Seminar Title: 20th Century and Contemporary Native Art

Curriculum Unit Title: The Geometry of Native American Art

Marnita A. Chischilly

Diné Institute for Navajo Nation Educators (DINÉ)

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Author Note:
Marnita A. Chischilly is an eighth-grade math/science teacher at Wingate Elementary School. Correspondence about this curriculum unit can be addressed to Marnita A. Chischilly, P.O. Box 735, Church Rock, NM 87311. Email contact: dineteachersinstitute@nau.edu

Introduction

Geometry has been a part of Native American art for centuries. The techniques of Native American art have been passed down from generation to generation. Over the years the art has changed and some is now distinguished as contemporary art, which still incorporates Native American art fundamentals. Rug weaving is part of this realm of Native American art. This unit take students into investigating and rediscovering the ancient artwork of rug weaving and the connection of our modern mathematics common core standard. Rug weaving is a complex and ancient craft that is still practiced in today's contemporary art world. The art form appears to be simple to most people, but it requires visual thinking and a sophisticated understanding of geometry.

Context

Our school is under the Bureau of Indian Education (BIE), with the following demographics relating to the school: the school is located in a rural area 17 miles from the nearest city and classified as a K-8th Elementary School. The student body is 100% Native American in ethnic origin, coming predominantly from the Navajo or Diné tribe and a few from the Apache, Zuni, and Sioux tribes. As for the academic student body classification, we have 18% Special Education students, 98% designated as English Language Learners (ELL), 10% Gifted/Talented (GT) students with the majority of 8% GT students placed on referrals for Leadership, leaving only 2% placed by Academic Achievements. All students receive free/reduced lunch, indicating a low socio-economic background.

The assessment tools used by our school for evaluating the ELA / Literacy area are the local teacher-developed formative and summative assessments, resource material assessment and daily monitoring techniques, the state sponsored ACCESS/WIDA, given to grades K-8th to evaluate the five English Language Development standards, also used to determine English Language Learner (ELL) status is the Partnership for Assessment of Readiness for College and Careers (PARCC) testing Grades 3rd – 8th. The Northwest Evaluation Assessment (NWEA) Measures of Academic Progress (MAP) tool for Reading, Mathematics, Language Arts and Science determines the school Academic Status or Report Card by the Bureau of Indian Education.

This coming year Kindergarten through 5th grade is self-contained, but 6th through 8th grade will be semi-departmentalized. Students have five periods with Math, English Language Arts, Science, Social Studies and an elective class. In the Middle school department classes are programmed for 55 minutes for each core subject and students rotate between the core classes in the morning. In the afternoon they will stay in their homeroom for social studies or science class. Elective classes will be scheduled throughout the day for each grade level, K-8. Elective classes include Physical Education, Computer, Accelerated Reading, and Navajo Language/Culture.

Demographically, my 8th grade Math class has a total of 58 students, ages 12 -15, comprised of three Inclusion - Special Education students, 55 students classified as English Language Learners, six Gifted and Talented students eligible by the Leadership strand, two by academic achievement, and an equal amount of boys and girls. A majority are day students and at least 1/4 of the students stay in the dormitory during the school week. There are five new students

transferring from other schools. The NWEA Fall 2018 - Math scores indicate a higher percentage of my students were in the lowest three divisions of Levels, 23% of my class were in the Lowest level, 50% fell into the Average Low level, and 23% were in Hi Low level; leaving the remaining 4% in the higher levels or proficient level. These score results indicate a need for a different approach of instruction, which I plan to do with this unit by embedding cultural relevancy.

For the past several years the school has been plagued with teacher shortage issues. Currently, we have three teacher vacancies and a vacancy for a school principal. If a new principal is hired, there may be new mandates, but for now we are continuing what has been established. Our Problem of Practice for the school this year is to focus on small group instruction in regards to intervention. For our district focus we are being trained to establish meaningful Professional Learning Communities to support our instructional planning. Other mandates include: new district calendar, training every Friday, aligning our lesson plans to district curriculum using Common Core State Standards (CCSS), creating our own assessments for CCSS and developing learning cycles using assessment data. Also, we have established Professional Learning Communities within our grade levels to collaboratively plan our instructional delivery and strategies.

