DOCUMENT RESUME

ED 478 056 RC 023 785

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TITLE Research Issues for Mathematics Education in Rural Communities: Focus on Native Americans. Working Paper.

INSTITUTION Ohio Univ., Athens. Appalachian Collaborative Center for Learning, Assessment, and Instruction in Mathematics.

SPONS AGENCY National Science Foundation, Arlington, VA.
REPORT NO WP-13
PUB DATE 2003-00-00
NOTE 42p.
CONTRACT NSF-0119679
AVAILABLE FROM For full text: http://kant.citl.ohiou.edu/ACCLAIM/rc/rc_sub/pub/3_wp/Nelson13.pdf.
PUB TYPE Information Analyses (070)
EDRS PRICE EDRS Price MF01/PC02 Plus Postage.
DESCRIPTORS Academic Standards; Alternative Assessment; American Indian Culture; *American Indian Education; *Culturally Relevant Education; Educational Change; *Educational Needs; Educational Practices; Educational Research; Elementary Secondary Education; *Mathematics Education; *Research Needs; Reservation American Indians; Rural Education
IDENTIFIERS *Montana

ABSTRACT

Low student achievement for Montana's Native American students has been a recognized fact since the beginning of the reservation period. The current push for mathematics and science education reform, coupled with federal and state accountability mandates, enhances opportunities for learning but also challenges Native students' culture and priorities. Native student learning in mathematics is influenced by contextual factors: federal, state, and local policy mandates; Native culture, community, language, and ways of knowing; the culture of poverty; isolation; and classroom practice. This paper reviews current research on several contextual factors, making connections between the literature and observations in schools on or near Montana's reservations. The first section looks at the history of the reservations and educational opportunities for Native students; the impact of policy, poverty, and isolation on these students and their schools; and the impact of Native American culture on the educational lives of students. The second section examines issues of standards and equity for mathematics education; it includes research and discussion on culturally responsive teaching, curriculum, and assessment. The third section discusses obstacles, challenges, and opportunities for achieving equity within this system and proposes research topics to help educators address them. Topics include local control; access and isolation; student mobility; and the lack of adequate tracking systems for student attendance, achievement, and district expectations. The conclusion describes what is working in schools on two Montana reservations and the future research needed to define a vision for closing the achievement gap for Native students. (Contains 30 references) (SV)

Working Paper No.13

Working Paper Series

Appalachian Collaborative Center for Learning, Assessment and Instruction in Mathematics

Research Issues for Mathematics Education in Rural Communities: Focus on Native Americans

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ACCLAIM's mission is the cultivation of *indigenous leadership capacity* for the improvement of school mathematics in rural places. The project aims to (1) understand the rural context as it pertains to learning and teaching mathematics and (2) articulate in scholarly works, including empirical research, the meaning and utility of the learning and teaching among, for, and by rural people.

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Funded by the National Science Foundation as a Center for Learning and Teaching, ACCLAIM is a partnership of the University of Tennessee (Knoxville), University of Kentucky (Lexington), Kentucky Science and Technology Corporation (Lexington). Marshall University (Huntington, WV), University of Louisville, and Ohio University (Athens, OH).

This material is based upon the work supported by the National Science Foundation Under Grant No. 0119679. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

RESEARCH ISSUES FOR MATHEMATICS EDUCATION IN RURAL COMMUNITIES: FOCUS ON NATIVE AMERICANS

One of the most significant themes that emerged from researchers, educators and parents in Indian country was an eagerness to see research translated into practice -- research that focuses on effective educational practices and ways to implement them.

Introduction

According to figures released by the Montana Office of Public Instruction in September 2002, 38 of the 43 schools placed on the state's "schools in need of improvement" list are on or near Montana's seven Indian reservations that serve a majority of the states' Native American students. Indeed, "Indian children in Montana public schools are in a crisis situation" (Montana Office of Public Instruction, 2001). This is not news. In 1991, 40 of 46 schools on the list were reservations schools. The state only uses one criterion to place a school on the list: if scores of students in two of the three tested levels (grades 4,8, and 12) fall below the 45th percentile on the Iowa Test of Basic Skills (ITBS) norm-referenced tests for two consecutive years, the school is categorized as "in need of improvement" (R. Lukenbill, personal communication, September 3, 2002).

Another indication of the crisis situation includes dropout rates for students on these reservations. During the 1996 school year, the dropout rate on the Northern Cheyenne reservation was about 50%. Although 144 Native American students from the reservation attended high school in 1996, there were 788 Northern Cheyenne students of high school age

(Montana Advisory Committee to the U.S. Commission on Civil Rights, 2001) Where were the remaining 644 students? It appears that in addition to those who dropped out, many students on the reservation weren't initially enrolled in the local high school.

As this paper will indicate, low student achievement for the majority of Native American students in Montana has been a recognized and often accepted fact since the beginning of the reservation period. According to the Montana Advisory Committee to the U.S. Commission on Civil Rights (2001, p. 61), "Indian children in Montana public schools are not excited about their own future or the future of their friends and relatives." In light of this, there is an urgent need to turn the trend around with the help of well-documented research on issues facing Native American education.

The current push for mathematics and science education reform, coupled with federal and state accountability mandates, enhance the opportunities for learning, yet at the same time challenge the culture and priorities of these students. Native American student learning in mathematics is influenced by several contextual factors: a) federal, state and local policy decisions and mandates, b) Native American culture, community, language, and ways of knowing, c) the culture of poverty, d) isolation, and e) classroom practice. The authors will review the current research on several of these contextual factors, making connections between research literature and situations observed in schools on or near Montana's reservations.

This paper is divided into four sections. The first section looks at the history of the reservations and the resulting educational opportunities for Native American students, as well as the impact of policy, poverty and isolation on these students and schools. The section concludes with a discussion of the impact of Native American culture on the educational lives of students. The second section looks at issues of standards and equity for mathematics education; it includes

research and discussion on culturally responsive teaching, curriculum, and assessment. The third section looks at the obstacles, challenges and opportunities for achieving equity within this system and proposes research topics to help the educational community address them. The section includes discussions of local control, access and isolation, student mobility and the lack of adequate tracking systems for student attendance, achievement and district expectations. The paper concludes with a conversation of what is working in schools on two adjacent Montana reservations and the future research needed to define a vision to close the achievement gap for Native American students.

