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ABSTRACT

Disability Research Encompassing Native Americans in Math and Science (DREAMS) is a comprehensive program that offers math and science experiences to Native American students with disabilities and encourages systems change in schools on or near Indian reservations in related domains. These domains include development of science instructional models based on hands-on learning and conceptual development, approaches to meet national science and mathematics standards, infusion of Native American culture into instruction and methods, accommodations for students with disabilities in science and math instruction, and career exploration in technical fields. DREAMS is a partnership between the University of North Dakota and 10-12 public and tribal schools in North Dakota. Project activities include curriculum and materials development; two annual week-long summer institutes for students, parents, and teachers; teacher education in science and mathematics; and systems change and liaison at participating schools. Program evaluation is based on attitude and achievement data from students and on feedback from parents and teachers about the effectiveness of the summer institutes and systems change. Assessment results for 1998 are summarized. (SV)

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DISABILITY RESEARCH ENCOMPASSING NATIVE AMERICANS IN MATH AND SCIENCE: A DEMONSTRATION INCLUSION PROJECT

In 1993 the National Science Foundation funded a project at the University of North Dakota entitled, "Disability Research Encompassing Native Americans in Math and Science" (DREAMS). The project is a comprehensive program designed to (1) offer experiences to Native American students with disabilities in the areas of mathematics and science, and (2) encourage systems change in schools on or near Indian reservations in the following four domains:

1. Encouraging development of science instructional models based on hands-on learning and conceptual development.

2. Facilitating approaches to mathematics curriculum aligned with standards set by the National Council of Teachers of Mathematics (NCTM, 1989). These standards also feature an emphasis on conceptual development via the use of models and manipulative aids, and stress child- and developmental-centered learning.

3. Facilitating approaches to national science standards set by the National Academy of Sciences (1996).

4. Engendering sensitivity to Native American cultural sensibilities in the teaching of mathematics and science. This entails the infusion of Native American cultural images into instruction and methods.

5. Creating accommodations for students with physical, sensory, perceptual, cognitive, and behavioral differences in mathematics and science instruction.

6. Career exploration in technical fields is undertaken with students, teachers, and parents.

In the remainder of this paper, DREAMS activities and outcomes are described. A section each is devoted to the organization of DREAMS, programmatic activities, evaluation procedures, and outcomes.

DREAMS Organization

Project DREAMS is constituted as a partnership between the University of North Dakota and 10 - 12 public and tribal schools in North Dakota (the number depends on where DREAMS students are enrolled). As might be expected given a program embracing such diverse administrative units and covering essentially the entire area of North Dakota, coordination is central to the program's success. A project director, housed at the University of North Dakota, oversees the many aspects of the program. The project director reports to two principal investigators.

University personnel from many technical areas are recruited by the DREAMS coordinator to serve as faculty for summer institutes, to mentor children, and to advise core team members in curriculum development. Faculty members from the physical and biological sciences, aviation and space studies, as well as the College of Engineering and Mines have been involved in DREAMS. Faculty in the College of Education and Human Development lend their knowledge of curriculum and instructional development to the project. In addition, the College of Education and Human Development's research wing is responsible for project evaluation.

Members of a core team recruited by the Project Director organize summer institutes and assist with curriculum development. One of the principal investigators is a professor in the field of rehabilitation and advises program faculty about accommodations for students with disabilities. Site coordinators, typically employed by schools where DREAMS students are enrolled, are paid a stipend by DREAMS to coordinate the efforts of project staff, teachers, students, and parents.

An advisory group is impaneled to provide technical assistance to the grant. Members of the advisory board include Native American persons, experts on science and mathematics curriculum, technology experts, disability specialists, and representatives of the public schools.

Program Activities

The five goal areas, improvement of (i) mathematics and (ii) science instruction, (iii) Native American cultural infusion, (iv) disability accommodation, and (v) career exploration are accomplished via a variety of activities. The DREAMS project consists of several aspects including curriculum development, summer institutes, pedagogical training for teachers, systems change, and liaison activities. These program activities are briefly outlined below.

Curriculum Development

When the DREAMS project was initially gearing up, faculty members from UND and program staff met to plan institutes and to develop curriculum materials. The primary emphasis of these sessions was writing curriculum for math and science instruction as currently advocated by professional organizations, developing disability accommodation, and incorporating cultural awareness into science and mathematics materials and methods. In their planning efforts, staffers emphasized conceptual and hands-on aspects of mathematics and science, as opposed to reading, memorizing, and reciting facts (e.g., Weiss, 1994).

