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Educators' Perspectives on Factors Impacting STEM Achievement in Rural Indigenous Student- Serving Schools

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This study addressed the question, "What factors do experts perceive as impacting STEM achievement of students in rural schools with predominantly Indigenous students?" A thematic analysis of interviews with 40 educators with a depth of experience identified six major themes: holistic STEM education, inclusion of local culture in STEM education, highly qualified staff, STEM curriculum and instruction, technology, and STEM funding. These themes were interrelated. Holistic education demanded more individualized curriculum and required more highly qualified staff who could adapt the curriculum and integrate technology with traditional knowledge, but these educators were harder to hire and retain due to low funding. It is emphasized that efforts to raise STEM achievement of Indigenous students attending rural schools should be embedded within consideration of the larger system, including the academic, emotional, and cultural experiences of students and financial, technological and human resources available.

STEM Education in Indigenous Student-Serving Schools

Most bills legislating educational policy or funding never even mention rural schools (Dahill-Brown & Jochim, 2018). Seldom do decision makers come to the prairie or a reservation and ask educators what they really need. This omission matters because rural school needs differ from their urban counterparts and rural Indigenous student-serving (ISS) schools differ from non-ISS schools. We refer as 'Indigenous student-serving schools' to those schools whose student body is majority Indigenous students, whether or not located within the borders of a reservation, which are externally imposed abstractions (John & Ford, 2017). Clearly, reservation boundaries are a factor in tribal sovereignty and legal issues. However, when 90% of students attending a school in a border town are from a specific Indigenous nation, regarding the culture and identity of children attending schools, the invisible line has minimal impact.

While rural schools are too often omitted from the national conversation, Indigenous education is even less frequently included in discussions of rural education, despite nearly three-fourths of high-density Indigenous schools being in rural areas (RedCorn et al., 2021). Compared to non-rural

schools, the proportion of white students is 22 percentage points higher in rural schools with a lower percentage of all other groups except for Indigenous students (Koricich et al., 2018). These Indigenous students are not distributed evenly across the rural landscape. 'Outer school districts,' that is the category furthest from a metropolitan area have the highest proportion of Indigenous students (Burdick-Will & Logan, 2017). These outer rural districts also have the highest proportion of beginning teachers, and these teachers are least likely to have a graduate degree, more likely to have graduated from less competitive colleges and have a higher turnover rate than metropolitan rural districts.

Geographic isolation, low housing options, lower salaries afforded by a diminished tax base, low enrollment threatening school closures, the need for teachers to fulfill multiple roles and difficulty recruiting highly qualified staff are common challenges for rural schools (House Rich & Stein, 2018; Preston, Jakubiec & Kooymans, 2018; Tieken, 2014). Rural schools have a lower percentage of students proficient in mathematics than suburban schools (Burdick-Will & Logan, 2017) with Indigenous students even less likely to be proficient, a trend that continues through adulthood. While 75% of U.S. high school graduates fail to meet math proficiency standards, the figure rises to 88% of

Native American students (NCES, 2018). As adults, urban residents have a higher proportion of college degrees – 33% vs. 20% of rural White adults and 10% for rural Indigenous adults (USDA, 2017).

Indigenous student-serving schools differ from other rural institutions both quantitatively and qualitatively. They are not simply more rural, with lower performance in mathematics, but also must address different community concerns. In ISS schools, the disconnect between students' cultures and the curriculum, and the distrust of schooling, most notably rooted in the history of residential schools, present additional challenges (Greenwood, 2009; Hewitt, 2017).

Researchers on both rural tribal colleges (Pavel, Inglebret & Banks, 2001) and rural K-12 districts emphasize the importance of adaptation of educational institutions to the local community. For Indigenous communities, the maintenance of Indigenous cultures and languages is a major concern. High school dropout rates are higher, achievement is lower, attributable in part to curriculum content and assessment that does not apply to students' culture and daily lives (Hewitt, 2017; Locke, 2018). Rural and Indigenous education concerns have some overlap but there are also significant differences. Inclusion of "local culture" in rural non-ISS STEM education might include lessons from National Agriculture in the Classroom on modern pig or poultry farms. An Indigenous educator may be teaching traditional uses of medicinal plants or miles traveled during the Ojibwe migration.

Few studies have tested the impact of integrating culture on mathematics achievement. The National Indian Education Study (National Center for Education Statistics, 2019) found that schools with materials on Native Americans/Alaskan Natives in the library, media or resource center had significantly greater proportions of Indigenous students who were high achievers in math and science. De Mars and Longie (2018) found Indigenous students attending schools on a reservation who played an educational math game that applied the Dakota value of perseverance, encouraging students to steady and continued effort in the face of difficulties, significantly improved their math scores compared to the control group. This program integrated a core value of Dakota culture with the Common Core (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010) standard of mathematical practice, "Make sense of problems and persevere in solving them."

