

Components of a Successful American Indian Computer Science Program*

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Abstract. From 1995 to 1997 a culturally relevant transfer degree program was developed at a tribally controlled Community College in Minnesota. Broad traditional values held in common by most indigenous peoples formed the backbone of the project. These values led to the formulation of several significant components of culturally sensitive programs which were enhanced by classroom practices adopted and distilled during more than two decades of teaching from middle school to the graduate level. Many of these coincided with and reinforced traditional American Indian values. In addition, practical lessons were learned while creating this new model of education. Our conclusion: the core of minority-centered education should be good teaching strategies applied to a specific population but applicable to and effective for all students.

States struggled with “The Indian Problem,” succeeding in annihilating entire tribes, displacing countless others, and destroying much of the cultural heritage of those who survived. Such atrocities are not soon forgotten, and racial discrimination, although these days often not overt, most certainly is also not relegated to the past. The impact of oppression permeates attitudes, causing a layer of distrust to influence the interactions of many American Indians with non-tribal people, often even between members of different reservations. The cost to both American Indians and American society as a whole is incalculable.

CONTEXT

Problem Statement

At a time in history when diversity is valued and recognized by some as a necessity, the ethnicity and gender statistics for computer science degree recipients are cause for concern. Table 1 indicates the disproportionately low number of minority graduates in CS and CE in recent years [3]. These numbers translate into underrepresented populations and the need for additional measures to increase diversity. In 1994, in an effort to combat this insufficiency, the NSF awarded a \$1.4 million 5-year grant to a small tribal college in northern Minnesota. The goal of the grant was to create a culturally relevant transfer degree program model, thereby increasing the number of American Indians entering and completing baccalaureate and advanced degrees in CS and Engineering. From 1995 – 1997, the authors created the framework of a successful program which could easily be replicated.

History

From genocide to a more civilized but certainly not benign policy of assimilation, the dominant culture in the United

Table 1. Degree Production by Ethnicity

Year	African American	Hispanic	American Indian	Total
B.S. Degrees in C.S. & C.E.				
93 – 94	172 (3%)	164 (3%)	9 (0.1%)	8,411
94 – 95	152 (3%)	145 (3%)	15 (0.2%)	7,561
95 – 96	207 (2%)	182 (2%)	12 (0.1%)	8,411
96 – 97	157 (2%)	180 (2%)	13 (0.2%)	8,063
97 – 98	251 (2%)	287 (3%)	39 (0.4%)	10,161
M.S. Degrees in C.S. & C.E.				
93 – 94	82 (2%)	64 (2%)	1 (0.02%)	5,189
94 – 95	55 (1%)	52 (1%)	3 (0.07%)	4,425
95 – 96	51 (1%)	39 (1%)	45 (1.1%)	4,260
96 – 97	48 (1%)	66 (2%)	4 (0.09%)	4,443
97 – 98	51 (1%)	41 (1%)	13 (0.3%)	4,934
Ph.D. Degrees in C.S.				
93 – 94	14 (1%)	9 (1%)	0 (0.0%)	1,010
94 – 95	9 (1%)	28 (3%)	1 (0.1%)	1,006
95 – 96	11 (1%)	27 (3%)	5 (0.5%)	915
96 – 97	6 (1%)	8 (1%)	0 (0.0%)	894
97 – 98	10 (1%)	6 (0.6%)	6 (0.6%)	933

This mistrust needs to be understood and overcome in the classroom before significant progress can be made. In order to achieve this, a great deal of patience, humor, and honesty are required, as well as respect for the local culture.

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Culture.

As the result of attempts to assimilate American Indians into the dominant culture, as well as naturally occurring differences between humans, there is a wide variance in beliefs even among those Indians considered traditional. The most basic question, what defines someone as Indian, elicits a range of answers such as blood quanta (percent of traceable Indian heritage), skin and hair color, fluency in their Native language (Anishinaabemowin in the case of the Anishinaabeg/Ojibwe/Chippewa), or a spiritual evaluation of attitudes, intent, and actions. There is no single recognized authority which can settle even this fundamental but sadly complex question. Thus, an attempt to define Anishinaabe culture, let alone American Indian culture in general, was beyond the scope of this project.