Although research has increased our knowledge of teaching and learning practices in mathematics that have proven successful for Native American students, "the interpretation of what this research means in the ways teachers are trained, schools are organized, curriculum is designed and instruction is delivered is still needed" (Deyhle & Swisher, 1997). Integrating successful research-based practices into the complex educational systems that educate preservice and inservice teachers, generate and implement policy, design curriculum, and provide accountability for the various stakeholders is a challenge for all who take up the charge. This challenge becomes more complex when set in Native American cultural contexts in rural and poor communities.

The Impact of History, Culture, Isolation and Poverty on the Mathematics Achievement for Montana's Native American Students

History of Reservations in Montana

In 1990, two thirds of Montana's American Indians resided on reservations, land bases the tribes reserved through treaties with the United States government in exchange for other lands (Montana Office of Public Instruction, 2001). Figure 1 depicts the approximate size of the seven Montana reservations. These reservations were established through treaties from 1851 through 1916. Montana's Native American students make up 10.5% of the state's public school population. The majority of these students attend schools on or near these seven reservations.

Figure 1

The reservations are located in sparsely populated areas of immense natural beauty. To get an idea of the distances between these reservations, picture a map of the state of Montana placed on the eastern third of the United States. If you placed the northwest corner of the state on Chicago, the southeast corner would almost reach Washington, D.C. In addition to being rural and isolated, these schools are in counties that consistently rank among the poorest in the United States.

The schools on or near the reservations are considered small (less than 300 students for elementary schools and 900 for the high school level) as defined by the Matthew Project, a study designed to find the correlation between school size and socioeconomic status (Howley, Strange, & Bickel, 2000). The majority of Native American students attend public schools on or near the

reservations. The remainder attend one of the state's two Bureau of Indian Affairs (BIA) schools, larger urban school districts, or parochial schools. Some of the districts are K-12 with various elementary, middle school and high school configurations, while others are K-6 or K-8 schools with self -contained classrooms. On each of Montana's seven reservations is is a two-year tribal college, established to provide local, affordable post-secondary education to reservation young people.

Throughout the hundreds of treaties negotiated between the various tribes and the US government from the late 1700's through 1871 (Juneau, 2001), American Indians have theoretically always had a voice in the education of their youth. The state, however, only recently acknowledged as much: Article X, Section 1(2) of Montana's State Constitution (1972) contains the following language:

> The state recognizes the distinct and unique cultural heritage of American Indians and is committed in its educational goals to the preservation of their cultural integrity.

Yet, "little has been done to fulfill this commitment and incorporate it into educational agencies, including public schools" (Montana Office of Public Instruction, 1999, p.6). Throughout the past 30 years several legislative "plans" and recommendations have been written addressing the needs of the American Native students, but few concrete laws or policies have backed these recommendations up with financial support. As of 1997, the token effort the Montana legislature gave to recognizing the richness of the Native American culture and the need for addressing the educational issues of its students was to designate one day a year as American Indian Heritage Day.

Recent efforts to address Indian education include the passage of House Bill (HB) 528 in 1999. The language in this bill *encourages* every Montanan to learn about the distinct and

unique heritage of American Indians in a culturally responsive manner, *to work cooperatively* with Montana tribes or those tribes that are in close proximity, and to provide the means by which school personnel *will gain an understanding* of and appreciation for the American Indian people. In addition, districts *may require* that all of their certified personnel satisfy the requirements for instruction in American Indian studies. School districts *are encouraged* to satisfy the requirements for instruction of Native American culture (Montana HB 528). One explanation for the lack of specific directives in the law is the state's strong emphasis on local control. The lack of specific directives contributes to the statement in the Indian Education For All Act of 1999 that "Indian students still attend schools where they do not see themselves present in classrooms, policies or curriculum. Non-Indian students still attend schools where they do not learn about their Indian peers with whom they will continue to work and live."

In 1996 and 1997, representatives throughout state involved with the education of Native American youth addressed their concerns to the Montana Advisory Committee to the U.S. Commission on Civil Rights. The speakers shared statistics, personal viewpoints, teaching experiences and educational concerns from all levels. As a result of these hearings, the committee found that in spite of a great deal of verbal acknowledgment of the problems, the results were negligible. The committee addressed these issues by recommending "concrete, numerical goals with specific timetables be established to move Indian education ahead in Montana" (July, 2001). The nine specific recommendations outlined by the Advisory Committee will be discussed within the context of various sections of this paper.

Rural Schools in Poor Communities

There are both opportunities and challenges for students living in the communities on or

near Montana's reservations. Most of the schools on the reservations are located in predominately Native American rural communities beset with poverty. The nearby off-reservation schools are larger by Montana standards, and the student population includes a mix of Native and non-Native students.

The Matthew Project first examined the impact of poverty on students in rural schools in a multi-state study concluded in 1989. This study, which focused on the hypothesis that school size mitigates the influence of poverty, was replicated in the late 1990's with seven additional states including Montana (Howley et al., 2000). For the purposes of the study, poverty was measured by the number of students on free or reduced-priced lunch. In contrast to previous research that indicated the strong negative influence of poverty on student achievement (Campbell & Silver, 2000), The Matthew Project found that the influence of poverty was reduced when schools enrolled fewer than 300 students at the elementary level or fewer than 900 at the high school level (Howley et al., 2000). The study found that the less affluent the community, the better students performed in smaller schools. In Montana, there "is startling evidence that students in smaller schools and districts outperform larger ones, even though they serve poorer communities"(Lewis, 2001). A question that needs to be answered is if this finding holds true for students in reservation schools.

Students in poor, rural communities encounter numerous challenges. Those include the limited number of out-of-school experiences to which they have access, which in turn limits the amount and type of prior knowledge needed for building new knowledge. Parents often have limited educational experience themselves and are therefore distrustful of schools or of new educational methods used in the classroom. Often the community is not included in discussions of the rationale for curricular changes the districts implement. Lastly, changes in administration

are frequent on the reservations; Campbell and Silver (2000) note that the high administrative turnover that characterizes schools in poor communities has often resulted in numerous curricular changes with little support or understanding of previously implemented initiatives.