While valuable, what these quantitative studies lacked was the perspective of the educators in the schools serving these students.

Greenwood (2009) sees the primary purpose of US education as preparing a competent, compliant workforce of consumers; however, personally, we did not have that experience in our own education. Dr. De Mars has worked with tribal schools in the Great Plains for over thirty years. She is now colleagues with the children of many of her students from early in her career. Growing up multiracial and poor in a combination of small towns, military bases and an urban alternative high school, the educational aspect of her schooling – as distinct from the social – was largely positive. Being good at math was praised, encouraged and her "ticket out." In Corbett's terms, she 'learned to leave.' Her own experience of education as providing options that go beyond the stereotypes of race and gender has been a major motivating factor in a career of teaching mathematics in underserved communities and developing educational technology to support mathematics education.

Ms. Taken Alive is an educator and a citizen of Standing Rock Nation in Little Eagle, SD. She has been involved in the lives of students and their families for more than twenty-five years as a teacher, administrator, and school board member. She left her reservation to attend the universities where she completed her studies and returned to the reservation to learn from the collective culture of the tribe. Although culturally responsive schooling has been advocated for over at least the past 40 years, schools on the reservation are failing to meet the needs of Indigenous students (Castagno & Brayboy, 2008). Truly culturally responsive learning for Indigenous youth is a highly complex endeavor that requires systemic change within and across several levels in our schooling system by taking into consideration the learning styles of Indigenous youth and their tribal cultural beliefs and practices. She is also committed to the implementation of culturally responsive teaching practices and shares with Hammond (2015) the belief that successful teachers get to know each student and develop a trust relationship. With a relationship being established, there is a responsibility of being available for students and families every day of every week.

To ensure consistency, either Dr. De Mars or Ms. Taken Alive participated in every interview. Ms. Burns Ortiz was a second interviewer as needed. All texts were coded by Dr. De Mars with Ms. Burns

Ortiz, Ms. Ma or Ms. Wang as the second or third coder. At the conclusion of coding, Ms. Taken Alive reviewed themes and quotations in the context of whole interview transcripts to ensure respondents' views were accurately represented.

Purpose of the Study

This research was conducted as part of a federal program with the objective of developing priorities for funding science, technology, engineering, and mathematics (STEM) educational technology. The research team's aim was to identify the major factors impacting STEM achievement in schools serving Indigenous students, as perceived by educators with extensive experience working in those schools, that could be addressed through technological innovation.

Sample

Participants are a subset of respondents in an ongoing study of educational needs in Title I schools, that is schools where over 40% of the students enrolled are from low-income families (U.S. Department of Education, 2018). A panel of experts was selected, defined as those whose experience made them uniquely qualified to provide insights (Weiss, 1994), in this case, insights into the needs of rural schools. A snowball sampling method was used. Initial participants were known personally by at least one of the authors through their professional contacts. Each of the initial interviewees were contacted by email, with an explanation of the purpose of the study, and a request for an in-person interview. At the end of each interview, participants were asked to recommend anyone he or she considered extremely knowledgeable regarding the educational needs of Title I schools. These educators were contacted via email, mentioning the colleague who had recommended him or her. In some cases, the original participants emailed their colleagues for us, copying the authors on their recommendation that the individuals participate in our study. Only respondents from ISS schools were included in the present study. At no point did we explicitly request referrals to Indigenous educators, however, this method resulted in a sample of 70% Indigenous respondents. While educators with Indigenous, rural roots were clearly more likely to remain in rural schools serving Indigenous students, it is also plausible that Indigenous educators were more likely to refer others of the same tribe.

Table 1
Demographic Characteristics of Study Participants

	<i>N</i>	<i>%</i>
<i>Gender</i>		
Female	25	63
Male	15	37
<i>Education</i>		
Bachelors	15	38
Masters	17	43
Doctorate	8	20
<i>Years of Experience</i>		
5-9	3	8
10-19	11	28
>20	26	65
<i>Race</i>		
Indigenous	28	70
White	12	30
<i>Role</i>		
School Administrator	25	63
Teacher	9	23
Support staff	3	8
After-school director	2	5
School board member	1	3

All participants were fully credentialed in their state which required at minimum, completion of an accredited teacher education program and passing an exam of basic academic skills. All had a minimum of five years' experience and experience in at least two levels of ISS schools, e.g., as a teacher and now a principal, or a student and now a teacher in a school serving predominantly Indigenous students. The modal respondent far exceeded these minimal requirements with over 20 years of experience, a master's degree and having attended schools similar to those in which they taught—sometimes, the exact same school—as parents of children attending schools for Indigenous students, as well having been a teacher, specialist, principal, and district-level administrator.