Background

As an added challenge, associated with the tribal college is a tribally controlled, state-funded community college which provides the faculty, buildings, etc., for both colleges. Total student enrollment is approximately 500, with less than 20% American Indian students from several different reservations. Hence, our project served a diverse student population not only in the mix of Indian and non-Indian students, but in the mix of students in our classes who chose whether or not to participate in the project, and in the wide range of ages (late teens to early fifties) of our project students. The extreme diversity of beliefs among the Indian students created difficulty in determining which activities were “culturally correct,” since what some found comforting and comfortable, others found intolerable.

Given the grim statistics of this ethnic group across the entire educational spectrum, it was no surprise many of our students were under-prepared in mathematics, study, and/or reading and writing skills, as well as critical thinking and problem solving skills. Students struggled constantly, expending much time, energy, and emotion on coursework, job and family responsibilities, and personal challenges ranging from lack of money for essentials such as food and gas to pregnancy, alcoholism, and legal problems.

A REPLICABLE CULTURALLY-BASED EDUCATIONAL MODEL

Unexplored Territory

The entire concept of “culturally relevant” curriculum, as it relates to American Indians, has remained almost entirely theoretical in nature, with much conjecture but little actual classroom application. To quote from the U.S. Department of Education’s Indian Nations at Risk report, “we need to ‘Indianize’ Indian Education. We need to Indianize the philosophy, the texts, the approaches, the methods, the

content...” [4]. Unfortunately, no one had ever Indianized a computer science program before, so we were venturing into uncharted territory with no signposts or guides.

Basic Values

Dr. G. Charleston, editor of the Indian Nations at Risk Task Force commissioned papers: *Listening to the People*, described three levels of Native education: Pseudo, Quasi, and True Native Education [2]. Pseudo is assimilation, a non-Native solution which attempts to teach Native students the standard American curriculum needed to assimilate into American society. Quasi generally teaches about Native cultural topics with a heavy emphasis on the material culture and is woefully inadequate to meet the needs of Native students. True Native Education emphasizes both high quality academics and the use of Native culture to teach Native students.

Building culturally relevant curricula does not mean simply adding more courses with the word Indian or Tribal in their title. It is not limited to merely substituting examples from the local culture, such as rice harvesting or beading, for more generic examples. Rather, it involves a fundamental change in the way regular core courses are taught, as well as a change in the entire approach and philosophy of education, i.e., *True Native Education*.

Further, not all aspects of the program should or need be “culturally relevant” since students obviously must live in a multicultural world and are to varying degrees already acculturated. Opportunities should be taken to ease students into a more goal-oriented perception of learning and working since the dominant culture stresses that viewpoint.

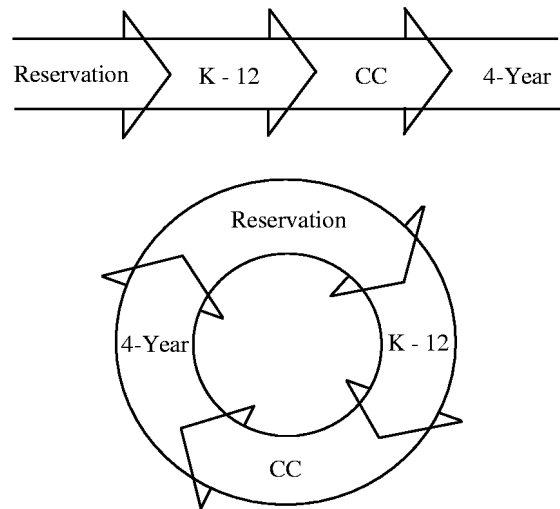


Figure 1. Pipeline and Circular Models of Education

The approach we developed is based on broadly shared traditional American Indian values, with the cornerstone tenet *all things are related or interconnected*. Inherent in

this belief is the idea no part is more important than any other, nor would any circle be complete if even one part is missing. Further, the concept, “We did not weave the web of life. We are merely a strand in it. Whatever we do to the web, we do to ourselves” (attributed to Chief Seattle) is found in this philosophy. It is another way of saying, in part, “What goes around, comes around.” These holistic beliefs reflect the traditional American Indian view of the world, and change the popular pipeline model of education into our circular model (Fig. 1). The sacred circle was incorporated throughout our project. It formed a dynamic circle of knowledge as a reflection of the integration of the four core courses, for example (Fig. 2).