Several districts with small schools have found the use of "place-based" education to be successful. Place-based education draws on local history, environment, culture and economics as a rich source of curriculum. The goal of place-based education is to ground learning in local phenomena and students' learned experiences (Smith, 2002). This form of education is founded on John Dewey's belief that many children have to put aside their life experiences in order to adapt to the ideas and activities of the public school. In contrast, place-based education encourages students to build on those life experiences.

The elements of place-based education are in alignment with successful research-based educational models for educating Native American students. Local culture and community values are used as the basis for the curriculum, helping blur the line between the school and the community. Learning experiences emphasize students as the creators of knowledge rather than the consumers of knowledge created by others. Teachers serve as guides and facilitators of student learning, often serving as team members of a project. Student work is assessed on the basis of its usefulness to the community and sustainability rather on the basis of sorting and ranking schools and students (Smith, 2002).

Possible research topics regarding Native American students attending rural schools in poor communities:

- Do the results of the Matthew Project, i.e. that school size mitigates the effects of poverty on student achievement, hold true for rural reservation schools?
- What impact does the use of place-based education have on student achievement in mathematics in schools with a majority of Native American students?

- Which types of pedagogy are most successful in raising student achievement for Native American students in poor, rural schools?

Influence of Native American Culture

Many Native American students have been raised in a very rich culture quite different from that of many of their teachers and administrators. A Native Alaskan teacher comments: "In order to teach you, I must know you" (Delpit, 1995). Not only are the cultures of Native American students different from that of their teachers, but the cultures of various tribes can be very different. Although there are cultural values common to members of the various Native American tribes, each tribe has its own language, spiritual belief systems and traditions. In general, the Native American culture is holistic, integrating the community, the individual, the environment, and spirituality. In traditional Native American communities, what is good for an individual is inextricably linked to the good of the entire community. Although there is a differentiated role for each individual that abides by the social order, drawing attention to one's self creates ill will within the Native American community (Northwest Regional Laboratory, 2002).

In the classroom, no one traditional learning style fits all American Indian children, either as individuals or as members of tribal groups (Montana Office of Public Instruction, 2000). To improve student learning, however, it is critical to situate mathematics education within the context of the culture in which it is being taught (Davison, 2002). In addition to culture, factors like gender, linguistics and socioeconomics all play a role in students' ability to learn mathematics (Cooper & Dunne, 1998; Zevenbergen, 2000 as cited in Boaler, 2002).

A first step in addressing the needs of the American Indian students is to establish an environment that conveys the value and strength of their cultural differences (Deyhle & Swisher, 1997). These cultural differences surface in areas of parental expectations, linguistics, assessment, and the value placed on certain aspects of learning and student behavior. For example, in the Native American culture, students are encouraged to learn by observing the adults in their lives and waiting to try out a new skill until they are fairly certain they know how to do it. Confusion can occur when the classroom teacher urges students to "guess and check" or "try" a method of solving a problem before the students feel confident enough to attempt it.

The relationship between parents and children is more egalitarian in many Native American communities than is found in middle class families in the Unites States. Native American adults respect children as independent-thinking adults at a very early age. Children are encouraged to be quietly independent and self-assured, often taking care of themselves at a very young age in contrast to the expectations of the traditional classroom, in which children are viewed as lacking the ability to take responsibility for themselves. As such, Native American parents are less likely to intrude or interfere with the decisions their children make (Deyhle & Swisher, 1997). Non-Indian teachers often view this behavior as a lack of parental discipline. Juneau paraphrases Lone Wolf, a Blackfoot Indian, who remarked "that among his people, children were never punished by striking them. That was no way to teach children; kind words and good examples were much better" (Juneau, 2001). These differences in cultural and family expectations of Native American homes certainly have the potential for affecting the teaching-learning process in public school systems dominated by white middle-class values (Montana Office of Public Instruction, 2001).

The impact developing a firm cultural identity has on school success is apparent in Lin's study cited in Demmert (2001) of 87 American Indian students attending a Montana college. Lin found that those students from more traditional Native families were more task- and achievement-oriented, had higher grade point averages, and spent more time doing homework than those from more modern families, who cared more about professors' opinions, yet ironically skipped more classes (p. 28). Although there has been a great deal of research that supports the importance of family and community attitudes on Native students' academic achievement, Demmert, reviewing the literature on Native education, stated that more research is needed to sort out under what circumstances parental and community involvement works most powerfully.

Cleary and Peacock (1998) make the following compelling challenge for all teachers of Native American students.

> The most important endeavor for teachers in Indian schools and in schools that serve Indian children is to see themselves as learners, learners who are open to understanding the reasons that children and communities are the way they are, learners who are willing to discover and consider the cultures of the school and the home of the child, and learners who are willing to change their ways of teaching so that children have a better chance in school and a better chance to have purpose and hope in their lives thereafter" (p. 6).

Strang & von Glatz (2001) and Demmert (2001) recommend the following research topics on connections between cultural identity and student achievement :

- Is there a shared definition of culture between indigenous communities and the dominant culture? (Strang & von Glatz, 2001)

- Are there cultural values within American Indian/Alaska Native communities that are lost when children attend school? If so, are there methods of teaching that will help to revitalize certain aspects of that culture? (Strang & von Glatz, 2001)
- What are localized, culturally specific ways of knowing, teaching and doing that can be translated into educational frameworks or models? (Strang & von Glatz, 2001)
- How is student achievement in mathematics affected when curriculum and instruction are guided by locally authenticated and aligned content standards, and student performance assessments incorporate high expectations based on tribal history and culture? (Strang & von Glatz, 2001)
- How does the student's "sense of self" (reflected in his/her sense of competence and sense of status) relate to motivation, academic achievement and retention in school? (Demmert, 2001).

In addition to the questions above, we propose exploring the following topics:

- How do teachers from other Native or non-Native cultures serving in a particular Native American currently learn about their students' history, languages, and cultural identity?
- To what degree do teachers currently integrate this knowledge in local mathematics programs?
- What strategies can teachers, schools or communities apply to provide teachers with the cultural knowledge necessary to support their students' mathematics learning?
- What factors contribute to the effectiveness of programs that show a positive association between academic performance and the presence of Native language and culture?