The initial sample consisted of 44 respondents. Four respondents were deleted who had less than five years of teaching experience. This left a sample of 40 respondents representing 32 different sites from states in the central United States. See Table 1. Educators from multiple institutions were contacted in three communities, so these 32 sites represented 29 distinct rural locations. All respondents worked in schools or districts with a population that exceeded 90% Indigenous students. All of the schools would fit the NIES definition of 'high-density schools' which

is 25% or more Indigenous students. With a few notable exceptions, the schools were characterized by high turnover with a disproportion of teachers and administrators both new to the profession and new to their role. Those exceptions were schools within commuting distance of much larger towns of 20,000-60,000, although it should be noted that a one-hour commute in rural states may be 60-75 miles.

Defining Rural

After the recommendation of Coladarci (2007), we define our determination of schools as ‘rural’ in both quantitative and descriptive terms. Of the 32 rural sites, all were in non-metro counties as defined by the U.S. Department of Agriculture (Cromartie, 2019). The typical school was in a town of less than 100 to 500 residents. The usual town consisted of four to six streets (in many cases, not all paved), a school building and one or two churches. The larger towns had a small grocery store and gas station, often in the same location, a restaurant, and, where alcohol was legal, a bar. These larger towns also were usually the site of the tribal administration, tribal college, a casino, and associated hotel. Larger here is a relative term. No school was in a county exceeding 10,000 residents and all were over 40 miles from the nearest town over 10,000 residents. Community size where schools were located ranged from one school in a town with a population over 4,000 to one school in a town of under 100 and two schools surrounded by fields in unincorporated areas. Graduating classes of the district high schools ranged from two to less than fifty.

School types included Bureau of Indian Education-operated schools, residential schools serving multiple tribes, public schools, tribally controlled schools, and parochial schools. The two characteristics that all schools shared were a rural location and $\geq 90\%$ of students who were identified as Indigenous according to published school demographic data. We refer to these schools collectively as Indigenous-student-serving (ISS) schools. Although, when known, it is preferable to refer to Indigenous communities by their tribal designation, in this study, we have combined dozens of schools educating students from many different Native nations as well as intertribal schools. We do not distinguish among the school administrative structures, nor do we identify any specific nation by name, to honor our guarantee of anonymity to participants.

Interviewee professions are shown in Table 1. In small school districts, many respondents served multiple roles, for example, high school business teacher and superintendent. In these cases, the interviewees were categorized in the roles in which they spent most of their time. By including administrators, teachers, after-school program staff and school board, we have followed a community-based approach to knowledge which allows multiple voices and perspectives to construct meaning (Kopish, 2018).

Given our selection criteria, our expert respondents had more experience than the typical rural, ISS school employees. They also differed in other ways that had not been part of our selection process. Our sample was consistent with the research of Oyen and Schweinle (2021) who found that students majoring in education who had themselves attended rural high schools were 5.5 times more likely to consider teaching in rural schools and that Native American students were also more likely to consider teaching in rural schools. While it was not a question asked directly of respondents, all 40 mentioned either their tribal affiliation or “being white” during the interview when discussing their educational background and experience, 28 (70%) of the respondents were Indigenous; 26 from federally recognized U.S. tribes and two from Canadian First Nations. Again, although respondents were not asked about their hometown or upbringing, all the Indigenous respondents and four of the white respondents, for 80% of the total, specifically mentioned during the interview having grown up in a rural community. For example, Ms. Adams (all names are pseudonyms), stated,

I didn’t grow up on a reservation, but I was raised on a ranch in [rural state]. I took the bus an hour each way to get to school. I didn’t know what I wanted to do when I went to the university, but I knew for sure whatever it was, it wasn’t going to be anywhere near a city.

Several of our respondents were raised on a reservation in the U.S. or reserve in Canada, attended residential school in a different Indigenous community, from elementary school through high school, and then, relocated to either their home community or another Indigenous community. Other participants had never left their home community for an extended period. Ms. Butler was typical of these educators.

I’ve only really lived here. I attended this school where I teach right now. I went to [the tribal

college on the reservation] for my Associates degree. Then, I took classes online and [commuted to university]. When a teaching job opened up here, I applied for it, and I have been here at [school] ever since. Of course, there were some years in between, and it wasn't all that easy, but I'd rather not talk about that.