Other aspects of our school include our hard-working staff, up-to-date facilities, and our somewhat modern technologies. Our school was built in 2005, which is fairly new, and the technology was purchased about a year later. Currently, our school does have two computer labs for the elementary, Kindergarten through 5th grade, and one computer lab for 6th through 8th grade. Each classroom has a smart board and three computers. At mid school, each classroom is equipped with 25 tablets. Although we are grateful for the luxuries of technology, some equipment is starting to wear down due to daily usage and so now we are in need of updated models, just as cell phones are outdated by the time you buy one and updated models are being advertised again.

Rationale

In this unit I plan to have students make a connection between the mathematical reasoning of geometry and the cultural aspect of Native American artistry. As part of our school district mandates, mathematics teachers are asked to seek activities that will involve modeling real-world situations using a variety of events, representations and analytical relationships of mathematical concepts. Also mandated is aligning lessons according to the common core math standards. Using the standards and district mandates, I plan to give students the opportunity to be actively involved in math through mathematical analysis and correlations that are integrated into the curriculum. My intention is to show that these types of activities can be incorporated into a geometry course as a way of teaching how geometry relates to the Native American art of rug weaving.

Another important component for developing this unit regards my students' cultural background or lack of cultural knowledge. We are at a point where our youth are losing their cultural knowledge, language, clan system, and identity. As educators, how do we bring our children back into learning their cultural heritage and their self-identity? In researching this phenomenon,

I feel a need for a different approach of instruction. To address this issue, I base this math curriculum unit on a commitment to cultural relevancy as a means to deepen the understanding of the math concepts and, in the process, bridge the knowledge of cultural heritage to my students.

This curriculum unit is created to support the understanding of geometry, which is one of the important components of 8th grade common core math standards. It is designed to enhance or present an in-depth understanding of the geometric concept of transformations. It is also designed to incorporate ELL strategies and cultural relevancy in supporting the understanding of the geometry focus. Therefore, in this unit I am creating a curriculum unit that addresses the fundamentals of 8th grade geometry using these content strategies.

The details of each component of the unit are as follow:

- One and two-dimensional concepts - To develop a strong foundational understanding of geometric concepts, using activities that involve concrete models, discussions, hands-on activities, practice in the usage of math vocabulary and illustrations.

- Develop an understanding of the relationship between math concepts and Native American art by using culturally relevant instruction in developing a deeper understanding of the connections to real world situations.

I plan to teach this unit during the second nine weeks of my eighth grade math class. The class will begin with review of the one-dimensional geometric concepts which, together, constitute an important basic foundational concept, and then lead into the primary focus of two-dimensional shapes in relation to understanding that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, translations and dilation. Also, in connection to this unit I will be utilizing cultural relevancy using the contemporary art form of Navajo rug weaving.

Content

Weaving

The Diné people have a philosophy that values beauty and harmony, which can be seen in their art forms such as weaving. Understanding the geometry of the weavings requires learning about the culture, history, and values of the Diné people. The story is told that the first loom was made from sky and earth cords. The weaving itself is made from the sunlight, lightning, crystals and white shells. These stories are told in full during ceremonies, which are very sacred to the Diné people. Many of the Diné stories involve the natural surroundings because the Diné believe in living in harmony with Mother Earth. The story of Spider Woman involves the interaction of people with nature and how these interactions became sacred to the Diné people. The stories are told from generation to generation in the Diné culture about the infamous Spider Woman and her weaving capabilities. Spider Woman is a deity that is very special in the Navajo culture. The Diné believe that she is the one that taught the Navajo women how to weave and so rug weaving is an important part of our Navajo culture.

The Navajo rug designs and patterns vary and some patterns have been influenced by non-Navajos, but the process of the weaving belongs to the weavers themselves; and, for them, it is a deeply creative and spiritual process. Also, some have pointed out the influence of Pueblo weaving and the introduction of Spanish sheep on Navajo weaving; but, again, those things do not diminish the deep cultural meanings that weaving has to the Diné people. What began with weaving women's dresses, where two identical blankets were sewn together, eventually became a single blanket (mantas). Then Chief's blankets were being made by the Navajo women, which became infamous, and these blankets evolved into different styles and designs. Over time, the Navajo rug became more intricately beautiful, diverse and sought after with each passing year. Types of yarns also changed, from natural hand-carded, hand-spun, and hand-dyed, to Germantown yarns, to native wool spun in small mills, and then to some of the prized Navajo Churro wool in today's contemporary art of Navajo rugs. Although, the patterns, techniques, and materials have gone through many changes, the Diné people still possess the sacredness and mastery of the art form.