Mathematics Standards and Equity

The recent national emphasis on content standards has included a focus on equity issues. The need to ensure mathematical literacy for all children is critical because "a society in which only a

few have the mathematical knowledge needed to fill crucial economic, political, and scientific roles is not consistent with the values of a just democratic system or its economic needs." In the future, "those who understand and can do mathematics will have significantly enhanced opportunities and options for shaping their futures" (National Council of Teachers of Mathematics, 2000, p.2). Mathematics standards are not confined simply to content, or what we will teach, but also include how we will teach that content and what methods we will use to determine student knowledge. This section will address culturally responsive practices in all three areas – content knowledge, pedagogical knowledge, and assessment practices.

The rationale for establishing math and science standards for all students is based on research that began in the 1950's. This research consistently indicates that the United States system of education is not providing an "equitable" education in math and science for all students – particularly for students of color (Schoenfeld, 2002). Mathematics and access to mathematics has long been recognized as a *critical filter* (Sells study as cited in Schoenfeld, 2002, p. 13) preventing or enabling students' access to technological literacy and higher education. Mathematics not only filters students out of classes, but may lead some to drop out of school or greatly restrict their career options (Hilberg, R.W., Salton, Youpa, & Tharp, 2002).

Equity is the first of six principles for school mathematics in NCTM's Principles and Standards for School Mathematics (2000). Equity does not mean that all students receive exactly the same instruction; rather, it demands that all students have access to the same concepts through appropriate accommodations and varied teaching and assessment practices. As discussed in the section on culture, equity should focus on making the content accessible for the student by setting it in a cultural context that has meaning for him or her. A quality education as once defined "does not necessarily translate into a fair and equitable education" (Montana Office

of Public Instruction, 2001). To summarize, today's mathematics standards may confront strongly held beliefs and values about schooling – for example, beliefs about who can learn what type of mathematics and how they come to know that mathematics. This outcome is as significant as the documents, tools and other products created by the standards (Jamentz as cited in Nelson-Barber, 1998).

Equitable solutions to the educational problems Native American students encounter are important in order to guarantee economic security, the ability and freedom to make informed choices, and the ability to fulfill their own particular life aims within their own communities and beyond (Nelson-Barber & Estrin, 1995). We must not fail them for "to fail children in mathematics, or to let mathematics fail them, is to close off an important means of access to today's society" (Schoenfeld, 2002, p.13).

Standards-based reform holds potential promise for addressing issues of equity. One reason for optimism is that the reforms promote a common vision of what students are expected to know and be able to do. In general, standards-based curricula encourage a more holistic, real-life, active learning sort of pedagogy, more consistent with the constructivist and sociocultural perspectives of learning that have proved effective with Native American students. Reform efforts typically include multiple forms of assessment rather than the singular use of norm referenced tests, which are thought to be culturally biased and antithetical to the ways Native American students perform (Fox, 2001).

Standards-based programs, however, also hold areas of concern for Native American children if members of the Native American community are not given input into identifying the content, selecting curriculum materials for classroom use, or designing appropriate methods for assessing student learning. The Native American community, parents and grandparents have

waited for decades for legislation and educational initiatives to provide true equity for their children (Montana Office of Public Instruction, 2001). As the educational and Native American communities in various regions seek ways to grant access for all students to mathematical knowledge validated by the students' culture, it is important for the research community to support their work by addressing questions like those below.

Recommended research topics on standards and equity:

- Are there classrooms in which American Indians/Alaska Natives are receiving standards-based instruction? How does one document implementation of standards and assessment systems? (Strang & von Glatz, 2001).
- What are the characteristics of schools serving American Indian/Alaska Native students in which standards are implemented appropriately? (Strang & von Glatz, 2001)
- What are the barriers to implementation of new standards and assessment systems in schools serving Native students? (Strang & von Glatz, 2001).
- What is the nature and longevity of the implementation of reform efforts in classrooms serving poor communities, particularly in rural and reservation areas? What are the implications of that reform on student achievement in mathematics?
- In states serving significant numbers of Native American students, are national mathematics education standards (e.g. National Council of Teachers of Mathematics, 2000) supported by state-level content and performance standards, and by the state assessment systems currently in place or under development?
- What differences exist between national and state level mathematics education standards, and national standards and guidelines for Native American learning (e.g. NWREL, 2002; NIEA, 1999; and AISES, 1994)? Given current researched-based understandings of students' mathematics learning, especially for Native Americans, what are the implications for student learning of the differences between these two categories of standards?

Culturally Responsive Pedagogy

Providing an equitable mathematics education for all students requires us to closely examine our teaching, the curriculum materials we use, and our methods for determining what students know and are able to do. This section focuses on the types of pedagogy that have proven successful in meeting the needs of Native American students in mathematics .

It has long been assumed that good teaching in one culture or community is good teaching in another. Research on culturally and linguistically diverse communities indicates that this is not always the case, as knowledge and ways of knowing are both culturally and historically situated (Nelson-Barber & Estrin, 1995). Appropriate discourse in one community does not look the same as discourse in another. Methods of questioning, probing, the role of the teacher and asking for student input differ in various cultures. There is a need to study "culturally responsive pedagogy" in order to better understand successful practices for teaching mathematics to Native American students. In addition to structural and curricular remedies, we need to focus on what teachers need to successfully teach Native American students. Contributing to the development of guidelines to inform teachers of teaching and learning approaches that are successful with Native American students is an important goal for researchers. This will assist instructors as they attempt to "bridge cultures and situate learning in meaningful contexts (Nelson-Barber & Estrin, 1995, p.7). The guidelines developed by the Alaska Native Knowledge Network (1997) with the help of the Alaskan Rural Systemic Initiative show what is possible. This extensive set of principles for preparing culturally responsive teachers who could implement the Alaska Content and Performance standards was based on research findings on successful teaching practices in culturally diverse classrooms. With

attention to the unique characteristics of each tribal culture, these could be adapted for use in Native American settings outside of Alaska.

Current research suggests that certain instructional sequences are more successful than others for teaching Native American students. A recommended instructional sequence builds on Native American students' intuitive and ethnomathematical knowledge. Ethnomathematical knowledge, including forms of mathematics embedded in culturally linked activities in everyday life and the workplace, can provide critical foundations for students. From this knowledge base the students can move to an understanding of symbolic representation and procedural knowledge that leads to understanding the underlying principles and theory. This sequence does not occur in a linear fashion, as students often move back and forth between these various stages of understanding (Trumbell, Nelson-Barber, & Mitchell, 2002).

