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About the Journal

Founded in 2013, the Journal of Teacher Action Research (ISSN: 2332-2233) is a peer-reviewed online journal indexed with EBSCO that seeks practical research that can be implemented in Pre-Kindergarten through Post-Secondary classrooms. The primary function of this journal is to provide classroom teachers and researchers a means for sharing classroom practices.

The journal accepts articles for peer-review that describe classroom practice which positively impacts student learning. We define teacher action research as teachers (at all levels) studying their practice and/or their students' learning in a methodical way in order to inform classroom practice. Articles submitted to the journal should demonstrate an action research focus with intent to improve the author's practice.

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EFFECTIVE MATHEMATICS INSTRUCTION FOR NATIVE AMERICAN ELEMENTARY STUDENTS: STRATEGIES FOR USING MANIPULATIVES

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Abstract Statistics from the National Center for Education Statistics (NCES, 2016) show that Native American students have high dropout rates and are outperformed by other racial groups on state assessments. Teachers of Native American students strive to teach to the best of their abilities, but may find themselves using traditional teaching practices rather than culturally appropriate practices for Native American students. The purpose of this mixed methods study was to determine the impact of culturally appropriate mathematics instruction with manipulatives on Native American students' engagement, achievement, and feelings about math and manipulatives. During this mixed methods study, a class of 10 Native American fourth graders participated in lessons taught using traditional instructional practices, and research-based, culturally appropriate lessons involving the use of manipulatives. Qualitative and quantitative data was collected to compare the effects of culturally appropriate teaching methods and traditional teaching methods with manipulatives. Data suggested that teaching math in a culturally appropriate manner with manipulatives positively impacts students' achievement and increases their use of manipulatives, but has little impact on the overall engagement of students or students' feelings about mathematics. Based on data collected during this study, teachers of Native American students should revisit their current instructional approaches to ensure they are teaching in a culturally appropriate manner and correctly utilizing learning tools, such as manipulatives, to promote achievement.

Keywords: teacher action research, Culturally appropriate practices, manipulatives, achievement, engagement, Native American students

Introduction

Statistics from the National Center for Education Statistics (NCES, 2016) show that Native American students have high dropout rates and are outperformed by other racial groups on state assessments. In light of these statistics, it is clear that traditional mathematics

instruction has been ineffective in Native American student populations. Prior research revealed that Native American students learn best in cooperative learning environments participating in hands-on activities (Jacobs, 2013). Manipulatives in math instruction provide a means for hands-on activities. However, manipulatives can become more of a problem than a solution in the classroom if not utilized in a culturally appropriate manner. The purpose of this action research study is to determine the impact of culturally appropriate mathematics instruction with manipulatives on Native American students' engagement, achievement, and feelings about mathematics and manipulatives. The following research questions guide this study:

1. Does implementing research-based and culturally appropriate manipulatives instruction positively impact Native American students' engagement and achievement?
2. What are Native American students' perceptions of math and using manipulatives in math class?

With so much at stake for Native American students, it is important for teachers to adapt their teaching, perhaps by adopting culturally appropriate teaching practices, including the appropriate use of manipulatives.

Literature Review

Culturally appropriate teaching has been a hot topic in educational circles for several years now. Teachers have been made aware that they must strive to teach their diverse student populations equitably, not just equally. However, most research regarding culturally appropriate teaching practices is focused on African American and Hispanic students, with little research pertaining to Native American students. Manipulatives, their effectiveness, and how to appropriately utilize them in instruction has been studied at some length, but not in the context of the Native American classroom.

Native American Students. There are Native American students who are successful in school and life, and come from nurturing, stable homes. However, Native American students are among the poorest of American students and get academically out-performed by students of other races, particularly White and Asian students (NCES, 2016). Rittle-Johnson, Fyfe, Hofer, & Farran, (2016) found that early math literacy is crucial in the development of mathematics skills, and that students from economically disadvantaged homes came to school with very little mathematics knowledge creating an early achievement gap. Most Native American students come from economically disadvantaged homes, meaning that they come to school with few mathematics skills and need effective instruction in order to close the achievement gap.