As I researched the topic of Navajo weaving, I found that most of the writing about Navajo weaving explores how Navajo rugs have been regarded as goods or merchandise that have been traded away or sold to non-Native people. For this reason the traders would encourage Navajo weavers to incorporate patterns suited to non-Native tastes that would guarantee the procurement of higher prices. Navajo rugs and blankets have been an important part of the trading business for the Navajo society, but we need to remember that Navajo weaving has been more than that for the Diné people. For the weavers, it has been a livelihood integrated with art, beauty, and their own philosophy. Therefore, Navajo rugs are more than just decorative art pieces to be sold for profit; they a personal gift from one society to another. Even though the rugs are often sold, the process of weaving is considered serious and personally meaningful work for the weaver.

This brings us back to Spider Woman's teachings of rug weaving, which can still be found in modern-day craftsmanship, as the art of weaving is done the same way as it was in the past, using a hand-made loom and hand-made tools. Each strand of yarn is placed into the loom, by hand, one strand at a time, and pounded gently down with a wooden paddle. The interlocking of the yarn with the threads of the loom keeps the rug from unraveling. It is truly amazing to watch a rug weaver complete the process. This is the reason why, when a Navajo rug is done right, it does not unravel when it is accidentally cut. This is a process not amenable to mass manufacturing, making the Navajo weaving process one of the most unique in the world.
The skills and philosophies of weaving are taught to young Navajo girls, usually by their mothers, grandmothers, or other older women, especially after they complete their puberty ceremony. Here are a few of the basic steps in creating a Navajo rug. Although we can use and learn these steps, it does not teach us the true value or philosophy that is held by an authentic Navajo weaver.

1. Wool needs to be collected by shearing the sheep. The wool is cleaned or can be washed.

2. The wool fur is carded to be straightened and to remove any tangles. The process of carding is like brushing hair with two carding utensils. These are two flat utensils similar to a steel hair brush. When carding, the wool is put between the utensils, your left hand holds the utensil on your lap, while the right hand pulls the other utensil away. This is done several times until the fur

is fully carded and untangled. Then you roll it into a cylindrical shape. The carded wool is called "roving."

3. Then the wool goes through the process of spinning, using a hand-held spindle. Spinning the wool takes a long time. Also, it takes practice in order to spin the fibers well enough to produce yarn that will be used in making the rug. When spinning the wool, you pull each piece of roving until it becomes longer and you attach it to the previously spun wool so that it incorporates when you spin it, and then you keep spinning and pulling on it until it forms a string. Many hours and days of practice are required to be able to spin the yarn into a smooth string without lumps.

4. The loom is prepared by using tightly spun yarn that will be used for the vertical warp. By this time, the weaver has a pattern in mind. When the weaver sets up the loom using the string, the string should be a finger-width apart. I remember my grandmother teaching me how to set up the loom and she didn't use any measuring tools, just her hand, finger, and yarn for measurement.

5. During the weaving process the yarn (less finely spun yarn, usually colored) is horizontally threaded through the vertical warp using over and under threading. A utensil used to help the weaver is a "batten", which is a long, one-inch wide stick designed to hold open the warp as the weaver inserts the yarn to and fro horizontally. When you weave the yarn into place, it is ideal to make sure you don't pull too hard because, when you do, the rug starts going inward like, assuming an hour glass shape. If you make it too loose, then you end up with lumps within your weaving. Another utensil used is the wooden weaving comb which is used to gently pound the yarn into place.

This entire weaving process takes many hours, days, and months of work to create a single rug or blanket, but to the weavers it is time well spent as they finish each product. Of course, many of the well-known weavers have been practicing their skills for years; therefore, it is an art that takes time and practice. It also takes skill and patience to be able to sit for hours creating a work of art.

Navajo weavers are very proud of their work, so they spend time in creating the right design. These are a few basic steps they use when drafting their product. First, they count the vertical threading for the loom and make sure the threads are evenly spaced. Next, before creating the design, the weaver marks two places on the rug, the vertical and horizontal center on the loom. By counting the weft strands and dividing by two, she finds the horizontal center of the rug.