Method

Data collection

Data collected for this research included interviews with 40 educators from 30 schools and two after-school programs, field notes from meetings with educators and site visits and documents provided by interviewees, including brochures and flyers describing after school programs, school and program websites. Two researchers were present during each interview, with one asking questions and the second recording responses verbatim. Interviewees were asked to schedule a minimum of fifteen minutes for the interview. We tried to be cognizant of interviewees' time and asked if they wanted to end the interview after 15 minutes. Only four of the 40 interviews lasted less than 30 minutes, with the typical interview taking an hour.

Although we began our study specifically interested in the application of educational technology to meet rural educator needs, to prevent biasing answers in a specific direction, we started each interview with open-ended questions on the respondent's experience and perceived barriers to developing STEM proficiency in students, ending the interview asking about technology. Respondents were asked to expand on their responses as warranted. For example, a respondent who stated, "Students have difficulty focusing during math class" would be asked, "What do you think interferes with their ability to focus?"

Most interviews were conducted in the educators' offices or classrooms, which provided an opportunity for observing the school grounds and meeting with students and staff. Four interviews were conducted in conference rooms during intermural academic or athletic competitions, which prevented visiting the school sites but did allow observations of several students from each school participating in activities.

Shortly before the interviews occurred, data which had been collected by a federal agency for a different purpose was used for publication of a report

reflecting negatively on many of the communities in which we collected data. As a result, many potential respondents were wary of speaking with us. Although we had been approved by the university Institutional Review Board, one reservation required approval by their own IRB as well, and by the time this approval was received the schools had been closed in response to the Coronavirus pandemic. On two reservations, no one agreed to an interview in response to our first request. It was only after a personal request from the second author, a citizen of the Standing Rock Nation (Hunkpapa/Mnicoujou Lakota) who had worked for over two decades in education in Indigenous communities that educators from those reservations agreed to be interviewed. As a precondition of the interviews, it was guaranteed that all data would be recorded and reported anonymously.

It should be noted that all these interviews were conducted in early 2020, before any of the schools had transitioned to distance or hybrid learning. The last interviews were completed the same week that the first schools began to close for in-person instruction due to the pandemic.

Coding

The 40 interviews yield 618 coded text fragments which were categorized into themes. All fragments were coded by two or three coders. After coding the first 100 themes, coders met and discussed any discrepancies. At this point, it was decided to allow text to be coded in up to two themes. For example, the research team discussed whether the following text should be coded under "STEM curriculum and instruction" or "inclusion of local culture in STEM education."

We need to do stuff that is hands-on with a cultural base – how does science class deal with that? ... We are planning to go into [local geological formation]. This is a geology lesson, but there is also [an Indigenous] culture story.

Our decision was to include this text under both themes. Allowing multiple themes increased agreement among the coders.

After all themes had been coded, themes were sorted, and the first author reviewed each text fragment again reading all the texts in a theme sequentially. This last pass at coding resulted in a second theme added to many of the texts. For example, this text

We need to be more hands-on in science education at our school. Why aren't we doing

more labs? Why is it just worksheets and textbook? Everything is outdated, the chemicals are expired and dried up. No one has been using them because they haven't been trained on them was originally coded under the "STEM curriculum & instruction" theme and was added under "highly qualified staff" as well.

The issue here was not funding to buy new laboratory supplies. As this administrator noted, the supplies had expired without ever being used due to lack of training for teachers on how to implement the labs in the curriculum.

Findings

Our initial goal was to identify needs of Title I schools that could be met by educational technology. We expected to categorize our text fragments into distinct categories and subcategories in a hierarchy, then separate out those boxes that could be addressed by technological solutions. When summarized using thematic analysis, we found that reality was more like a spider web, as shown in Figure 1.

Holistic STEM education demanded a more individualized curriculum, inclusion of local culture in STEM education, more highly qualified teachers to develop both curriculum and relationships with students. Experienced, well-trained teachers had students who were more academically successful and thus had different needs in future years. These teachers also were better at creating their own

curriculum that was engaging and integrated local culture. Limited funding for STEM classes contributed to obsolete technology, lack of materials for hands-on activities and high staff turnover. Better trained staff used software that produced data that informed standards to be addressed as part of educational policy that determined curriculum. No matter how hard the mentors assigned to us by our funding agency pushed to identify a discrete problem that could be solved by technology, our respondents pushed back and insisted that any successful solution needed to consider the whole child and system.

The first two themes -- Holistic STEM Education and Inclusion of Local Culture -- we considered to be key as these focus on the students as individuals, members of a family, an Indigenous culture and society. Students do not learn in a vacuum.