Native American Perspectives and Culturally Appropriate Instruction. Traditional methods of mathematics instruction may not be culturally appropriate for Native American students. Jacobs (2013) wrote, "…although Indigenous mathematics knowledge paths are seldom considered, mathematics was highly developed in ancient Indigenous cultures throughout the world" (p. 158). Many teachers are of European descent and may not realize that the manner in which they teach is geared toward "mainstream" Americans: White, middle-class, and male. Teachers of Native American students need to instruct in a way that speaks to Native American perspectives and cultural values.

In Native American culture, everything is its own being. This includes people and animals as beings, but also includes natural elements such as air, water, and earth. Jacobs (2013) challenged teachers to take a Native American perspective when looking at mathematics and numbers; he wrote, "…[Think] of math not as static, but as always changing. Numbers are beings in constant change. To play with the possibilities of this change through mathematical operations is to look into the most basic aspect of relationships" (p. 164). Within the Native American view of mathematics, numbers are beings that relate to each other, and people relate to the numbers by manipulating them through mathematical operations.

With respect to all beings, Native American children are less accustomed to mainstream American perspectives, such as working hard to achieve in a competitive atmosphere. A Native American student is more likely to celebrate a being as it is, rather than what the being has done in terms of achievement. Therefore, a classroom structure that is highly competitive should be replaced with one that is highly collaborative. "Cooperation rather than Competition" is one of Hankes' (1998) principles for teaching Native American students, in which students work together to solve problems, rather than try to outdo each other as they would in a competitive setting.

Additionally, Hankes (1998) and Jacobs (2013) both found that Native American students respond to contextual, hands-on mathematics instruction. Jacobs (2013) stated, "Without context, knowledge is empty" (p. 161). Students must have relevant contexts with which to visualize the "beings" of numbers operating, and be provided with hands-on ways to manipulate these beings while solving math problems. Hankes' principles support the idea of collaborative, relevant, hands-on mathematics instruction in the Native American classroom, particularly by reframing problem solving as sense-making and integrating the students' lived experiences. Additionally, Jacobs (2013) discovered through his research evidence of the effectiveness of collaborative, hands-on instruction for Native American students.

The Importance of Using Manipulatives. Boggan, Harper, and Whitmire (2010) defined manipulatives as physical objects that can be used as teaching tools to engage students in the hands-on learning of mathematical concepts. Educational research indicates that the most valuable learning happens when students construct their own understanding of mathematical concepts, which can often take place by giving students opportunities to use manipulatives. Research by Carbonneau, Marley, and Selig (2012) found that using manipulatives in mathematics instruction produces a small to medium-sized effect on students' achievement, when compared to instruction that used only abstract symbols.

According to the constructivist learning theory, explained by Piaget, students build understanding upon experiences. Mudaly and Naidoo (2015) wrote about the Concrete, Representational, and Abstract (CRA) model of teaching, which is founded upon constructivist views, and its relation to the use of manipulatives in mathematics instruction. Within the CRA model, students move from concrete understandings, to representational reasoning, to abstract, conceptual knowledge. Manipulatives serve as the

foundational piece of concrete understandings, from which students can construct representational and abstract mathematical knowledge. The National Council of Supervisors of Mathematics (NCSM, 2014) also drew parallels from the constructivist theory of learning to the use of manipulatives. The NCSM (2014) stated that because of the experiential nature of the use of manipulatives, students are able to build mathematical knowledge from the use of manipulatives, so manipulatives should be used in mathematics instruction.

Correct use of Manipulatives. Van de Walle, Karp, Lovin, and Bay-Williams (2014) asserted that the most widespread misuse of manipulatives is done by teachers first, not students. Van de Walle, et al. contended that student misuse could be prevented by allowing students to have free time with the manipulatives before using them for problem solving, and by correcting manipulative misuse of the teacher. One example of a teacher's misuse occurs when a teacher tells students to "do as I do" with a manipulative. This merely teaches students a rote mathematical procedure. Van de Walle, et al. (2014) stated, "A rote procedure with a manipulative is just that - a rote procedure" (p. 25). Teachers must be challenged to relinquish some control of the use of manipulatives, even going so far as to let students choose which manipulatives to use to solve a problem.