The instructional sequence for Native American students should combine a constructivist approach to learning complemented with a sociocultural perspective. The constructivist approach "recognizes students as active meaning-makers," building on their prior knowledge, while the sociocultural perspective "recognizes the importance of social and cultural systems and their associated values and expectations on students' learning" (Trumbell et al., 2002). Reform pedagogies reflect both approaches by encouraging instructors to teach concepts in meaningful contexts through the processes of inquiry and exploration. These explorations can make connections with, and reinforce the value of, Native American culture. Proponents of culturally responsive pedagogy also recommend that several types of assessments be available so that students can demonstrate what they know and are capable of instead of relying on one "test" (Trumbell et al., 2002). The teacher's mediation of the different curricular and assessment approaches described above is central to promoting equity. The teacher's task then centers on

helping students make connections between their personal meanings, culture-based systems, and the systems of the school (Nelson-Barber & Estrin, 1995).

Conflicts between reform pedagogy and Native American students' ways of learning can, however, occur when the observational and contextual learning modes of Native American students conflict with the traditional verbal interchange that occurs in many classrooms today. As noted earlier, Native American students are more likely to observe behavior until they feel competent to successfully attempt a problem in contrast with the trial-and-error method encouraged by many teachers in today's classrooms (Deyhle & Swisher, 1997; Trumbell et al., 2002).

Communication between students and teachers from diverse cultures can be confusing, and misunderstandings can occur as their communication styles interact. A dialogue between teacher and students, in which the students' prior knowledge and experience is woven into new concepts and ideas, can be very different from the traditional Western form of teacher-dominated classroom dialogue. When students are engaged in shared open-ended questioning and large and small group discussions that center around Native students' own culture and experiences, they are quite eager to join in the discussion. This challenges the deficit notion that Native American students are non-responsive to teacher questioning (Tharp & Yamauchi, 1994).

Some overall suggestions follow for teachers and schools that wish to encourage a more culturally responsive classroom.

1) Respond to the strengths and differences of Native American children based on a deep understanding of their culture (American Indian Science & Engineering Society, 1994; Hilberg et al., 2002; Nelson-Barber & Estrin, 1995; 2002; LAB at Brown University, 2001).

2) Situate classroom practice in holistic contexts, including the recognition of the importance of spirituality in the culture (American Indian Science & Engineering Society, 1994; Nelson-Barber, 1999; 2002).

3) Align classroom experiences with assessed cultural needs and concerns of the community. (American Indian Science & Engineering Society, 1994; Hilberg et al., 2002; 2002)

4) Use research based instructional methods known to address the learning needs of Native American students, such as the constructivist and sociocultural approaches discussed above (Deyhle & Swisher, 1997; Hilberg et al., 2002; Nelson-Barber, 1999; Nelson-Barber & Estrin, 1995; LAB at Brown University, 2001).

The preparation of non-Native teachers must include experiences leading to a deeper understanding of Native American culture, its family and community structures and its history. "A caring teacher with the belief that all students can learn and a deep understanding of their culture are critical factors in Native American students' success" (Deyhle & Swisher, 1997, p.122).

Research possibilities for establishing a culturally responsive classroom:

 What mentoring and professional development systems could be put in place for pre-service, early career, and experienced teachers in schools serving a majority of Native American students to ensure culturally responsive teaching?

 What are the characteristics of a high-achieving, culturally diverse mathematics classroom in which family and community values are validated? (Strang & von Glatz, 2001). How is the validation of family and community values measured?

- What instructional practices have been demonstrated to be effective in helping American Indian and Alaska Native students achieve mathematically in reservation and off-reservation schools?
- What effect does the use of computers as instructional tools have for Native American students?

Curriculum

The approaches for establishing a culturally responsive classroom discussed in the previous section share many characteristics with standards-based pedagogy that form the basis of what are known as standards-based curricula. Soon after NCTM's Curriculum and Evaluation Standards (1989) was published, it became apparent that commercial curriculum materials were not available to help teachers implement these standards. Furthermore, teachers did not have the content or pedagogical knowledge necessary to implement the type of instruction the standards envisioned. Since that time, several standards-based curricula (for example, the Connected Math Project, Six through Eighth Grade Mathematics, Math in Context, Core-Plus) have been produced that show promise in helping Native American students close the achievement gap in mathematics (Fox, 2000; Boaler, 2002). The standards themselves, some researchers believe, also hold promise for Native American students, especially if tribes and communities become involved in setting their own culturally responsive standards (Demmert, 2001).

Although research indicates students in poor and rural communities learn best through approaches that encourage a combination of constructivist and sociocultural pedalogical approaches to teaching and conceptual understanding (Knapp, Marder, Zucker et al. 1995, as cited in NCTM, 2000; Fox, 2000), many districts in poor and rural communities rely instead on

procedurally driven, also known as skills-driven, curriculum materials. There are many reasons schools choose a skills-driven curriculum. They range from a high-stakes emphasis on norm-referenced test performance, perceived university expectations, a teaching staff lacking the necessary mathematics content or pedagogical knowledge, and a propensity to choose familiar materials over less traditional ones. This traditional view may include not only what is taught and how it is taught, but also who can succeed in learning mathematics. In her work in low-income and culturally diverse communities, Gutierrez (1996, 1999, 2000, 2002) as cited in Boaler, (2002), concluded that the greatest hope for providing equitable teaching environments is to focus on practices of teachers using reform curricula.

To their credit, many of the schools serving Native American students on these reservations are attempting to use standards-based curriculum materials that are based on the learning and teaching philosophies described above. Research indicates, however, that most teachers in the United States are not prepared to successfully implement these materials (TIMSS USDOE, 1997; Ma, 1999). Mathematics education in the United States often consists of teaching isolated skills or procedures without building on prior knowledge. This type of teaching frequently occurs in low-income schools based on the "conventional wisdom" that students are deficient and that the curriculum should follow a fixed sequence of lessons, emphasizing practice and moving from basic to more advanced skills without ever addressing problem-solving or reasoning (National Council of Teachers of Mathematics, 2000). This is a belief reinforced by the use of norm-referenced tests as the only mandated assessment in many states.