Other key values were: Respect for oneself, others, the earth, and tradition; Cooperation is valued and encouraged; Honor in giving back to the community; Teaching by example; Humor is integral to life; and Individual Spirituality [1].

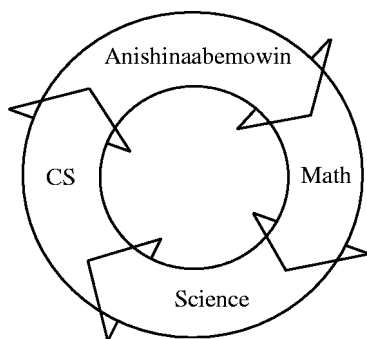


Figure 2. Curriculum Integration

Cultural Model Components

The basic values listed in the previous section formed the bedrock from which we developed our educational model. Based on them, we divided our model into the following six components.

Relevant Examples. The phrase “hanging feathers and counting arrows” (Quasi Native Education) describes superficial changes which can often perpetuate stereotypes and do more harm than good. Instead of simply mapping Indian words to English equivalents, we looked for relationships between classroom concepts and examples to which the students could relate, often by using analogies or stories. In essence this gave students “hooks” on which to hang new material which was unfamiliar to them, thereby reinforcing concepts and affording a greater understanding. As many educators have found, humor is often an excellent addition to the classroom. The action of a `break` in a C/C++ `switch` statement was likened to the Harry Chapin song about a truck hauling 30,000 pounds of bananas losing its *brakes* on a mountainside. Boolean expressions were associated with “good parenting” (AND : both parents must say yes) and “not so good parenting” (OR : only one parent -

or both - need say yes). Variables as storage locations were described as shoeboxes with appropriate labels (names), types and sizes.

Relevant examples should be “non-mathish” if at all possible, or use very little math sophistication. It may be you can introduce math concepts with a real life example, then point out how the math fits in. For example, given a problem to determine how many beads we must order to complete a design in which the number of beads doubles in subsequent rows (think of triangle, hourglass, or diamond shapes), we could discuss exponentiation, exponential growth, and summing a series.

Hands-on Activities. Doing and experiencing, rather than simply listening or discussing, provides a much stronger impact on most students and allows for alternate learning styles. This type of activity is quite natural in computer and science labs. Supplemental worksheets that guided students through a single concept using small programs and incremental changes were developed. Students could complete these worksheets at their own pace and were encouraged to experiment and make new discoveries for themselves.

There are other numerous ways to incorporate a hands-on approach to computer science. The study of various looping constructs was augmented by acting them out on the stairs in the commons area. This not only appealed to the students in the class, but was a good PR tool to capture the interest of other students. The lessons on sorting happened to coincide with long-awaited spring weather, so we took class outside, picked up sticks at random, and demonstrated the behavior of the various sorts by ordering the sticks according to length and using sidewalk squares as our array cells.

Planning activities which are inclusive, cooperative, and geared to students’ abilities and level of understanding provides positive reinforcement that each student is capable of success and builds their excitement about learning.

Core Course Integration. As many schools are doing, we moved toward “computing across the curriculum,” using computers in math and science classes, as well as exploring examples and assignments in the computing courses which were based on concepts seen in other core areas. This was one of the most challenging components, both for the breadth of its vision as well as for the coordination and time required of the instructors. An example of the type of integration we hoped to achieve was the study of the focal length of a lens in Physics, the simplification of the associated equation in Algebra, followed by writing a program to calculate focal length of lenses in CS.