Providing students with appropriate choices of manipulatives is important. Carbonneau, et al. (2012) found that perceptually rich manipulatives were most engaging. Lehmann (2015) offered a list of perceptually rich manipulatives including beans, counters, blocks, toys, and even simple objects like erasers. Larkin (2016) discovered that simply turning students loose with a manipulative is ineffective, and that educators must first be aware of a student's developmental abilities before unleashing them on a manipulative with the expectation that the student will have success with a mathematical concept just because a manipulative is present. Overall, Larkin found that students established connections between objects and mathematical concepts best when their use of a chosen, perceptually rich manipulative was scaffolded.

Culturally appropriate mathematics instruction that promotes collaboration and hands-on experiences is vitally important for the success of Native American students, most of which come to school educationally disadvantaged. Manipulatives, if used correctly, can be a culturally appropriate element to include in the mathematics classroom. Some strategies for correctly implementing manipulatives are identifying students' developmental abilities before beginning instruction with manipulatives, offering students time to choose from and play with a variety of perceptually rich manipulatives, scaffolding the use of student-selected manipulatives without teaching rote procedures, and encouraging collaborative problem solving of contextually relevant problems with manipulatives.

Methodology

Site and Sample. This action research took place at a small public school on a Native American Reservation in a Midwestern state. The school has approximately 185 students enrolled K-12, with 24% of students on Individualized Education Programs (IEP). Additionally, the school district has been identified as a Priority school by

the state Department of Education, due to underperforming test scores, poor attendance, and a variety of other school factors. One hundred percent of students attending the school receive free lunch and breakfast, indicating that many students have limited monetary resources.

Using convenience sampling, fourth grade students were the potential participants of this action research. The fourth grade class consisted of 11 students. One of the students was not a participant in the action research because the student gets pulled for special education services during most of the mathematics class period. The class had three students who consistently perform at grade level on a variety of assessments, including the Smarter Balanced assessment. The other seven students fall into strategic and intensive categories according to the Response to Intervention model (RTI) and defined by Aimsweb and the Standardized Test for the Assessment of Reading (STAR) Math assessments.

Based on teacher observations preceding the study, most of the 4th grade students became distracted or disengaged during math class. The high-achieving students found themselves waiting on the low-achieving students. The low-achieving students exhibited fixed mindset behaviors, in which they often disengaged from the learning process as soon as a task became difficult. The disengaged characteristics of the students, as well as the variety in achievement levels, made the students of the fourth grade class ideal potential participants to measure the effectiveness of culturally appropriate manipulatives instruction on student engagement and achievement.

Procedures. Qualitative and quantitative data were collected during this mixed methods action research study. Author 1 had a dual role in this action research as both the mathematics teacher and the researcher. As the teacher, lessons were strategically planned and delivered, and learning experiences with manipulatives were facilitated. As the researcher, qualitative and quantitative data were collected and analyzed it in order to answer the research questions.

As the researcher and teacher, author 1 recognized that the motivation of this study was to implement culturally appropriate practices for utilizing manipulatives with Native American students at the elementary level and to measure the effectiveness of those practices. Based on the exploratory nature of this study, conclusions were drawn solely on the data collected throughout the study.

Ethical Considerations. In order to conduct this action research ethically, permissions were gathered from all necessary parties including the Institutional Review Board (IRB), school principal, parents/guardians, and participants. Parents and participants were made aware that participation was voluntary, no penalty would be given for not participating and no incentives would be given for participating, withdrawal from the study was an option at any time, identifying information would be kept confidential, and that every measure would be taken to make sure that all aspects of the action research adhered to the Family Education Rights and Privacy Act (FERPA).

Data Collection. This action research study consisted of two phases and was conducted over approximately four weeks in February and March 2018 with ten fourth grade participants. Throughout this study, participants were asked to take surveys, engage in class activities using manipulatives, complete worksheets, and take pretests and post-tests. The risks for participants over the four-week timeframe were minimal, no more than typical risks for students involved in standard classroom experiences. In order to protect students from typical classroom risks, such as embarrassment from getting a problem incorrect, students were held accountable for the high expectations and rules that have been set in place since the beginning of the school year. Adherence to these rules and expectations established a respectful and safe class atmosphere conducive to learning.