In her work with two middle school teachers implementing the Connected Math Project, one of the NSF supported reform curricula, Boaler (2002) found that the ways in which the teacher

mediated the curriculum for the students had a greater impact on student learning than the interaction between the student and the curriculum. For example, the teachers in these schools introduced real-world mathematical activities by participating in the conversations with the students regarding the task. Students were never left to interpret text-based problems alone. She concluded that the teachers and their teaching are central to the promotion of equity (pp. 246-249).

Research topics regarding reform based curriculum:

- What methods do teachers use to successfully enact reform curriculum for students in Native American classrooms? (Boaler, 2002, p. 245).

Assessment

To design appropriate assessments for what students know and can do, it is essential to take into account the ways in which Native American children have traditionally been assessed. Relying on standardized testing alone is bad practice and bad policy (Elmore, 2002). It limits students' opportunity to demonstrate what they know and are able to do in ways that will be discussed later in this section.

The *No Child Left Behind* Act, passed by the United States Congress in January 2002, gives states twelve years to ensure that all students are proficient in math and science as defined by individual states and determined by annual testing in grades 3-8. Although a criterion-referenced test is being designed to reflect Montana's content standards in mathematics, the state currently requires all students to take the norm-referenced ITBS test to determine grade-level

proficiency. This practice occurs in spite of the fact that it conflicts with recommended standards and guidelines for culturally responsive assessment of Native American students (Bordeaux, 1995; Elmore, 2002). Since the main purpose of standardized tests is to sort students, items that most students can answer are not included, which makes the test of little use in assessing what students can actually do relative to what they have been taught. The use of standardized tests alone to measure performance has met with a great deal of criticism nationwide and could shortchange Native American students (Bordeaux, 1995).

Indigenous peoples have traditionally used performance assessments to determine how each individual could best contribute to the survival of the tribe, clan or village. These "assessments" were designed to support the teaching and learning of students' understanding of the skills, cultural traditions and values as determined by parents and the community and to inform local communities about the work its students can do. Success was seen as both a personal achievement and a community asset. Recognizing individual achievement based on a norm-referenced test works in opposition to the importance of place and tribal bonds the Native American communities encourage (Deyhle & Swisher, 1997; National Council of Teachers of Mathematics, 2000).

A brilliant example of this type of performance assessment occurred during the summer of 2002 on the Crow reservation in Southeast Montana. With the help of an architect from the Seattle-based Red Feather Development group, three middle school Crow girls used money they won in the national Bayer/National Science Foundation competition to build a straw-bale study hall building for tribal members. "For the 11,000 members of the Crow tribe, such tangible accomplishments are rare" (Nijhuis, 2002), but are a much greater validation for the individuals

and the community than the assessment the state uses to determine student knowledge and school accountability.

Nowhere is the effect of standardized testing more harmful than when it separates the school from the community, teachers from assessment, and relegates important decisions to distant policymakers. In its draft policy statement on assessment and accountability in public schools, the Rural School and Community Trust (2002) states that one of the greatest risks in testing is the effect it has on teachers and how they teach. These policy decisions force teachers and districts to focus curriculum materials and teaching on skills and procedures rather than using a more holistic, constructivist conceptual approach known to be more effective in teaching Native American students

The real challenge for schools on or near the reservations is that of providing a worthwhile mathematics program while facing the limitations of standardized assessment (National Council of Teachers of Mathematics, 2000). As schools and communities collaborate to establish a coherent set of norms and expectations, they must also determine how those expectations will be assessed. The Rural Schools and Community Trust (2002, p. 2) is currently designing an assessment system that could be adapted by local districts and schools. The essence of these assessments will require students to apply what they know to real world problems. Students will be required to not only demonstrate *what* they know but also that they know *how to use* that knowledge. This assessment process will include designing a project, using authentic rubrics and internal and external project reviews, involving a critical friends group or mentor, and engaging in a portfolio review process. After these expectations and assessments have been agreed upon, students and schools can be assessed for internal accountability. In this way assessment is integrally connected with the goals of teaching and learning. Until there is an

investment in this type of assessment by the community and educators, low-performing schools may get worse relative to high-performing schools (Elmore, 2002). In the meantime, we must not use the current focus on limited assessments as an excuse for adhering to a skills-based, rather than a standards-based, curriculum and instructional approach (Campbell & Silver, 2000).

Possible research topics regarding assessment:

 What combinations of assessments could be used to validate community values for mathematics education, and also serve as evidence of proficiency for math content and performance standards needed for state and federal accountability?

How do innovative assessment practices, such as the place-based assessment system recently proposed by the Rural Trust, affect student achievement?

 Are there assessment instruments and procedures that penalize some students more than others (e.g. according to gender, ethnic/linguistic background etc.)? What are critical dimensions or features of tests or rubrics that facilitate more accurate portrayals of students' knowledge and skills? What methods of assessment have proved successful by schools serving Native American students? (Strang & von Glatz, 2001).

 What processes could be used to validate mathematics assessments and tests for Native American students? For example, how might cultural validity (as delineated in Solano-Flores & Nelson-Barber, 2001) be determined?

 What policy factors influence Native American student achievement on various types of assessments (student transfer policies, attendance policies, test factors, support

services, policies for developing curriculum and selecting curriculum materials etc.)? (Strang & von Glatz, 2001).

 To what extent are Native communities, tribes, villages etc. involved in developing and implementing standards and assessments? What are the differences between assessments and standards systems developed by and with input from Native educators and those developed by non-Natives? (Strang & von Glatz, 2001)

 How does one determine the authentic assessment instruments and procedures for assessing student learning; do these vary for different content areas of mathematics and for diverse populations?

How can student assessments better take into account traits of the learner (values, culturally defined "ways of knowing," etc.) that might critically interact with and distort or advantage the assessment of student learning?

What are the levels of achievement on standardized assessments (e.g., NAEP) for Native American students by grade level or age, state, type of school (public, tribal, BIA), and tribe, and how have those levels changed over the last 10 years? 20 years? (Strang & von Glatz, 2001).