Actually, we strongly suspect the participation of instructors in all the core courses probably had as much as or more impact than our attempts to integrate the courses. Rather than seeing us for only fifty minutes once a day, we spent several extra hours with the students as we audited the various classes in the curriculum. This made the students

more familiar and comfortable with us, and reinforced the feeling of community we were trying to foster.

Language as a Core Course. To many Indians, language and culture are synonymous. By making Anishinaabemowin, the language of the Anishinaabeg, a core sequence in our curriculum, we hoped to give a new perspective or different worldview to non-speakers. As well, we wished to provide recognition and validation of our students' culture and emphasis on the importance of their language and traditions. As with many indigenous languages, Anishinaabemowin is in danger of becoming extinct on the local reservation so preservation efforts are an urgent necessity. Owing to instability in the assignment of faculty to teach the language courses, however, it was expedient to replace the language requirement with art courses. We were lucky to have an excellent Art instructor from another reservation who also taught cultural diversity courses. She brought to our students the challenge to broaden their thinking which we were seeking.

Relevance to Tribe. To honor the ideal of giving back to the community we actively worked to foster the drive and commitment in our students to do so, regardless of their race or how they defined community. One computer science course at the end of their studies was devoted to individual projects the students helped pick for themselves. Several tackled language preservation projects which used computers and other technology to archive and teach Anishinaabemowin (which is why the inclusion of the language classes was so important). One woman wrote a program to be used where she worked on the reservation, and was delighted to finally understand how useful computers (and her new programming abilities) could be to people on the reservation. Another woman explored the use of an EEG interface to allow people with physical handicaps to use their brainwaves to move a computer mouse. She viewed all of humanity as her community. These projects highlighted the relevance of their academic studies to their lives, something from which all students can benefit.

Community Building. We feel one of the keys to the success of our project was the degree to which we were able to engender a sense of community within our students. When a group feels like a team and has team spirit, they are likelier to succeed, complete their initial degrees, and continue in their studies. To this end, we used the weekly ACSE meeting to provide an opportunity for students to get to know one another and work together. We made no distinction between students based on their race. Any student who wished to participate in the project was welcomed, all ACSE students received a stipend (based on courses, progress, and nothing else), and all were subject to the same policy rules. Since racism is an acquired attitude, it can be fought with education, by individuals coming together to learn about each other in order to see past skin color or any other basis for discrimination.

TEACHING HUMANS

A Spiritual Philosophy of Teaching

We believe teaching is more than just a profession; it is a sacred trust. As teachers, we are in the honored position of being able to help our students on their life journeys by working to build their self-esteem and self-confidence, and by helping them see clearly their inherent worth and the variety of options they have. As one of our students put it, we believed in her until she could believe in herself.

Principles Derived from Classroom Experience

Several decades of teaching have blessed us with some insight into effective teaching techniques. This list is by no means exhaustive, but we've tried to outline some of the most basic methodologies garnered through our own experiences.

First do no harm, one of the basic tenets of medicine, should form the foundation of any philosophy of teaching, and it should be of utmost importance to anyone from the dominant culture who teaches minority students. Everyone is concerned with meeting their own emotional and ego needs – don't meet yours at the expense of your students.

A non-threatening, supportive environment must be provided in your classroom. As noted earlier, there are serious trust issues with which to contend in working with American Indians. Obviously that means no weapons, drugs, or violence, and no ridicule. Less obviously it means finding ways to say a response is incorrect without belittling the student. Allow students time to form questions and thoughts, again without feeling they are being judged if they take longer than you find comfortable. Have all your students raise their hands in unison the first day of class and repeat "I don't understand" so they realize the sky does not fall when those words come out of their mouths.

Ask "How do you feel about this?" rather than the standard "Are there any questions?" or "Do you understand?" This allows students to express frustration or doubt without putting their egos on the line, since students are often unable to respond to the latter questions in the midst of confusion or while feeling time pressure.