A curriculum guide centered around the biological sciences was produced as a model by project staffers (The Circle of Life, Greenwood, 1996). The guide contains readings regarding cultural infusion and disability accommodations. In addition, activities are included illustrating hands-on science and mathematics approaches. Circle of Life materials include a video depicting infusion and accommodation activities in action. Since the initial start-up period, curriculum planning sessions have continued as project personnel develop materials for each summer institute.

Summer Institutes

A central feature of DREAMS is a twice yearly summer institute, one held in June, the other in August. The week-long summer institutes provide opportunities for students, parents, and teachers to get together and explore mathematics, science, and Native American culture. Teachers likely to work with DREAMS students during the upcoming school year are recruited to attend the August institute. Summer institutes are held in a variety of settings around the state of North Dakota. The August 1998 institute held at UND was built around the theme of flight-and-space.

Students are exposed to many science, math, and cultural activities during the summer institutes. The camp-like atmosphere of sessions is enhanced by frequent fellowship and recreational activities. All the fun, however, is underpinned by serious intent: To expose students, parents, and teachers to the possibilities of learning science and mathematics, to the enchantment of exploring the physical universe with these tools, and to the possibilities of attending college and pursuing careers in technical fields. A sampler of activities from the August 1998 institute is provided below:

- Space Activities Exploration
- Comparing the Geology of Earth and Mars
- Planet Facts
- Construction of a Planetarium
- Internet Searches and Use of Presentation Software
- Culture Star (Ojibway and Mitchif Cultural Activity)
- Flight Simulators
- Airport Tour
- Egg Landing Activity
- Designing and Launching Bottle Rockets

Culture teachers, representing the indigenous peoples of North Dakota, play an important role in summer institutes. The culture teachers design opening and closing sessions which infuse the institutes with an air of respect for people of the prairies and northern forests. In addition, lessons and activities centered around Native American culture are included in institute programming for both children and adults.

Pedagogical Training in Science and Mathematics

Stipends and travel awards for teachers who work with DREAMS students during the school year are included in DREAMS funding. Teachers' summer institute schedules are arranged such that about half of their time is spent with students--observing and assisting project faculty--and about half in instructional sessions dedicated to exploring current thinking in mathematics and science curricular domains, as well as cultural infusion and adaptive methods.

Participating teachers also receive 3 mid-year "booster sessions" and earn credits at the University of North Dakota by completing projects related to (1) curriculum change, (2) accommodations and cultural considerations, and (3) mathematics and science assessment practices.

Systems Change and Liaison

Site coordinators are funded by DREAMS to ensure that teachers are supported in their efforts to implement change in science and mathematics along the lines described above. Site coordinators monitor progress of DREAMS students at participating schools and keep lines of communication open between teachers, parents, and university personnel. For example, curriculum and disabilities-accommodation materials needs of teachers are communicated back to the university (and hopefully met) in this way.

Project Evaluation and Student Assessment

Evaluation of DREAMS is conducted by staff members of a semi-independent agency, the Bureau of Educational Services and Applied Research (BESAR). The Bureau is the technical assistance and research arm of the College of Education and Human Development at UND. An evaluation study was proposed by the director of the bureau in light of the goals and practices set out in the original grant proposal.

Evaluation is based on collection of opinion and assessment data from students enrolled in the project. In addition, feedback is sought from parents, core team members, culture teachers, and teachers regarding (1) effectiveness of the summer institutes, and (2) systems change.

Student Data

Three subtests from the Woodcock-Johnson Psycho-Educational Battery-Tests of Achievement (1989, 1990) are employed to track students' progress in mathematics and science achievement. The science subtest was individually administered, as were both mathematics subtests from the WJ-R tests of achievement. One of the mathematics subtests assesses use of basic arithmetical and mathematical algorithms at a basic level of mathematics performance; the other is designed to tap problem solving skills.

The Attitude Toward Mathematics subtest (ATM) of the Tests of Mathematical Abilities (TOMA-2, Brown, Cronin, & McEntire, 1994), formerly the Estes Attitude Toward Mathematics Scale, was also administered to students. The ATM was designed to tap affective responses to the discipline in order to track the degree to which DREAMS programming was impacting students in this regard. Attitude toward science were measured via a 12-item questionnaire. Student perceptions of technical careers was assessed via a structured interview. All student data will be gathered at least twice, with most students being assessed three times.