During phase one traditional teaching practices were utilized, and then during phase two culturally appropriate teaching practices were implemented. See Table 1 for a comparison of traditional and culturally appropriate practices used in these phases. Throughout each phase, both qualitative and quantitative data were collected to answer the research questions:

1. Does implementing research-based and culturally appropriate manipulatives instruction positively impact Native American students' engagement and achievement?
2. What are students' perceptions of mathematics and using manipulatives in mathematics class?

Table 1: Traditional Instructional Practice versus Culturally Appropriate Practice

Traditional Instructional Practice	**Culturally Appropriate Practice**
Competitive classroom	Cooperative classroom
Individual work	Collaborative work
Lecture and worksheet	Discussion and hands-on experiences
Choice of manipulative made by teacher	Choice of manipulative made by student
Use of manipulative determined by teacher	Use of manipulative determined by student
Mathematics problems that are contextually irrelevant to students' lives and experiences	Mathematics problems that are contextually relevant to students' lives and experiences

Qualitative data were collected by conducting a survey about students' feelings about math and manipulatives, and recording observations of participants' levels of engagement and comments during discussions in a journal. Quantitative data were gathered by scoring tests and assignments, as well as comparing grades from week to week.

During phase one, approximately two weeks, traditional teaching practices were utilized and data were collected in order to compare students' achievement, engagement, and feelings about mathematics and manipulatives to data collected when culturally appropriate practices were used. The lessons during this phase were teacher-led, with word problems that had no relevant context to the lives of participants, and had a competitive nature as students worked individually or in teacher-selected groups to complete their assignments quickly and accurately. The use of manipulatives during this phase reflected traditional teaching practices. When manipulatives were made available to participants specific, non-negotiable instructions were given as to which manipulative was used and how students used it. Additionally, manipulatives were only available as students worked individually to complete a worksheet. There was little discourse between students during this week. Discussions were done in a whole class setting with me asking all the questions and participants supplying answers directly back to me.

This phase included a re-teaching week. From experience, Author 1 hypothesized some re-teaching of the concept taught using traditional teaching practices would need to take place. Assignments were collected and scored but not used as data since they consisted mostly of unfinished assignments, and it would have been difficult to quantify what learning had occurred because of teaching practices and what learning had occurred simply because the participant was given more exposure to the concept.

During the second phase, approximately two weeks in length, research-based culturally appropriate practices for teaching Native American students with manipulatives were implemented. The data collection process during this phase was the same as the process in phase one. Participants could choose which manipulative to use and how to use it, they also worked in groups or partners playing games with manipulatives, discussing their findings, and trying out different manipulatives to model problems that were reflective of their experiences.

To conclude phase two, all data were analyzed to answer the research questions. An evaluation of participants' engagement was done in order to compare engagement during both phases. Observations recorded in the observation journal served as qualitative data to track the engagement of participants. These data were compared to the baseline data and analyzed to conclude whether or not the engagement levels of participants changed as culturally appropriate practices were implemented.

Student achievement was also evaluated. To evaluate achievement, quantitative data from pretests and post-tests as well as assignments and grades were compared. Growth data between pretests and post-tests from both phases were compared. Achievement data were compared cumulatively to determine the impact of culturally appropriate teaching practices and research-based manipulatives instruction.

To re-evaluate the perceptions students held of math and manipulatives in math class, participants were asked to retake the survey they took in phase one. The two surveys were compared to see if participants' perceptions changed. These qualitative survey data were analyzed to determine in what ways the perceptions of participants changed.

Results

To measure engagement, qualitative data in the form of an observation journal were collected and reviewed to find themes or reoccurring behaviors among participants during the two phases. Engagement was noted in the observation journal when all students were participating in a learning activity or discussion. Disengagement was noted when a misbehavior arose, a participant shut down, or a participant was very hesitant to engage in a learning activity or discussion.