This is similar to finding the equivalence of $X = 0$ on a coordinate plane.

Then, using a strand of yarn, she determines the total height of the rug, then folds the yarn in half, and uses this measure to mark the vertical center of the loom.

This is similar to finding the equivalence of $Y = 0$ on the coordinate plane.

Therefore, for the rug on the right, the center of the rug is defined where $X = 0$ (which the weaver determined by weft count) and $Y = 0$ (which the weaver determined by the yarn measurement), which is then determined to be the origin, as is similar to finding the origin on a coordinate plane. By marking these measurements the weaver is able to design a pattern that is centered. Also, during her weaving, the weaver will often count the number of wefts in each

design shape to ensure that the rug to the right of the horizontal center is an exact reflection of the rug's left side. At the vertical center, the weaver often reflects the design or shape across the center line or the X axis. This process of counting to keep track of where design shapes are to be placed is important for making the rug pattern symmetrical in appearance. So the weaver is knowledgeable in measurement, counting distance, finding points, symmetry, transformations and forming patterns. Hence, the Navajo woman weaver is knowledgeable in the concepts of mathematical geometry.




Courtesy of Wikipedia

Geometry

The approach to geometry in middle school can differ greatly from the one that students encounter in elementary school, but students are still expected to understand the basic foundational math skills of geometry learned in the elementary level. Elementary school geometry often deals with identifying shapes and their properties, and in middle school it is transitioned into proving and reasoning through complex relationships. This causes my students to feel they lack the necessary skills to succeed in learning the math concepts necessary to master the geometry math strand. Also, it seems geometry is often the last content covered in every grade level math classroom, which is usually in the last quarter of the school, when yearly assessments are being conducted. So, it seems to me, when geometry is taught at the end, it can become neglected or not given the necessary time needed for mastery. Hence, by understanding some of the reasons behind this difficult transition and finding ways to counteract it, I created this unit to support my students in their learning and move them forward in learning higher-level math. The unit entails the 8th grade math concepts of transformation, which is a concept that, if implemented strategically, can be comprehensible and lead to mastery. Therefore, I plan to implement this unit during the 2nd quarter of the school year to give students the opportunity to understand the geometry concepts and support student success.

Transformation

In “Connecting the Art of Navajo Weaving to Secondary Education,” Mary K. Kirchner and Rez Sarhngi explain, “Transformations supports interpretation of our physical environment as well as provide us with a valuable tool in problem solving in many areas of math. The study of geometric transformations begins with the students understanding of visualization, mental manipulation, and spatial orientation regarding figures and objects” (Kirchner and Sarhngi, 2011). Through the study of transformations, students develop spatial visualization and the ability to mentally transform two-dimensional figures. Two-dimensional transformations are important topics for all students to study, and so all middle grade students should be taught these

concepts. Also, the study of geometry with transformations will enhance the understanding of geometry for students by providing them with hands-on experimentation. Also, motivating students through the use of culturally relevant connections engages the students in learning the math and their culture.

Spatial reasoning and spatial visualization through transformations help us build and manipulate mental representations of two-dimensional objects. Most of my students have difficulty with mental math so this skill will be taught using hands-on investigation using graph paper to demonstrate the reasoning. Students will investigate shapes, including their components, attributes, and transformations in order to have a better understanding. Additionally, students will have the opportunity to engage in systematic explorations with two-dimensional figures, including representations of their physical attributes. The geometric transformations in this unit are composed of four basic concepts: translations (slides), reflections (flips or mirror images), rotations (turns), and dilations (size).

Kirchner and Sarhngi state, "Transformation concepts provide background knowledge to develop new perspectives in visualization skills to illuminate the concepts of congruence and similarity in the development of spatial sense. It's important to understand that spatial reasoning, including spatial orientation and spatial visualization, are concepts that support an individual's mathematical ability" (Kirchner and Sarhngi, 2011). As I researched this topic, I found that it is suggested that students understand the geometric transformations by the end of eighth grade in order to succeed in higher-level mathematics.

