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DREAMS: Strengthening Math and Science for Native American Students with Disabilities

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Abstract

The Disability Research Encompassing American Indians in Mathematics and Science (DREAMS) project was designed to facilitate the entry of Native American students with disabilities into science and technical careers. Students, their teachers, and family members attend two summer institutes annually where university faculty and a core planning team design and implement hands-on, integrated science and mathematics experiences. Teachers and school officials offer technical assistance in four domains: (1) culturally-sensitive teaching, (2) systems change in mathematics and science instruction, (3) career development in technical areas, and (4) disability adaptations in science and math instruction. Evaluation data and the experience of the authors over the first four years of the project are described.

Introduction: What is Dreams?

DREAMS (Disability Research Encompassing American Indians in Mathematics and Science) is an experimental program serving 30 Native American students with disabilities by teaching mathematics and science through classroom-based and other activities. The program, focusing on elementary students 8 to 14 years old, is supported by a multi-year National Science Foundation grant. Students are introduced to science and math activities during the two, one-week summer institutes held each year since 1995. During the summer institutes, DREAMS educators, tribal elders (culture teachers), university faculty members, mentors, and role models design and deliver hands-on science activities to participating students. Teachers who will work with the students during the subsequent school year receive in-service training during the sessions. Those participating in the DREAMS program come to realize that many of the students have the potential to succeed in technical careers such as engineering.

Members of a core team (funded via the project) also provide technical assistance in the schools during the year. In addition, these individuals are responsible for advocating systems change in science and mathematics instruction. Based on emerging views of pedagogy in these areas, program representatives advocate hands-on, experiential-based, integrated activities in science and mathematics. In addition, a concept-heavy approach is emphasized in contrast with the traditional read-test, facts-based approach.

Teachers draw from their own area of expertise and then add adaptives and introduce Native American culture. Goals of the DREAMS program are as follows: 1) to increase professional, parent, and student awareness of the options available to Native Americans with disabilities in the mathematics and science fields; 2) to enhance curriculum, hands-on experiences, and counseling options for participants; 3) to increase team building and liaisons among the university , schools, and parents; and 4) to effect permanent change in the infrastructure of the school systems.

Summer Institutes

DREAMS staff members organize two, one-week institutes for selected North Dakota Native American students with motor, orthopedic, or sensory disabilities. The initial institute, held in June of 1995, did not include children, but consisted of training sessions for faculty and staff in the use of adaptives for teaching students with disabilities, cultural awareness, and general preparation for meeting the children. In the initial institutes faculty and teachers were involved in developing a set of curriculum materials, entitled Circle of Life , which focused on earth, air, fire, and water.

When students are brought in, hands-on activities with high interest levels are stressed. More recent institutes have been structured around themes, taking advantage of the university environments and personnel. Energy was one theme chosen for a summer institute, while space and flight was the theme of the August, 1998 institute. Activities during the "space and flight" sessions included construction of a planetarium, visits to flight simulators and an airfield, presentations by space science faculty on planets of the solar system, and a chance to design and shoot bottle rockets.

The first six institutes (initial grant) focused on developing curriculum which was culturally connected and developmentally appropriate for the target students. In addition, the curriculum needed to meet the national standards in science and mathematics and also address students' varied mobility and sensory needs. In 1998, the start of a follow-on grant, the focus changed from curriculum development to the professional development of teachers of DREAMS students. Hands-on, minds-on, national standards, adaptive curriculum, culturally appropriate curriculum, adaptive technology needs, and learning styles are addressed during the year-long professional development of DREAMS teachers.

During the institutes, a number of field trips were taken by the students and staff. Places such as Turtle River State Park, Teddy Roosevelt National Park, Fort Union, Bismarck Zoo, an ostrich farm, a dairy farm, Falkirk coal mine, the Coal Creek power plant, Garrison Dam and hydroelectric plant, the State Capitol at Bismarck, and the State Heritage Center were visited. During institutes students were provided with evening activities such as picnics, bowling, and swimming.