Observational data revealed that when traditional practices were implemented there was twice as much disengagement than engagement. For example, participants demonstrated disengaged behaviors when working individually with a manipulative I chose in a manner I insisted upon. This traditional approach led to misbehavior, and at best participants simply performed rote procedures with little learning being accomplished.

On the other hand, observation data revealed that when culturally appropriate practices were implemented there was an equal amount of engaged and disengaged behaviors. Participants' engagement with their chosen manipulatives increased when working with a partner or small group, rather than individually, and there was an increase in participants' problem solving with manipulatives when the problems they solved were relevant to their experiences.

A major theme that emerged from the observational data was "choice." There was a correlation between the amount of choices, a culturally appropriate practice, and engagement. The more choices offered, the more participants engaged. Whether it was offering a participant a choice of who to work with, what manipulative to use, or how to use a manipulative, participants consistently had the most positive response to manipulatives and tasks when they were given choices. According to the data, there were five times more occurrences of participants using manipulatives when given a choice of which manipulative to use and how to use it. See Figure 1 for comparisons of the effects of traditional and culturally appropriate practices.

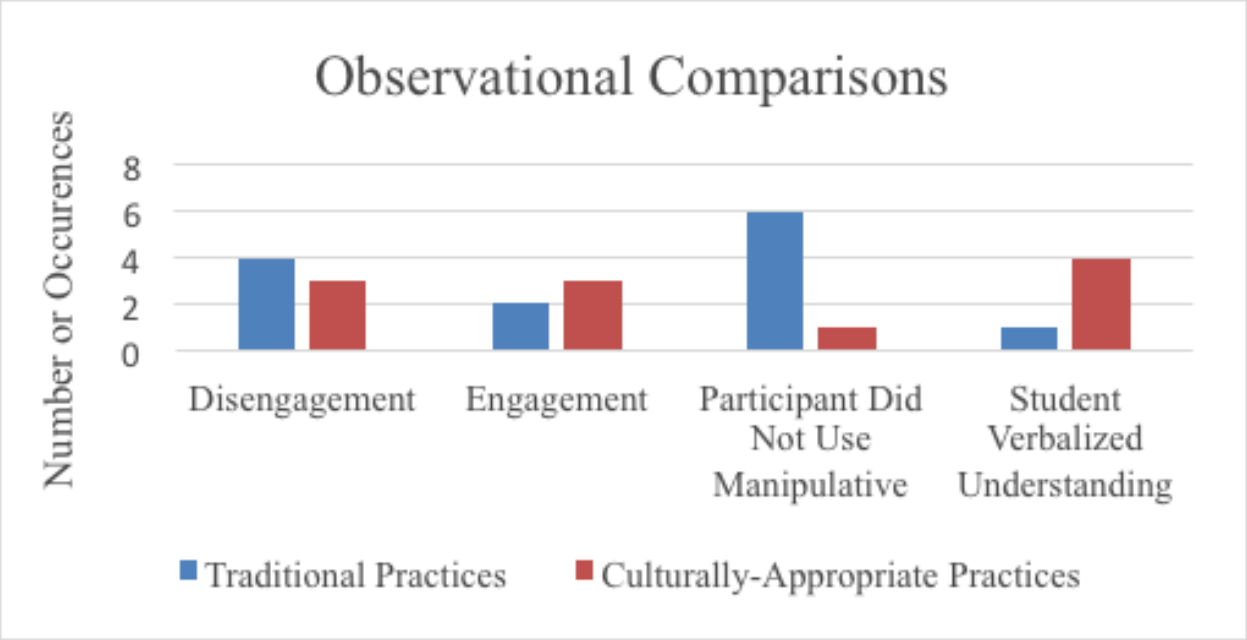

Figure 1. Observational Comparisons

Data to measure achievement were collected in the form of worksheets used to calculate weekly grades, growth between pretests and post-tests, and observational notes of instances where a participant was able to verbalize a mathematical understanding. When traditional practices were used, there was an adverse effect on participants' achievement measured by weekly grades and pretest and post-test comparisons. Thirty percent of participants' grades fell from the previous weekly grade, and fifty percent of participants scored fewer points on the post-test than pretest. On the other hand, when culturally appropriate instruction with manipulatives was used, participants saw achievement both on their weekly grades and on the post- test. Seventy percent of participants' grades improved and all participants scored more points on the post-test than the pretest. Additionally, data from the observation journal revealed that when culturally appropriate practices with manipulatives were implemented there were four times as many instances of participants verbalizing a mathematical understanding than when traditional practices were used.