In addition to the formal methods mentioned above, students are being assessed via observation and interviews. Following each lesson and activity, students attend "talking stations" where staff members interview them regarding perceptions of the activity, their conceptual development and understanding regarding the nature of the just-completed activity, and its relationship to past learning. Highlights of these interviews are to be recorded and used in program evaluation efforts. A survey form was developed which each student fills out upon completion of summer institutes. The survey form is used to assess students' perceptions of the quality of institute activities and presentations, and to ask once more about learning. Comprehensive Test of Basic Skills scores are collected yearly from participating districts for each student.

Adult Evaluation

As is true of students, adult participants are asked to provide qualitative and quantitative impressions of all summer institute activities. This is accomplished via a survey document developed especially for DREAMS and which is revised each summer in light of the specific activities planned during the institute. To a great extent, feedback from adults and students is employed to redesign and redirect summer institute procedures and activities.

Adult participants complete an instrument about North Dakota Tribal cultures (Tribal Cultures Survey; TCS). As no effective instrument was available, the TCS was adapted from an instrument which referred to the role of tribal cultures in the overall education picture in North Dakota. Items were changed to reflect middle school and secondary education issues. Because the instrument was not directly employed prior to its use in DREAMS evaluation, part of the assessment process has been to establish the psychometric properties of the tool. It has, to this point, yielded a single factor which appears to tap the level of sophistication regarding Native American cultural issues. Higher scores on the 13 items identified via principal components analysis seem to measure positive attitudes toward Native American cultural resilience and recognition of the struggles of Native American individuals in Euro-American society. The scale is internally consistent; a Cronbach's (1951) alpha of .86 was calculated from the first round of data collection. Items from the instrument which did not load on the principal factor, generally

showed ceiling effects (all participants responded in a manner indicative of positive attitudes toward Native American society and culture.

Teachers were asked to rate the quality of the instruction they received in several domains on a ten-point scale, from 1 = very ineffective to 10 = very effective. In addition, a lengthy interview was held during the August institute, supplemented by written responses during booster sessions in November. It is planned that participating teachers will be interviewed a third time during June 1999.

Assessment Results

As the Congress of Rural Special Education deadline approached, the first cycle of student standardized assessment data had not been completed. However, teacher interviews and feedback from parents, staff, teachers, and students attending the August 1998 institute were available. A summary of these results is presented below.

1. The student activities (learning experiences and recreational) at the summer, 1998 DREAMS Institute were seen as effective by all categories of respondents. Students rated most activities positively, but particularly those with hands-on components or where significant sensory experiences were noted.

2. A downside may exist regarding the degree to which hands-on and sensory-rich activities are stressed. While the motivational elements of these activities are clear, the cognitive-conceptual aspects may not be optimal. Expanding the use of "talking stations" and providing opportunities for older students to explore the subject in more depth may be ways to improve the cognitive-conceptual aspects. Likewise, conceptual continuity between activities within institutes and from one institute to the next may be helpful.

3. Subjective evidence for student learning exists in the form of unsolicited written comments from teachers regarding the increased level of maturity shown by students (as compared to when they first started attending) and their ability to handle more conceptually difficult and abstract content. Risk-taking by students in the learning activities has increased, in part due to their growing comfort with each other and the learning process.

4. Preliminary evidence exists that the level of sophistication regarding Native American cultural appreciation has increased among adult participants as a function of the efforts of DREAMS culture instructors and contact with persons from other cultures.

5. Teachers served in the program rated instruction and experiences highly. They were very complimentary regarding the usefulness of their experiences in concept-based, hands-on curriculum development; cultural infusion; and disability accommodation for their classrooms back home. They were in agreement with the content of the mathematics and science instruction and curriculum standards as presented.

6. It was difficult from teacher data (August or November) to determine a sense of any specifics related to teaching methods or philosophies beyond statements endorsing "hands on" and "child centered." For example:

    a. Despite the question being directly posed, no commentary was forthcoming regarding how the standards affect assessment, nomention was made of curriculum integration or

ways to conceptually connect a series of hands-on activities in a workable curriculum plan.

b. Teachers endorsed inclusion of and accommodation for students with mild disabilities in their classrooms. However, it was difficult for them to articulate specific methods for accomplishing this.

c. Teachers endorsed incorporation of Native American culture into mathematics and science in principle, but were not forthcoming as to how this could be done (August) nor that it was being done (November). Sensitivity to and acceptance of cultural differences was endorsed by teachers as a method for accommodating Native American students and their families in schools.

7. Teachers found that consultation with parents was helpful both at the institute and at home. However, participating teachers requested that they spend more time directly with students during the institute.

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