During spring 1998 institute, for example, students and staff members visited a dairy farm. During the lesson the next day, the concept of volume was introduced through the use of cream and milk cartons (½ pint, pint, quart, ½ gallon, and gallon sizes). Students and staffers transferred water from several small cartons to larger cartons to determine the relationship between them. Extra time was spent by the senior author with a blind student so that he could literally get a feel for the relative sizes of the cartons. A friendship was developed such that when the faculty member's voice was first heard at the next institute in August the student remembered that staff member's name. It is incidents such as these that led us to expand our view of the capabilities of students with sensory and other disabilities .

Participants

The program was designed to provide additional education in math and science for Native American students with disabilities. Because of the nature of some of the disabilities and targeted ages, most of the children came with parents or guardians. Also attending the institutes were teachers, university faculty, mentors, site coordinators, culture teachers, role models, the program director, and the PI's (principal investigators). Overall, the organization and coordination efforts were very large and challenging as the population of some institutes reached 100 or more.

Disabilities

The disabilities of the children were rather diverse. Conditions of participants included asthma, cerebral palsy, visual impairment/blindness, orthopedic disabilities, hearing impairment, juvenile rheumatoid arthritis, cleft/lip palate, stroke, oxygen deprivation, and speech. These disabilities caused a number of students to be wheelchair bound, to have limited use of their hands, arms, or legs, to have limited physical stamina, or to have sight and hearing limitations. Also, some of them were on medication which limited their mental functioning and ability to concentrate.

Assessment/Evaluation

The DREAMS project funds a comprehensive evaluation. Evaluation of student learning outcomes is difficult, but is built around a twofold approach. First, the Woodcock Psychoeducational battery will be given to students at least yearly. This will allow comparison of student knowledge of science concepts with a national sample. This phase of the project is in its initial year, so data is limited. In addition, students visit "talking stations" after experiencing a lesson or activity, where they are expected to explain about the concepts they learned.

Children evaluate in writing all activities from each institute, as do the adults involved in the program. Participating students also fill out attitude toward mathematics inventories and questionnaires dealing with their interest level in mathematics and science careers.

Teachers are extensively interviewed regarding systems change and observed/visited in their classrooms. Core team members are also interviewed periodically to evaluate systems change aspects of the project. All adults answer surveys about the quality of the institutes, and attitudes toward disabled persons. A new instrument was developed during the 1998 session dealing with attitudes toward Native American culture.

Outcomes and Benefits

Several themes emerged from the first rounds of evaluation. These are presented below.

<u>Hands-On Science and Mathematics.</u> When asked to rate activities, both students and parents favored lessons which included hands-on participation. Generally, science experiments producing noise, or movement were endorsed by students. For example, in the August, 1998 institute, the activities receiving the highest student rankings were the egg toss (a structural engineering project) (M = 1.13 on a two-point scale; sd = .33), photo recording (M = 1.12), flight simulator (M =

1.05), and airport tour (M = 1.04).

Several students also wrote on their surveys that they wanted even more "hands on" and "real" activities. One student specifically wrote, "I want even more excitement and action." A teacher astutely observed, however, that the emphasis on sensory experience must be carefully paired with academic learning. The motivational component was observed, but this excitement must be balanced with the opportunity to reflect on concepts. Plans are underway to hold talking stations following each activity, where students will discuss mathematics and science activities with trained teachers. Perhaps in line with this, several students, parents, and mentors argued that more advanced concepts could be handled by older students.

Because of the desire to keep students engaged with learning, many activities and social events were planned. These came in for some criticism, with many participants among both children and adults arguing that the pace was too hectic. Thus, for future institutes, a more reflective pace is planned. This lighter scheduling will probably also foster reflectivity and concept development.