Participants' perceptions of mathematics, manipulatives, and themselves as mathematicians changed very little when culturally appropriate manipulatives instruction was used. To measure the perceptions of participants, results of an anonymous survey were reviewed. The survey, taken at the beginning and end of the study, was three questions in length and required participants to circle a response that was most true of themselves. One survey question asked participants if and how much they liked mathematics. The answers to that question did not change from the start of the study to the end. Despite different teaching techniques and varying levels of engagement and achievement, there was no difference in how much participants liked mathematics.

A question regarding how good or bad participants thought they were at mathematics varied little from the beginning to the end of the study. One of the largest differences was seen in the category of participants who felt they were "math masters" as opposed to being "good at math," "okay at math," or "really bad at math." At the beginning of the study forty percent of participants felt that they were "math masters." At the end only ten percent did. However, the total percentage of participants who felt they were either "good at math," or "math masters" varied only slightly, with only five percent less feeling they were "good at math" or "math masters" at the end of the study.

Discussion

There are several notable findings from the data analysis. First, findings regarding how culturally appropriate practices affect the engagement levels of participants are somewhat inconclusive. The observational notes made regarding engagement did not differ significantly when culturally appropriate practices were implemented. However, it was made clear by the data gleaned from observational notes that when culturally appropriate practices are used participants are more likely to engage in activities using manipulatives, especially when given choices regarding how they work with manipulatives.

Second, data indicate that participants achieve more when manipulatives are used in a math class that supports culturally appropriate instructional practices. For example, during phase one, fifty percent of participants' scores dropped from the pretest to the post-test, indicating that traditional practices had an adverse effect on achievement. When culturally appropriate practices were utilized and the teacher presented manipulatives in a proper manner, participants used manipulatives more often and completed more assignments resulting in higher achievement measured by grades and performance on the post-test. Data from grades and post-test scores revealed that using culturally appropriate practices with manipulatives increased achievement for seventy percent of participants, with thirty percent of participants maintaining their grades. Figure 2 compares grades of participants. As illustrated, sixty percent of participants achieved more when culturally appropriate practices with manipulatives were utilized, and no participants had a failing grade.