Take the time to listen to students tell you about what's going on in their lives because it's impacting your classroom whether you understand how at the time or not.

Be honest with your students at all times. Learn to be yourself in your classroom because students have excellent bullshit detectors. You, the teacher, should admit when you make mistakes and apologize when appropriate.

Use humor in your classroom if it's part of your personality. Students can become frustrated or bored, and levity can help relieve the pressure or regain their attention. Fear of failure can, in and of itself, block the learning process. However, it's hard to be afraid when you're laughing. While it's good to be able to poke a little fun at

yourself, never embarrass a student by making jokes at their expense.

Respect your students. They do not choose to be slow learners, or to have sick children and miss class. Few of us want to be failures. Do your students perceive you as being helpful in their learning experience, or someone who sets up barriers for them? Yes, the material may be difficult, and students may not have the ability or background to grasp it. It is especially important to help such students understand they are not failures. It is too easy for ego and self-image to be tied into academic success or failure. Allowing them their dignity leaves the door open for further learning experiences. Try not to interrupt students, most especially those who seldom talk. Hear them out so they feel what they have to say has merit and is valued, because *we're all part of the circle*.

Use positive reinforcement, including smiles. If a student gets any part of an answer correct, let them know it. When they finally grasp a point they've worked hard to understand, let them know you applaud their achievement. It doesn't take much effort to say "Good job!" or even "I enjoy seeing you learn." There always seems to be time for constructive criticism, make time for "strokes" as well.

Give students individual attention and the opportunity to ask questions both in and outside the classroom. Students with low self-esteem need to know they are just as important as students who demand attention or who are not afraid to ask questions. Giving your attention to quiet students lets them know you value them and they have innate self-worth. Look at your students, establish eye-contact with them to assess how well they are absorbing the material. Often confusion or the wish to ask a question is mirrored in a student's face or demeanor. Pause occasionally to give your students time to think about what is being said and to collect their thoughts. Your classroom atmosphere should encourage questions and interruptions - you can always opt to answer outside of class when necessary.

Encourage experimentation or "what happens if..." activities. Successful computer scientists learn to try new ideas, write small programs to see how things work, and are not afraid of breaking the computer. Sometimes at the beginning level there are too many new concepts so students will have no idea what to hold constant and what to vary in an experiment. It may be helpful to show them how to do this by example, especially when a "what if" question comes up in class.

Begin with a "do as I do" lab for students who are unaccustomed to computers, allowing them to type in exactly what you do as you give explanations. This type of "hand-holding" can help give students the confidence they need to overcome their fear of breaking the computer or frustration with not knowing what to do next.

Allow students to work in teams on some projects and homework. They can often learn from each other, and if the group as a whole is responsible for knowing the answers, it

behooves members to cooperate and help each other. This is good training for working on programming teams.

Require some individual work, for example exams and some programs, to encourage individual students to learn for themselves. It is not sufficient that students who understand be compelled to help those in a group who do not. The ones who lack understanding must make their own efforts, and ultimately be responsible for their own learning.

Don't lower expectations. Students tend to live up (or down) to what is expected of them. Thoughtfully and clearly setting realistic long and short term goals, and sharing them with the students, can help clarify the learning experience and emphasize to students what is most important in a morass of details. Seeing how something fits into the big picture is beneficial not just to students, but to you as well.

Be open to new ideas and interpretations. Hear a student out before analyzing what they're saying. If what you're doing isn't working, think about trying a new approach. Just because something has always been done a particular way doesn't mean it is the best method. Experiment and discover what works best with your students. Find a variety of ways to present the same concepts. *Don't be afraid to depart from the common in search of the extraordinary - sometimes you find it.*

Give regular quizzes (e.g., every Friday) over the concepts or facts you consider most important which were covered during the week (and don't be shy about pointing out quiz material as it's covered). This reinforces the important material, lets you know if there is a gap between what you expected them to learn and what they actually learned, and gives students an idea of the type of questions which may show up on hour exams and the final.