I would also recommend that students study transformations of geometric figures to enhance the development of spatial sense. Students should have an opportunity to study two-dimensional figures through visualization and exploration of transformations. Thus, students should apply transformations; describe size, positions and orientations of geometric shapes using slides, flips, turns, and scaling; identify the center of rotation, line of symmetry, similarity and congruence of the figures.

Translation

Translation is a slide or the movement of the figure in the magnitude of movement that is related to same distance or that the shape moves every vertex or point by the same distance in a given direction. It's to recognize that a shape and its image are parallel and that the distances between the pre-image of the shape and image after the move are equal and moved at the same length as it translates. It is important to look at the direction of the translation of the figure because certain directional movements are easier to perform than others, especially when the movement of a figure in a translation moves in a horizontal direction to a diagonal direction.

Reflection

Reflection is the mirror image of a figure from the left to right or vice versa position over the y-axis or x-axis or over a line on a coordinate plane. Sometimes, students have problems performing the right to left reflection and have a tendency to interpret the movement as being top to bottom. Other misconceptions are when a student identifies a reflection as a translation when symmetric shapes are used. Also, sometimes they misunderstand reflections and confuse them with rotation of the figure. So it's important that students have an opportunity to use visual

examples to deepen their understanding of the concept and have them investigate using manipulatives.

Rotation

Rotation describes how a geometrical shape turns around a center point, called the center of rotation. When a geometric shape rotates on a coordinate plane, it stays exactly the same distance from the center point, and the shape orbits around that center point. It's important that students understand the shape is congruent as it rotates around a fixed point. The rotation of the figure may be clockwise or counterclockwise. Students can rotate manipulatives around a center point at 90 degrees, 180 degrees, 270 degrees and 360 degrees.

Dilation

Dilation describes how a geometrical shape changes in size, but keeps the same shape. When a shape gets bigger, we call it enlargement and when a shape gets smaller, it is called, reduction. The amount the shape enlarges or shrinks is called the scale factor. If the scale factor is more than 1, the shape is enlarged. If the scale factor is less than 1, then the shape is shrinking. If the scale factor is 1, then the shape stays the same or congruent. Another way of explaining dilation is to note how it is similar to a camera zooming in and zooming out. The image gets large or small, but it's still the same image. This can be conducted using computer enlargement and reduction of images.

Unit Objectives and Essential Questions

Having unit objectives and essential questions are important components in planning a curriculum unit to align lessons in sequential order, so they are appropriately scaffolded. I will be using these unit objectives and essential questions during my unit lessons. During my research in math transformations I found several unit objectives that would align with this unit plan which are as follow:

Objectives: Rotations, reflections, translations and dilation - Students will investigate:

• line to line measurement -line segments to line segments of the same length -angles to angles of the same measurement -parallel lines to parallel lines distance measurement
• the meaning of translation, rotation, reflection and dilation.
• two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, translations and dilations.
• the relationships between the interior and exterior angles of a triangle.
• the relationships among the angles formed.
• when two angles of one triangle are congruent to two angles of another triangle, the third angles are also congruent.
• congruence of corresponding angles, how it determines similarity for triangles, and congruent figures have the same shape and the same size.
• similar figures have the same shape and not necessarily the same size.
• dilation is a figure which is enlarged or reduced using a scale factor.
• transformations can be described using coordinates on a coordinate plan.
• the sum of the interior angles in a triangle is 180°.
• when two angles of one triangle are congruent to two angles of a second triangle, the triangles are similar.

Essential Questions:

1. What careers would use these concepts? Explain.
2. Where do you encounter the transformation math concepts in daily life?
3. Why is it important to understand transformations?
4. Demonstrate and explain translation, reflection, rotation and dilation.
5. How are the cultural teachings related to the math concepts of transformation?
5. Write a reflection of your learning. Was cultural relevancy an important component?
6. Explain how transformation relates to other Navajo art forms.
8. Explain how transformation relates to other Native American contemporary art.
9. Explain or demonstrate how your ancestors demonstrate their knowledge of transformation.
10. What was your favorite part in the curriculum unit? Why?