Obstacles And Challenges For Montana's Indian Reservations

This section will describe some of the obstacles and challenges that one of the authors, Nelson, along with other faculty and graduate fellows associated with the NSF Center for Learning and Teaching in the West, have identified in their work with mathematics and science

teachers and administrators of Native American students on and near Montana's Indian reservations. These observations occurred as Nelson and others conducted field work with the schools on two Montana reservations during the past year and a half. During this time, Nelson and others met with superintendents and building principals at each school, followed by individual and joint meetings with mathematics and science teachers in grades 5-12. The obstacles and challenges identified by these schools and their students fall into three broad categories: student mobility, access and communication, and local control. We will briefly describe the issues in each category and make suggestions for further research. Details of this work can be found in (Nelson, Simonsen, & Swanson, 2002).

Student Mobility

Students on or near the reservations in Montana have traditionally moved freely among the local schools without regard to academic ramifications. The reasons for mobility include academic needs, discipline and attendance problems, moving to live with other extended family members, and playing on a winning athletic team. On these two reservations, the schools are governed by nine separate school districts, including one parochial and one tribal school. Each district has a separate curriculum, uses different teaching materials, and has separate attendance and discipline policies. In testifying before the Montana Advisory Committee to the U.S. Commission on Civil Rights, tribal education committee members found it was impossible to determine the dropout rate because of the high-mobility of students. Counselors do not have time to track these students. "Kids can move out and we can't catch up with them. Many are lost through the cracks" (2001).

The recent federal *No Child Left Behind* Law (2002) stipulates that students from failing schools be given the opportunity to transfer to another school at the expense of the failing school. In the case of students in the reservation schools, transferring freely among schools has worked to the detriment of student success. If all students were to transfer from the reservation schools that are on the state's "schools needing improvement" list to off-reservation schools, it could indicate the demise of on reservation schools and the much-needed involvement of the local community.

In order to follow the movement of students between schools, the Montana Advisory Committee to the U.S. Commission on Civil Rights (2001, p. 62) recommended implementing improved procedures to track and follow up on Native American students as they move between schools and school districts. In addition to enrollment data, the tracking system could serve as a database for varying curricula and materials used across the system schools.

Possible research issue addressing student mobility:

- How can several small districts work together as a system to benefit the needs of all students including those who frequently move among the schools in the system?
- Do high student mobility rates have implications for achievement and assessment for Native American students attending school on or near Montana's reservations? If so, what can be done? (Strang & von Glatz, 2001).
- What is the actual student mobility rate between schools? What percentage of the students in a school transfer within a given year? How many times does a student move among schools during a three-year period?

Access and Communication

Another challenge for educators and students in these reservation schools centers around the issues of communication and access. The nine districts serving the two reservations' students are scattered over several thousand square miles. Driving from a school on one side of a reservation to a school on another can take more than an hour. During this time cell phone service is not available and other services such as food and fuel are scarce. Internet service is sporadic and slow for most of the schools on these reservations. The servers are often down or not working.

Establishing a learning community within a school or school system requires consistent collaboration among teachers and administrators. On-line communication can be a useful tool when distances are great and opportunities for face-to-face communication are limited. When Internet service is not reliable, however, teachers will not depend on it or use it to its full potential. This limited access and communication limits the ability of teachers to collaborate for professional growth.

The lack of consistent on-line service also hurts student learning. If there are too few students in a single school or too few qualified teachers for a particular class, on-line classes can fill a void. If the technology to access these courses is either unavailable or inconsistent, the ability of students to participate in on-line classes is compromised. The mathematics to which students have access must not be contingent on where they live or the social conditions in which they live. Students in poor, rural communities must have the same access as those in more affluent communities, even though the delivery method may be different (Campbell & Silver, 2000).

Suggested topics of research on issues of access and communication:

- How do limitations in on-line access affect student performance?
- How does the difficulty of on-line communication affect the types of instructional practices carried out in the classroom?
- What on-line courses are available to students and what success do students have who are enrolled in them?
- What are some barriers that limit collaboration between schools and community-based organizations? What are some factors that enhance and strengthen collaboration? (Strang & von Glatz, 2001).
- To what extent and for what purposes are distance-learning methods used in schools serving Native American students, by grade level, type of school, community characteristics, and tribe? (Strang & von Glatz, 2001).

Local Control

A third obstacle schools encounter is that of local control. Local influences over what students are required to know and how they demonstrate this knowledge has traditionally been the cornerstone of public education in the United States. In Montana, school districts and communities closely protect the right to exercise a wide latitude in executing their own priorities and policies. While this practice may have advantages, it also has the effect of diffusing and dividing accountability for all of its students. The Advisory Committee to the U. S. Commission on Civil Rights (2001) strongly urged the creation of a central governing body with the authority

to require statewide compliance with the constitutional mandate to guarantee the equitable education for all Montana's students..

On Montana's reservations, several small rural districts may serve the same population of students, but each district has locally developed curricula or belongs to different curriculum consortia. The educational communities in these districts choose their own texts and materials to implement that curriculum. These materials can vary widely in philosophy and structure. Policies regarding the make up of the school day, the number and length of periods, and the school calendar can vary widely. As students transfer between schools, this inconsistency limits the access students have to a coherent curriculum.

In addition to determining the content taught and the materials used, local control also determines who stays and who leaves administrative and teaching positions. Many local school boards are comprised of Native Americans who are long time residents of the reservation community, while the majority of the teachers are non-Native. As stated earlier, Indian ways of knowing and learning can be at odds with the local educational community. When the philosophies of what should be taught, how it should be taught, who should teach it, and how the knowledge of students should be tested conflict, friction occurs. Clearly, a priority of researchers and practitioners is to continue the efforts to encourage collaboration between teachers, administrators, and community and tribal members to ensure that all students have equal access to quality mathematics opportunities.

Suggested areas of research on the issue of local control:

- What are some cultural barriers that limit collaboration between schools and tribal- and community- based organizations? What are some factors that enhance and strengthen collaboration? (Strang & von Glatz, 2001).
- Under what circumstances can parental and community involvement have the greatest effect on curriculum and classroom practices resulting in increased student achievement?
- What type of accounting or tracking system could be used to encourage consistency of policies, curricula and assessment expectations for students attending school within these systems?