Holistic STEM Education

A theme that educators repeatedly brought up, the one we labeled "Holistic STEM Education" was the need to educate the whole child, considering their individual achievement levels, family environment and social history. Ms. Hanson, an educator at a residential school commented,

When they have a [bad] day, I don't get on their case about getting math done. Developing relationships with kids is more important.

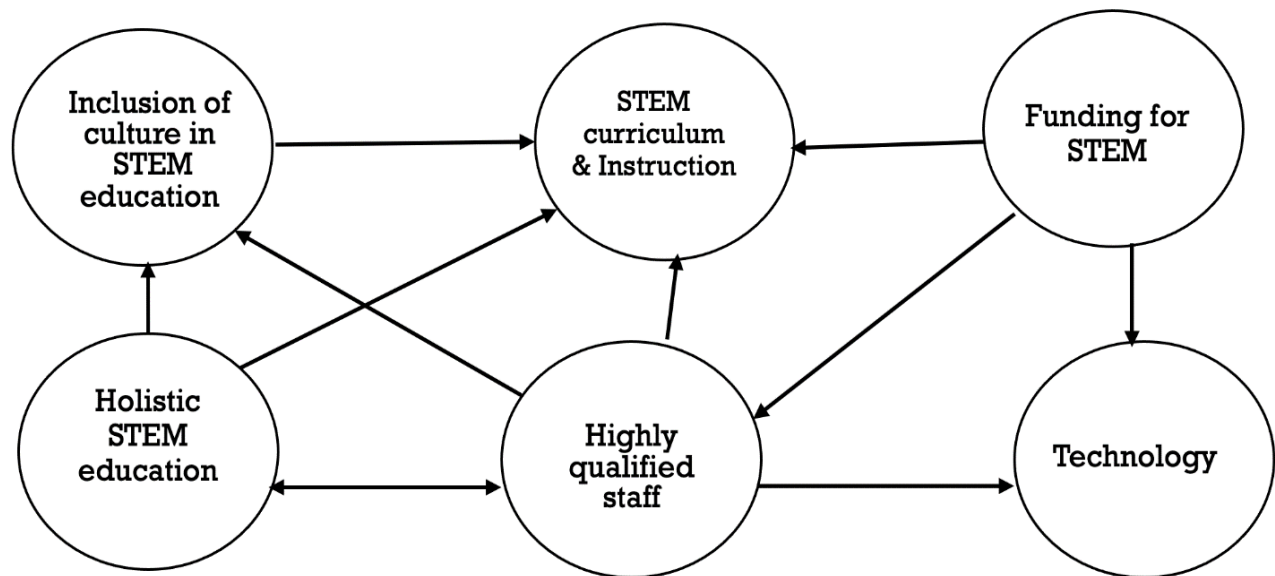


Figure 1: Six connected themes

Trauma sensitive schools training – it’s all about developing relationships, understanding where kids come from. Kids are not going to focus on this when X happened. You can’t reach them all every day.

The holistic education theme frequently overlapped with STEM curriculum and instruction. Differentiated instruction was required, both because students entered the classroom at different levels of academic proficiency, and due to high rates of mobility between schools and inconsistent curriculum

This systemic failure to provide data across school systems to accommodate student mobility was particularly an issue in mathematics, which has the most hierarchical structure of any K-12 discipline. Students who haven’t learned division are not ready for fractions. Not knowing the baseline from which to begin resulted in teachers re-teaching information students already knew or skipping over material they assumed students had already covered.

Despite the challenges, students experienced success when their needs were met by adults, whether at home or in school. Mr. Keo, an administrator, told us:

Our biggest needs are for [consistent relationships] – we serve such a high transient population, students moving from the reservation to have more opportunity. I would say the biggest part of our success is we found that if they have one trusted adult the odds of succeeding increase by 50%, with two trusted adults you see a 90% increase in chance of success.

Inclusion of Local Culture

The second key theme, Inclusion of Local Culture in STEM education connects with holistic STEM education, STEM curriculum and instruction and highly qualified staff, but this theme was mentioned so frequently it warranted its own category. We use the term “local culture” here rather than Indigenous cultures because interviewees made clear that although they were interested in Indigenous knowledge in general, particularly at inter-tribal schools, they were also emphatic that the inclusion of the students’ specific tribal languages and cultures was important. Respondents fell into three groups: those who worried technology and mainstream standards would replace the local culture; those who thought culture was important but were concerned a

and communication across those schools. For example. Ms. Johnson told us,

We have a lot of kids who are transient – so they might go to four schools a year – and at this school, they should have learned this, but they didn’t; then they go to the next school where they already covered something that the kid didn’t learn at the last school. Then they go to another school and by the end no one really knows what the kid knows. And it’s not like they’re going from one (high performing) school to another.

focus on culture would not prepare the students for success in the larger society; and those who believed that integration was possible but not happening often enough. Mr. Greycar, an administrator, saw tribal cultures as a strength and consistent with holistic STEM education.