Strategies

To improve student achievement, I incorporate ELL strategies, appropriate modifications, and accommodations into my lessons. Students frequently work with a partner or as part of a cooperative group made up of no more than four students. Students are expected to help each other whenever possible, whether completing a hands-on activity or reading a section from a book; the learning styles of students in this class are predominately visual and hands-on. To increase comprehension and retention, I plan hands-on activities and incorporate visuals, props, and graphic organizers into my lessons. A variety of ELL strategies could be used with this unit, such as small group and whole group instruction, cooperative learning, partner reading, modeling, hands-on activities, demonstrations, visual aids, previewing text, summarizing information using class discussion and/or group discussions, performance task, and content relevancy. For this unit I will focus on cooperative learning, vocabulary, visuals, hands-on activities, and math discourse.

1. Students will create vocabulary cards to use within their cooperative learning groups.
2. Students will work in groups to discover which transformation occurred. They will use the coordinates to prove their answer.
3. Students will use manipulatives such as pattern blocks, coordinate grids, visual images, and other visual aids to support their learning.
4. Student will have think pair share discussions and group discussions.
5. Students will present results to the class.
6. Teacher will monitor and facilitate learning.
7. Teacher and students will have open discussions regarding misconceptions, strategies, ideas, reasoning, and problem solving.
8. Students will write one thing that they learned (reflection) exit ticket.

Cooperative Learning

Cooperative groups are arranged so they are in a heterogeneous group to support student learning. Learning mathematics requires a solid foundation of concepts, but not all students learn at the same pace or in the same way. Allowing for more customized learning can provide

students with the opportunity to learn foundational concepts with support from their peers, which keeps them engaged in their learning. Within the heterogeneous group, low-level readers are placed with a higher-level reader. Verbal students are placed with less verbal students. I group together and give extra support to students who need frequent redirection, positive reinforcement, or have behavior issues. IEP modifications for students with special needs are used when appropriate. These include extra time for completion of assignments, assistance with reading, shortened assignments, completed samples and examples, simplified instruction, frequent and immediate feedback, redirection, and praise (lots of praise).

Vocabulary

An important component for this unit is the geometry vocabulary, which we will review throughout the unit and use during our math discourse. In *Vocabulary for the Common Core* Robert J. Marzano and Julia A. Simms assert, "When it comes to learning math, English language learners (ELLs) are challenged with the task of learning academic language of math and learning math content simultaneously" (Marzano, 2013). So, when ELL students articulate their thinking processes through language, they are able to complete math practices/activities and identify gaps in their understanding. When students obtain this skill they understand what they need to practice on. As a teacher, I would model this process in order for my students to learn how to use it. For instance, when I am modeling think-aloud, I use visuals on the whiteboard and gestures. I know language is important not just in reading and writing, but in learning mathematics as well. As a teacher, it is important for me to make math lessons comprehensible for my students as well as provide them with the opportunity to develop their language skills. Providing students ample opportunity to interact with math vocabulary is an important strategy. I understand how important it is for students to understand math vocabulary in order to be successful in solving word problems, following instructions, understanding and using mathematical terms correctly in math discourse and being able to achieve proficiency. We tend to think of mathematics as a subject that does not require a strong command of language. In reality, however, mathematical reasoning and problem solving are directly impacted by language and rely upon a firm understanding of basic math vocabulary. In the Common Core math practice, "Attend to precision" correlates with how well a student understands the vocabulary as they solve a problem. Providing students with ample opportunities to engage with math vocabulary should be a primary focus in teaching math. I recommend designating a wall in your classroom to be used for a word wall. A word wall provides students reinforcement of vocabulary words learned throughout the school year and helps them remember the concept associated with that word. Encourage students to contribute to the word wall, as well. Some vocabulary terms that should be added to the word wall for this unit include evaluate, justify, evidence, describe, establish, area, perimeter, congruent, similar, symmetry, transformation, translation, reflection, rotation, dilation, coordinate plane, vertex, center point, x-axis, y-axis, patterns, tessellation, parallel, distance, angles, shapes, triangles, trapezoid, square, rectangles, equilateral, isosceles, right angle, scalene, distance and other pertinent geometric vocabulary terms.

Activity: The class will begin the vocabulary part of the unit by defining the terms in their own words after the instructor has given them lessons on their meanings and has provided visual clarifications (Anchor charts). Students will create a vocabulary list using index cards, and the

cards will be kept in the folder or on a ring for them to use during instructional lessons and during intervention time in small groups or in pair-share. Use of vocabulary review cards supports their learning. These cards will feature the word on one side and the definition with an example on the other side. Students will also be able to use these as flash cards during intervention group time. Even though they have the word wall, students should be provided with a hands-on vocabulary resource such as the cards to reinforce spelling and definition meaning. The more they interact with words the more vocabulary knowledge they will obtain.