What's Working on Montana's Reservations

The previous list of challenges and obstacles to improving student achievement on Montana's reservations highlights the need to concentrate on the system of schools on or near the reservations that serve the same population of students. This section will outline events that have occurred and appear to have the potential for positive impact on closing the mathematical achievement gap for students within these reservation systems.

Recently the new Center for Learning and Teaching in the West (CLTW) sponsored an open forum for mathematics and science teachers on or near the two reservations. Teachers were given the opportunity to share how they felt their students were doing, what was working to ensure success in mathematics and science for these students, and what materials they were using. In addition, they were given the opportunity to discuss identify changes they felt were needed to help students succeed. Teachers were eager to share their thoughts; many commented

that this was the first opportunity they had had to openly address their successes, concerns, and beliefs. Extending and building on this type of collaboration has great potential to lead to changes that can help close the achievement gap for students in mathematics and science in these schools.

Another example of what's working is the outreach program of the local tribal colleges. Rural Systemic Initiatives sponsored by the National Science Foundation and carried out by tribal colleges have encouraged reservation teachers to use various NSF sponsored standards-based curricula. Although research indicates these materials are very challenging for teachers to implement and require a great deal of professional development and community support, teachers are eager to try materials that might make a difference in their students' mathematics achievement. A multi-faceted program of standards-based curricula, multiple forms of assessment, high-quality math and science preservice education and professional development, administrative support for teachers, and parent and community involvement will improve achievement rates and lower dropout rates (Demmert, 2001). Collaboration between all levels of educational practitioners with the community appears to be having a positive effect in this direction.

Summary of Suggested Research

Many of the research questions given in this paper came from the authors' interpretations of teacher and administrator interviews and classroom observations. Other suggestions came from the American Indian and Alaska Native Education Research Agenda (Strang and von Glatz, 2001) – the result of an executive order signed by President Bill Clinton (Executive Order No.13096, 1998). Among the activities that stemmed from this order was a nationwide effort to

involve tribal leaders and Native education researchers and professors to develop a research agenda. This effort is significant because it was guided by Native commitments to self-determination, the perpetuation of Native languages and cultures, and a commitment to finding effective ways of educating Native children and youth. Because of the commitment of members of the Native American community, this research has the potential to significantly improve the schooling of Native American students (Demmert, 2001; Deyhle & Swisher, 1997).

Major underlying themes for approaching research on Native American education include a focus on success, tribal sovereignty, and sensitivity to tribal differences (Strang & von Glatz, 2001). We need to better understand the pedagogy, standards, assessment, and curriculum materials that have been successful in educating Native American students.

Researchers must work closely with members of the Native American community and respect the tribal rights of that community during the research process. Native American permission for the research design, methodology and instrumentation is critical, following practices like those currently in place in the Navajo Nation. Ideally, Native Americans should be members of the research teams. The inclusion of Native Americans in the entire research effort will ensure better collaboration and provide for higher quality research.

There is clearly a need for research that involves Indian teachers, students, parents, and elders in both urban and rural schools, off and on the reservations, in discussions and policy development impacting the education of their children. The timely emergence of empowerment and community-based models for research and evaluation provide a path for inclusion of these stakeholders in conducting research in Native American education.

The structure and purpose of schools, and the society in which these schools are situated, must be carefully considered during the evaluation of the success or failure of American Indians

in their K-12 and postsecondary experiences (Deyhle & Swisher, 1997). Throughout the paper, the authors have suggested research questions that could help shed light on the influence of the culture of the Native American student as it encourages or subverts their understanding and use of mathematics.

Concluding Remarks

Somewhere after your third or fourth visit to the schools on the reservations, you find yourself anxious to return. The land is beautiful and raw, the distances are vast, the children are bright and the need for understanding and collaboration among all stakeholders is great. Research has provided us with the characteristics for successful mathematics reform and the successful education for Native Americans. Research has also given us an array of issues to be addressed as we work with the systems in which these children live and in which their teachers teach to increase student achievement.

Research has helped educators make a difference. We know more about how culturally responsive teaching affects student learning. We know that teachers grounded in the culture of the students they teach make a difference. We know that for those individuals who have strong cultural identities and know their language, a culturally relevant curriculum is less important. Conversely, for those who are less grounded, cultural integration of the curriculum is more important. We know that when research is perceived as a partnership between the researcher and the community and is sustained over time, the results benefit all parties concerned. Still needed, however, is the "interpretation of what this research means in the way teachers are trained, schools are organized, curriculum is designed and instruction is delivered" (Deyhle & Swisher, 1997, p. 182).

It is important to look beyond the performance of individual students to the systems in which they are educated (Nelson-Barber & Estrin, 1995). Establishing a coherent curriculum among the reservation schools and the development of teaching philosophies consistent with research of best practices for Native American students needs to occur. A tracking system should be developed for use across the system to ensure students do not fall through the cracks, and that they encounter some form of consistency in their educational experiences as they move between schools. Ongoing professional development and collaboration among teachers, schools and districts needs to be established, giving them a forum to share methods they've found successful as well as to discuss recent research on the many issues of education for Native American children. Collaboration over these great distances needs to occur both on-site and on-line. Finding ways and means to encourage this collaboration is key to providing support for teachers, students, and the community. Research on the issues suggested in this paper will guide us in this work.

There are many challenges for these systems. State and federal accountability policies are having a tremendous effect on schools that are already struggling to integrate their rich cultural values with the predominant educational culture. Montana's tight economic situation, like that currently faced it many states, makes it difficult for the state to provide financial support for designing assessments to more equitably address what students know and are able to do. The remoteness of this region's reservations schools, combined with the relatively low teacher salaries typical in a rural state like Montana, makes it difficult to find quality teachers to replace those who leave. Technical support to provide consistent on-line communication and support for ongoing professional development and collaboration is critical.

The problem is not whether we can make a difference for these children; the issue is how to support and maintain these efforts in a complex system influenced by many factors. For too long the needs and interests of our Native American children have been either ignored or glossed over. Now is the time for Native and non-Native educators to come together with members of the Native American community to establish clear research-based guidelines and expectations for Native American children and to collaboratively work within the educational systems to ensure that those guidelines and expectations become reality.

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