<u>Instruction Highly Rated.</u> Instruction for teachers and activities generally, were well received by participants. For example, participating teachers rated mathematics pedagogy instructions they received very highly. The quality of mathematics instruction averaged 9.46 [sd = 0.59] (on a 10-point scale, N = 13 in all cases), while the usefulness of information for classrooms was rated 9.44 (sd = 0.50). Information and presentations regarding science instruction received ratings of 9.37 (quality) and 9.19 (utility).

In interviews, teachers appeared to embrace the hands-on, concept rich approach advocated by project personnel. The teaching style they related could best be described as child- and developmental-centered. That is, they all endorsed mathematics and science instruction featuring a cycle of student observation/ interviews followed by activity-rich lessons. However, as of August, 1998, few of the teachers could verbalize curriculum theory or a sense of connectedness from concept-to-concept, nor specifics of assessment. It remains to be seen whether the specifics of curriculum development will emerge by spring of 1999.

All teachers endorsed sensitivity to American Indian culture in science and mathematics instruction and could voice methods for accommodating cognitive, behavioral, and sensory impairments. Specifics for adjusting instruction in light of American Indian culture were few and far between, though the majority of teachers (many of whom were American Indians themselves) mentioned respectful school-home relationships as a centerpiece of culturally sensitive teaching. Others advocated building science around nature and ecological themes.

<u>Positive Outcomes Cited.</u> Data is being developed which will allow project personnel to track concept development among students. However, a frequently-cited finding (parents and core team members) was that students who had participated in the program over several years had grown more intellectually and behaviorally than could be explained by their advancing years. These students appeared confident and poised as they negotiated the university campus.

University faculty members and other adults involved in the project cited numerous benefits for them personally, some of them not always directly related to the project itself. Primary among these was personal growth. One faculty member from the College of Engineering and Mines, stated that he benefited most from the diversity. This same faculty member also argued that he "will see his future electrical engineering students differently" because of his DREAMS experiences. Specifically, he increasingly came to see students in terms of their potential, rather than as a sum only of their disabilities. Each student can learn and grow, given that science, mathematics, and technology teachers approach them as individuals with specific learning needs to be discovered. Putting it in terms of science and technology, each interaction between an instructor and a student is an experiment in learning. This engineer will bring that emerging view to teaching his college students. The same faculty member also believed that it is beneficial for science, mathematics, and technology college instructors to experience instruction at the elementary, middle-school, and secondary levels.

University participants cited a comfort level change in terms of working with students with disabilities. Noting their abilities is one way this changed sensitivity played out. A second way was that science, engineering, and mathematics faculty members reported that they were less inhibited about social exchanges with disabled individuals--as a direct result of participating in DREAMS.

Challenges

One of the biggest challenges is that of working with totally blind or totally deaf children and adolescents. Many typical communication methods must be adapted in order to reach these students. When presenting material one has to keep this in mind. For persons with blindness, one has to have models or aids (adaptives) for the students to feel or touch in order to help them understand. For persons with deafness or hearing impairment, it is even more challenging in that the instructor may not realize that the student is not receiving information aurally. Similarly, students on medications may appear to be lackadaisical. It is common for very bright students to appear dull or disinterested as a side effect of their medication. Unless the teacher is aware of these situations, the student may not achieve his/her full potential.

A challenge for the senior author (as a college teacher) was reaching down to students' conceptual or developmental levels. University faculty would frequently request information about which concepts students would likely know. Many faculty members reported that it "stretched" their range as teachers--but also in the ability to relate to a variety of people across ages and walks of life. University instructors take a lot for granted (perhaps too much, sometimes). The assumption is entertained that students know calculus, for example. But when working with grade school students, instructors must ask questions much like the following: Do they understand concepts such as area? volume? gravity? These were the challenges, but there were also many opportunities. This type of sensibility, that of not taking background information for granted, has changed and improved our approach to teaching engineering at the university level.

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Biography

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