A big piece in our area is people really understanding what culturally responsive teaching is and finding out the ways students learn best. What we are doing now is not working. Tribal communities are collective communities.

Ms. Chavez, an experienced science teacher, agreed with the value of integrated instruction but saw the lack of highly qualified staff as a barrier.

Teaching the science with Indigenous history would make it more relatable. But, I believe most teachers lack the knowledge to include Indigenous history into science.

An administrator in another state, Ms. Dumaris, agreed with this sentiment.

We need somewhere that would make it easy to learn about resources that teach the standards.

We need a way to connect teachers, like “Ms. A at school Y is doing this great lesson in using Indigenous knowledge to teach science.”

On the other hand, Mr. Nez, a science teacher, was conflicted regarding integration of culture in the curriculum.

Make education cultural. Where did [example from local Indigenous culture] come from? As a teacher, I worry these things that they have interest in learning about aren’t quite the things that will help them succeed in a fast-moving tech world, but, on the other hand, what helps them succeed is passion.

In contrast, Ms. Bear Tail, an Indigenous language teacher, saw a conflict between technology and culture.

It's just not available, the technology using [Indigenous language]. Students are losing their cultural identity. A lot of the outside influence is taking the youth and young adults to the point where they lose that cultural identity. Culture needs to be taught in schools.

STEM Curriculum and Instruction

STEM Curriculum and Instruction connected tightly with the previous two themes. Given that educators interviewed were across states, tribal nations, school structure and job title, the degree to which they agreed on curricular needs was striking. They wanted a STEM curriculum that was hands-on, project-based, at appropriate grade level for students and consistent, with training for teachers to implement that curriculum. Appropriate to students meant, first, at the student's current level of achievement, which ranged across several years within a single grade level. In the smaller schools, where teachers had multiple grade levels within a class, the range of instructional levels was even greater. Secondly, STEM curriculum should be related to students' interests, as illustrated by the responses from teachers from three different schools:

Ms. Tennyson: When I look at my class what they are doing as 7th graders is way below that grade level. When I look at our 8th graders, not as far behind – but we skipped over the review. [I cover] integers, like terms, equations, maybe coordinate planes - if we get to it. If you can add and subtract, you can at least figure what change you're supposed to get back.

Ms. Lebeau: Teaching math, I use checks and a stack of bills to get them to balance a checkbook. We use real world applications. If they are not understanding area and perimeter as it applies to floor plans, I put it in terms of buying carpet and flooring and trim. What is the cheapest way and what do you like? Compute the cost for each and find the price difference.

Ms. Frey: Cross curriculum works. We do a lot of things. In teaching geography about the states, I will have the students pick one place to go to and then plan a trip. We're integrating between the classes. In their math class, they compute total vacation costs.

Highly Qualified Staff

Highly Qualified Staff is a theme summarized as, hiring and retaining staff, with adequate training, both pre-service and professional development. Highly qualified teachers are the center of the determinants of STEM achievement. They can make up for many other weaknesses in the system. She or he can create a curriculum that is project-based or hands-on to meet the needs of students. Highly qualified teachers can create differentiated instruction to address the needs of students across a wide range of grade levels in the same class, as these three teachers illustrated, in describing their math and science lessons,

Ms. Lebeau: After the first year, no one came in and checked on me, so I didn't ever touch the textbooks. I'd go to websites and find free stuff. I begged, borrowed and 'stole' stuff.

Ms. Tennyson: A lot of my curriculum was hands on, especially for math. We made a city of geometric shapes. We used the football field for measurement. I developed my own curriculum. I used playing cards, dice. We made arrays with the rows of little circles on the Target bags. Kids' math scores went up so much.

Mr. Nez: I develop my own curriculum. I go off what the kids want. Also, I try to include relevance to their life and also get them some physical exercise. But I know there are a lot of things I don't know. When that happens, I feel like I'm letting them down. I try to find something that can reach the kids. When I came, the school was computer based. They said I could go project based – but there were no resources to help me do that.

Unfortunately, in most schools, low funding for salaries and professional development was a factor in recruiting qualified teachers and administrators and in turnover. Recruitment was an ongoing challenge due to high turnover. One administrator said, "Teachers come here for 2-3 years then they leave. We continually have first-year teachers. We're always rebuilding. With constant new administrators, too, there's no consistency."