Alternately, at the end of every class meeting have students write down what they consider the most important thing covered that day, and what they found most confusing. Reading through their (anonymous) responses can be a real eye-opener for any teacher.

Collect homework, even if all you do is put a check on it. CS is inherently time consuming and students need to feel the time they put in is at the very least noticed. Because homework is considered a learning tool and should be strongly encouraged, allow students to work with each other (as long as they note with whom they worked and it happens only occasionally). Give credit for handing in assignments, not whether the answers are correct, then provide solutions so students can check their work and understanding.

LESSONS LEARNED

Students

Students must be evaluated for placement into appropriate classes. Be honest with students about the amount of time it will take them to complete their degrees. Letting students slide through a two-year program by lowering standards sets

them up for failure either in the workplace or upon transfer to a four-year institution.

Obviously the problems which beset your students begin long before they arrive in your classroom, and the scope is much larger than you can possibly address. Long term solutions must start at the pre-school level. Try to include a component in your grant or make your own effort to work with those who teach the associated K-12 school. They are producing the students who will some day enter your classroom.

Build a good working relationship with your institution's student financial aid director. Financial aid rules are complicated and seem to evolve almost daily.

Even students who have used computers may have no idea how components look or fit together - the machine is a total mystery. After first teaching them basic safety precautions such as unplugging everything, students may like to take apart and put together a computer. Let them name their computers, which gives them a feeling of ownership thus prompting more gentle use. If you can get donated components, allowing students to build their own computers can significantly increase their comfort levels and enthusiasm.

If at all possible, develop internship sites which accept more than one student per term. For some American Indian (and female) students, isolation and new situations are difficult to the point of being impossible to tolerate. By sending students in pairs or groups, they take with them their own support system.

First generation college students often have no concept or understanding of what a four-year degree entails, and a four-year institution can be intimidating as a new experience. Our students deeply appreciated field trips to meet the chairman and explore the department to which they would eventually transfer, even though it was only twenty miles away. Talk with your students about the meaning and requirements for various degrees and your academic experiences. Bring in people with advanced degrees, especially those who can act as role models. Encourage (sometimes to the point of being pushy) students to test their own limits by applying to undergraduate research programs or submitting papers to conferences. Results may exceed your wildest expectations.

Track student information from the very beginning of your project. Keep data on everything from how they were recruited, ethnicity, gender, age, number of children and whether they are the primary (or often sole) caregiver, whether they own a PC, why they drop out, where they go and what they do after graduation. You'll need these not only for statistics in reports and to help make corrections to your program, but also to understand more fully the people with whom you are working. When we reviewed our student information, we discovered students who dropped out of the program were more likely not to have access to a computer at home than those who remained in the program.

Personal Wellbeing

First, ask yourself why you're teaching American Indian students. What ego needs are you fulfilling? Do you identify with or hope to become Dances-with-Wolves? There is a world of difference between respecting an Indian culture and wanting to become part of it.

Prioritize your goals or risk burning out. You can't do it all, and won't do anyone any good if you deplete your energy. Recognize the magnitude of the problems you, your students, and their families, are facing. You need a support system just as much as your students do.

If you're working under a grant, involve your grant officer at the funding institution to the greatest extent possible. Get into the habit early of frequently contacting and reporting to your grant officer.

Send monthly (or at least regular) reports not only to your grant director, but to your administration as well, and the advisory board if you have one. Keeping the lines of communication open and notifying your administration of developments, accomplishments, and problems is crucial to the success of your program.

Document decisions as you go along. You may be asked to justify them later, and it can be difficult to recall all the circumstances.

Be Passionate About Your Work

Paraphrasing the Peace Corps motto, teaching is the hardest job you'll ever love, and we think it's the best job in the world. If you feel enthusiasm for what you are doing, it will be communicated to your students as well as give you personal satisfaction. Your students are the reason to be in the classroom. If you keep their best interests in mind, they can't help but succeed.

We firmly believe the core of minority-centered education should be sound teaching strategies applied to a specific population but applicable to and effective for all students. We wish you well on your journey.

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