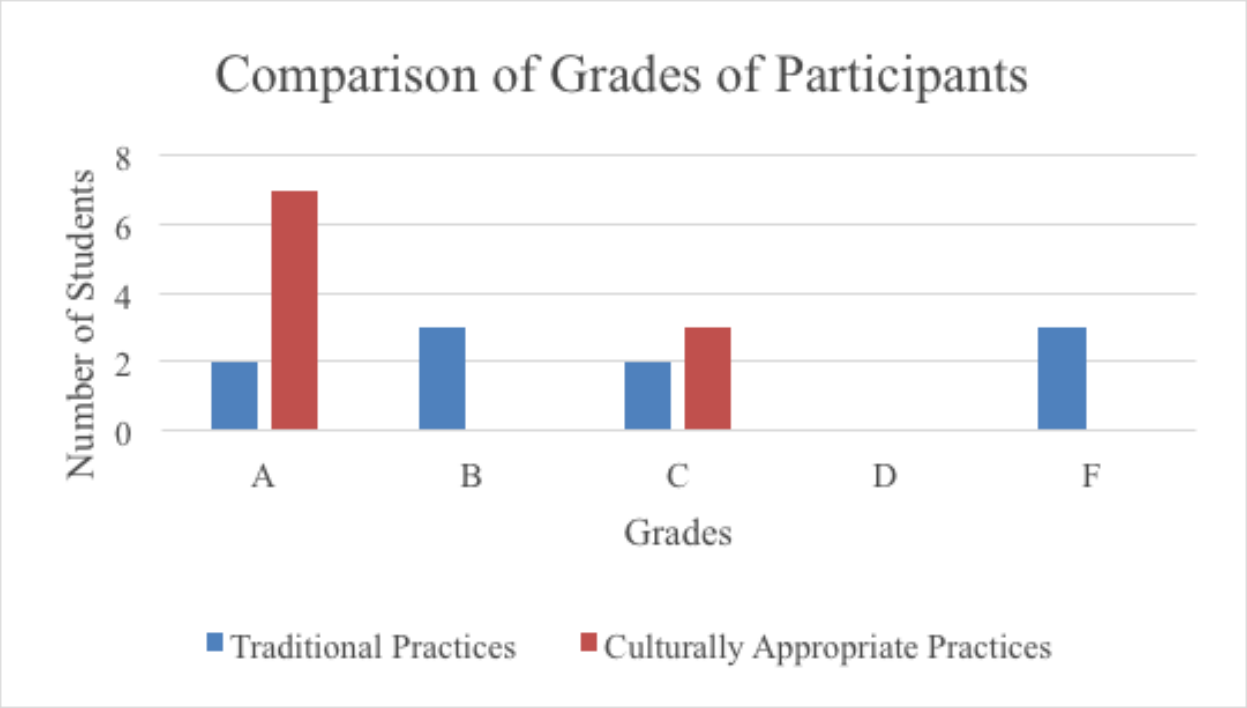

Figure 2. Comparison of Grades of Participants

Third, participants' perceptions of math and manipulatives did not significantly change when lessons were taught in a culturally appropriate manner with manipulatives. The survey data revealed that some students lost confidence in their mathematics abilities, going from "math masters" to just being "good at math." But, overall, more students felt like they were "good at math" or "math masters" after the week of culturally appropriate lessons was taught.

Implications

This study's purpose was to find out if using manipulatives in a research-based and culturally appropriate manner in a mathematics classroom serving Native American students affected students' achievement, engagement, and feelings toward math. The data collected throughout this study showed that students' achievement rose when manipulatives were used appropriately during lessons that were tailored to fit Native American culture. However, data indicated that engagement and feelings toward mathematics did not differ significantly when manipulatives were used using research-based best practices in a culturally appropriate manner. In order to increase achievement for Native American students, mathematics teachers of Native American students should evaluate their use of manipulatives and the structure of their lessons to ensure they are using manipulatives appropriately and creating lessons that are sensitive to Native American culture.

Understanding one's teaching materials and best practices for teaching students of varying cultures can be applied to any teacher. As this study illustrates, using best practices and culturally appropriate methods yields greater student achievement than traditional teaching

methods alone. To facilitate this, teachers should become familiar with research-based teaching strategies for their content areas and culturally appropriate teaching strategies based on their student population. This study was limited by the number of participants involved and the length of the study. A longer time with a larger group of participants may provide more comprehensive data from which to draw conclusions.

Conclusion

The focus of this study was to gauge the impact of culturally appropriate mathematics instruction with manipulatives on Native American students' engagement, achievement, and feelings about math and manipulatives. By implementing culturally appropriate practices and effective instruction with manipulatives, teachers of Native American students can increase achievement, even though students' engagement and feelings toward mathematics and manipulatives may not change. Native American students are a vulnerable population and educators who teach in a way that honors the culture of their students, and who wield teaching tools in accordance to research-based best practices, give their students a greater chance for learning and achieving.

About the Authors

Traci Stiegelmeier is originally from Ridgeview, South Dakota. In 2012, she graduated Summa Cum Laude from the University of Mary with degrees in Early Childhood Education, Elementary Education, and Special Education. After graduation, she spent three years teaching second grade and three more years teaching elementary math at a rural elementary school on a reservation. In 2018 she earned her Master's degree in Curriculum and Instruction from Black Hills State University. Currently, Mrs. Stiegelmeier is taking a break from her teaching career to stay at home to raise her son and help her husband, Levi Stiegelmeier, on their family farm. Email: traci_truax@hotmail.com

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