Visuals

As an educator, I feel it's important for me to set the stage that maximizes the amount of learning accomplished by my students, and teaching mathematics using visual aid provides a powerful pathway for learning. Providing visuals is an important instructional strategy in teaching math to support student comprehension. Any of the following will not only make math more interesting, but will also help my students retain what they learn: using colorful anchor charts, interactive notebook activities, math posters, word walls, math procedures, guided instruction, whiteboard modeling, interactive smartboard lessons and other math instructional tools. In learning sequential step problems, highlighting each step in a different color can also support the learning process. Other types of visuals, including online resources such as math tutorials or math video games are engaging tools for students.

Activity: Have students keep journals to write about what they have learned, address questions they may have relating to recent lessons, create colorful notebook anchor charts, explain/justify their solutions, summarize and reflect on lessons. This journal helps students understand the importance of math writing and using vocabulary. I have used math journals for many years and it has made a great impact on student learning. Also, math journals can be utilized to store students' own anchor charts to reinforce the math concepts learned. One important anchor chart is the word problem solving organizer or the steps in solving word problems. At our school we use the graphic organizer CUBES. They paste in their journal this graphic organizer, (CUBES) acronym for Circle the key numbers, Underline the question, Box any math "action" word, Evaluate the problem, Solve and check. This graphic organizer will be used as an organizational tool and visual aid in solving real world mathematical problems. Hence, math journals are an important tool in my math class because they supports student learning, reinforce concepts and serve as a communication tool within the classroom. Students also enjoy reading feedback from me when they write their reflections on what gave them the most support during the lesson. Sometimes, students also write to their group leader on what they need help with. The math journal can be utilized in a variety of ways. Throughout this unit students will use their math journals as part of their learning tool.

Activity: When modeling math procedures or providing guided instruction, I like to create anchor charts alongside the lesson to post afterwards as reference tools. These anchor charts should be colorful to help students distinguish each step of the math procedure. Anchor charts developed during lessons are more meaningful to students than math posters that are hard to see or hard to understand. When they create their own anchor charts, most students retain and/or have a better understanding of the process.

Activity: A presenter is the best resource for integrating cultural aspects into any subject. In our community we do have Navajo rug weavers and we have establishments within our field trip area that have rug weaving demonstrations. Requesting a field trip to local establishments that have Navajo weavings such as the Window Rock Museum or Richardson Trading Post would be an ideal educational field trip. Provided with experience of the authentic process, the students will be able to understand the importance of the Navajo weaving and the relationship between the traders and the rug weavers. Many of our young Navajo students have not had the opportunity to visit these establishments and it would benefit them by browsing through the store and analyzing the authentic Navajo woven rugs and their retail cost. This would also encompass having students exposed to other contemporary native art such as basketry, jewelry, beadwork, tapestry, paintings, etc. Field trips are always a good way of getting students involved in their educational progress and, with this type of field trip, they will be provided with a culturally relevant educational experience.

Activity: Providing students with visuals can support the learning of geometry concepts. I usually research math videos on YouTube to find good visual representations of the concepts aligned to my lessons. There are so many math videos to choose from and sometimes it takes several hours for me to choose the right one. I would recommend teachers choose videos that would be appropriate for their own students because every class has different demographics. Using this type of visual aid has helped my students in their learning, and technology has always been a good way to engage students. Sometimes I give the students a chance to find a video on their own using the class tablets, but I have to monitor as they watch. This encourages students to find math resources on their own. Several students have let me know that they are now watching math videos and they are learning more about concepts they are learning in class. Therefore, I plan to incorporate time for my students to watch the concept of transformation, using YouTube videos to facilitate their learning. I would encourage them to learn about their own culture, as well. During my research for this unit I found several cultural videos that were good learning tools, especially regarding Navajo rug weaving. Of course, there are some videos that are not appropriate and that is my reason for monitoring the students as they search the different videos. As educators, we all know that our first step in allowing students on the internet is to discuss internet etiquette, and what types of videos are appropriate for learning in class and at home. In other words, I always have to remind my students that our tablet usage is based on how well they utilize their device as a learning tool, and I advise them to be respectful when using any school supplies and materials.

