contribute to the lack of exposure to computers and IT, resulting in unfamiliarity and unawareness of CS as a career track. This was mostly due to economic constraints that limit resources needed to familiarize American Indians with computers, IT, and the field of CS. An important feature of these themes was their consistency across responses by both HSIs and TCU students. The dearth of CS jobs in tribal communities limits students' pursuit of CS degrees, as many prefer to stay within the community rather than leave.

For the effective functioning of cultural relevancy, educational institutions must value diversity by accepting and respecting differences. In general, American Indians have very different histories, cultures, customs, traditions and values from those of mainstream White students. Native students' educational choices are affected by unique cultures and heritages. Equally important is recognizing diversity among American Indians. Not all American Indians share a common culture; instead, cultures differ based on the tribes that individuals

belong to, the geographical area they inhabit, the languages they speak, and so forth. For diversity to work effectively, a cultural self-assessment program should be in place. Educational institutions should be able to see how their goals of valuing diversity are affecting American Indians. Faculty and staff must be trained to effectively utilize the knowledge gained about American Indian cultures. Administrators should develop policies that are responsive to cultural diversity. Institutionalized cultural knowledge can enhance educational institutions' ability to better serve American Indian students.

Finally, there is a need to conduct more studies at TCUs. This article has focused only on CS. However, American Indians at TCUs are entering IT careers from a variety of directions including associate degrees or certificates in IT-related fields such as business data processing, computer office skills, computer support technology, information systems, microcomputer operations, multimedia design, network support specialist, Web service design, and so forth. This suggests that American Indian students are pursuing IT or technology-driven fields through available opportunities at TCUs. As there are only a handful of TCUs when compared to the number of tribal communities located across the U.S., our research demonstrates that an individual's comfort level in leaving their community for an urban setting or a mainstream college or university to pursue CS remains one of the key factors that impact the number of students who choose to pursue CS. As such, our research advocates for more recruitment and CS program development at TCUs.

A greater collaboration between HSIs and TCUs can create opportunities through shared commitment, vision and resources. For TCUs, role models, American Indian CS professionals and/or students via distance learning from HSIs can offer solutions posed by the field while serving as mentors and conduits to computer and technology access. Distance learning addresses the challenges of recruitment of teachers and access to resources impacted by rural and isolated locations of TCUs. For HSIs, the encouragement of cultural relevancy can result in changes in the institutional environment that supports engagement of diverse student perspectives and ways of knowing and learning.

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