Even when teachers were experienced and motivated, they could be stymied by barriers ranging from policy to lack of resources. Ms. Vandal perceived the same need for individualized curriculum but did not have the same flexibility within her school:

A lot of the times, it's 'here's this and teach it.' That makes it really difficult. I don't have the buy-in as a teacher. I'm told to do another thing on top of an already full plate. I love science, but we haven't been able to teach science. We're so low in math and reading, what we're currently doing is teaching reading and math instead of science and social studies.

Impact and Use of Technology

In contrast to the agreement on curriculum, views on the fifth theme, **Impact and Use of Technology**, varied greatly across schools. Some schools had adequate funding for hardware and software but no training. Other schools had limited budgets but teachers made innovative uses of what was available. Ms. Grand, for example, gives each student a card with a letter, A, B, C or D. She writes questions to check understanding as she teaches.

I use [app she learned about at a conference]. I can scan the card with my phone to see if students have the right answer. It's like the clickers used in big college classes but way cheaper. It's a free app and website. I use the smart board for when students take notes. I can connect the document camera to it and students can copy a graph projected on the smartboard. We use iPads for online testing. We use [math apps] on the iPad for review.

Not everyone had the experience of Ms. Grand, who had been teaching for several years at her current school. In contrast, Mr. Baszler, an administrator, told us:

Our biggest need with technology is more tech training, specifically around curriculum. We got active panels, but I'm not sure how they're using them. There is so much that they could use those for. We need trainers to come to our school so they can provide hands-on training for the teachers. We have to take care of our teachers because they take care of our kids.

In other classrooms, teachers were trained and the biggest need was hardware. For example, Ms. Butler told us:

I can't use 'tech books' because we're not a 1 to 1 school. I only have 8 or 9 iPads, not enough for a class. Lots of our iPads are outdated, so we can't download the newer apps. We have more than some schools do just because we're a tribal school and we get the e-rate grant and that pays for our internet. You can hook up a microscope

to your smart board. We have microscopes in our lab, but they're old so it doesn't work.

There was general agreement from our respondents on two issues. One, that all components were necessary for effective technology implementation, hardware, software, and training. Two, while teachers like Ms. Grand were able to develop engaging, appropriate STEM lessons despite technological limitations, even the highest quality teachers were hampered by limited supplies and technology. Respondents held a shared belief that the students in their classes would gain even more if their teachers were given the same resources available at more affluent schools.

More qualified teachers make more use of the available technology and are more likely to develop cross-curricular, culturally responsive lessons. Teachers, however, are not superheroes. Even highly qualified, experienced teachers can be overwhelmed by the demands, simply not having enough time to do everything that is required of them, frustrated by inadequate software, insufficient training and limited funds. Ms. Calling Bull teaches in a school with less than 100 students and has three grades in her class. She groups the students by reading level, not by grade. She is frustrated by the reading software the school uses because it will have the fourth graders working toward fourth-grade standards, whether they are a year below or a year above. Activities are determined by the grade she inputs with no option for individualization.

Funding

Funding was connected to all the other themes, including lack of funds, restriction on use of funds and unreliability of grant funding. It prevents schools from buying software and supplies that meet students' needs, from retaining highly qualified teachers and from maintaining intervention programs long enough to know if they are working.

Mr. Taylor: Teacher salaries in [state] are low so it keeps people from going into teaching.

Ms. Grand: If I want to make a change [and] if it's something that costs money, I can present it to the administration, and they would determine if they would fund it. Most of the things I go for don't cost money because I don't want to go through the process of getting money.

Ms. Lake: Sustainability ... is an issue. So many things come in and out. It's the newest thing. But they don't offer resources for it to be continued (financial support of the program), after say 2 years of use when we have data to show it is working.

Discussion

It became apparent early on in our research that although there were overlaps, there were also clear differences in the factors considered important by ISS and other rural schools, and that rural schools serving Indigenous students had some additional specific concerns. This drove our decision to begin analysis of the data by considering these schools as a separate group.

Our initial charge in collecting these data was to identify the needs of Title I schools that could be addressed through funding of educational technology innovations. No matter how much a funding agency might want a model to raise STEM achievement of Indigenous students in rural schools with a simple educational technology solution, the data simply did not fit. In terms of frequency, technology was the fourth-most frequently mentioned theme – and use of technology in STEM education was a question specifically asked at the end of the interview. While educators were interested in technology their interest was predicated on adequate funding for professional development, hardware and infrastructure support, technology that supported local culture, integrated with cross-curricular STEM instruction. They most emphatically wanted to tell us that absolutely nothing would substitute for highly qualified staff, nor could deployment of any software ignore the fact that the typical classroom served students across several years of grade level and who had good reasons for being disengaged with academic content.

Consistent with prior research (House Rich & Stein, 2018) we found funding to be a major factor in STEM achievement because it affected schools' ability to hire and retain well-qualified staff, provide adequate professional development, purchase hardware, software and supplies. It's been said throwing money at a problem isn't a solution for education, but it may be when the problem is that the schools don't have enough money.

The sample of educators we interviewed were overwhelmingly Indigenous themselves and from rural backgrounds. Neither ethnicity nor family background were part of our selection criteria.

However, we found that teachers and administrators who had a long tenure in these systems with high turnover fit a definite profile – they had been raised in communities highly similar to the ones in which they worked. In this, our results are consistent with Gallo (2020), despite the fact that our schools were over 90% Indigenous students while the student body in her study was over 90% White. If schools are to meet the challenge of retaining highly qualified staff, a “grow your own” policy of recruiting, educating and training teachers from rural, Indigenous communities should be attempted.

Our own experiences as educators have led us to concur with Indigenous leaders in education (Crazy Bull, 2015; Faircloth, 2009) and those of our respondents who see the promise of education that combines traditional knowledge and contemporary experience. This integrated education provides youth the capabilities to be successful whether they choose to leave their home communities or remain. Speaking from our own experience, it is exhausting to navigate through the curriculum that teaches only about the history of other people, that does not include the strengths of one's own culture. Even when Indigenous people are included in the curriculum it is from a predominantly deficit perspective - alcoholism and poverty in current day or how treaties were forced upon people and then broken in history.

Rural Indigenous student-serving schools are well-situated to lead the way in culturally sustaining/revitalizing pedagogy and educational sovereignty of Indigenous nations. As RedCorn et al. (2021) noted, reservations, which are predominantly located in rural areas, serve as the cultural center for many tribal nations. Schools in and near Indigenous communities generally have more access to educators in the local Indigenous language and culture both in the school and the community at large than do the typical urban school. Urban schools must meet the challenge of addressing cultures of students from dozens of tribal nations (Lee & McCarty, 2017). Rural Indigenous-student serving schools are more likely to be serving students from a single tribal nation, making it easier for them to develop curriculum appropriate to the needs of those students.

The curriculum can -- and should -- include an accurate history of Indigenous peoples (Dunbar Ortiz, 2014) as well as be expanded to include Indigenous scientists such as botanist Robin Wall Kimmerer (2013) and anthropologist Beatrice Medicine (2001). What those elements -- Indigenous scientists; resources that combine science and Indigenous

cultures, such as the Native Case Studies (<https://nativecases.evergreen.edu>); or resources that combine mathematics, technology and Indigenous cultures, such as the Growing Math Project (<https://www.growingmath.org>) -- all have in common is a holistic curriculum. In contrast to earlier assimilative education that attempted to break ties to communities (Greenwood, 2009), effective science and mathematics education strengthen ties through connection of content to students' lives as both rural residents and Indigenous children and youth. Technology can have a role in this holistic education, primarily as a facilitator, that makes it easier to assess children's knowledge, as with Ms. Grand's clickers, the forum to share Indigenous STEM education ideas that Ms. Dumaris desires. However, as Ms. Calling Bull noted, resources, whether technology, teachers or curricula, are ineffective if they insist on acting as if all students are identical.

Limitations

This study was limited to educators working in 32 institutions in 29 rural sites in the central United States, with student bodies comprised overwhelmingly of Indigenous students. Results are most applicable to similar schools. These institutions represent a small fraction of all 574 federally recognized tribes, with very small numbers of Indigenous students who were from Southwestern tribes, Native Alaskan or Hawaiian. All our respondents lived and worked in rural communities on or near tribal lands. While 54% of Native

Americans live in rural areas and 68% live on or near their tribal lands (Deweese & Marks, 2017), this leaves nearly one-third of Indigenous students who do not live near tribal lands. Their educators' voices were not included.

Research (Soriso, 2013) and our own respondents spoke about the difficulty of cross-ethnic collaboration, wanting to avoid the "white savior" complex where non-Native teachers swoop in from outside the community to "fix" Indigenous children. Further, the majority of the schools we studied were located on or adjacent to reservations, where many of our respondents resided. In both their current residence and family background, our respondents were likely to experience residential segregation and thus may have had fewer contacts with non-Indigenous educators. As workplace segregation tends to be less of an issue than residential segregation (Hall, Iceland & Yi, 2019), it's also possible that lack of contact with non-Indigenous educators was not a factor in referrals. Our respondents were predominantly Indigenous educational experts referred by other Indigenous educators. Since the vast majority of research in rural education is done by non-Indigenous researchers, collaborating with other non-Indigenous educators and researchers, this sample could also be considered a strength, as they bring voices seldom heard to the conversation.

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