Hands-on Activities

Hands-on activity is an important instructional strategy to support ELL students in their learning process. By using hands-on learning, students have a better understanding of math concepts and how they are applied in the real world. Manipulatives are engaging tools that make learning math concepts more engaging. They motivate my students in their learning, by having them construct physical models of abstract mathematical ideas. Manipulatives build my students' confidence by giving them a way to test and confirm their reasoning; they are useful for solving problems; and they make learning math interesting and enjoyable.

Using real artifacts provides students with an understanding of the attributes and relationships of geometric shapes. This can be applied in Native American art by analyzing the geometric shapes of the artifacts such as pottery, weaving, baskets, and other artifacts. The concepts of congruence, similarity, and symmetry can be understood from the perspective of geometric transformation in the designs. Fundamental components are translations, rotations, reflections, and dilation, most of which are related to the artistic works of many Native Americans. By relating these concepts, students learn with a deeper understanding and develop an insightful outlook on the math understanding for their ancestors. Also, developing a critical area of mathematics in an organized unit deepens and extends understanding of geometry for all students.

It's important to use manipulatives for students to obtain the desired math concept. I recommend manipulatives such as pattern blocks and I advise having students use a desk-size coordinate grid to support their understanding of different transformations. These are important resources for students to utilize as they develop their understanding of the math concepts. Also, by using either a reproduction of a Navajo rug or an actual rug for students to handle, they will grasp the connection of how math has a relationship to the art form. At the beginning of the unit a majority of the lessons can be conducted in this manner using the pattern blocks and the coordinate grid. Once students grasp the concept they can use visual representations of a transformation on a coordinate grid either on a smartboard, on computer or on paper. Also, it's important to use the ordered pairs to pinpoint the distance of the transformation. When I use this type of lesson, my students are given the opportunity to investigate or I use guided instruction. It depends on the objective and outcome of the lesson you planned.

Math Discourse

Math discourse is another important strategy as it entails ways of discussing, representing, critical thinking, sharing ideas, and expressing thoughts orally or in writing. A tool to encourage discourse is sentence starters. They provide the support English language learners need in order to fully participate in math discussions; they contextualize and bring meaning to vocabulary; they provide a structure for practicing and extending English language skills; and they help students use the vocabulary they learn in grammatically correct and complete sentences. These sentence starters can also be used for partner talk, asking a question, and group discussions.

Activity: During class lessons, incorporating partner talk allows more students to participate in classroom discussions and eliminates the pressure that comes with speaking alone in front of a large group. It supports positive peer collaboration, and it's also a good way to listen for understanding or misconceptions as students discuss their ideas or their learning. I enjoy students figuring something out together because it builds trust and a good collaborative relationship. Using this method encourages students to facilitate their own learning without fear of making mistakes. Of course, it is difficult when they begin conducting partner talk, but it's important to continue until they become used to the idea. Once they are comfortable with talking to their partner, the students share ideas, understanding and supporting each other in their learning. Partner talk or Think Pair Share is an important part of my daily math class. You can incorporate any of the essential questions into this activity.

Assessment

After gathering background information and assessment data regarding the students, I chose to use the selected assessments to support their educational level. Our students need structure during the lessons and they need to know they are learning as expected, so immediate feedback is important. For my formative assessments I use thumbs up, exit tickets, parking lot, emoji reflection journal writing and question/answer strategies. Summative assessments that were selected are appropriate for these students, according to their data information. Another summative data I use is the NWEA assessment, which is given at the beginning of the year, the middle of the year and the end of the year. This lesson is being completed during the second quarter so they will be given the NWEA middle-of-the-year assessment. This data will demonstrate their understanding of the geometry math strand of the unit.

Throughout the year I will be teaching the students reading strategies to understand how to decipher word problems to help them have a better understanding. Reading word problems is also a math skill that I address with my ELL students. The assessments for this unit are standardized and will include word problem solving questions. I will also implement test-taking strategies with the different strands of math concepts throughout the school year. Therefore, math vocabulary is vital for students to understand, in order for them to prepare for standardized assessments and for everyday learning. The following is another way of assessing students, which is using math projects.

Project Ideas

- An art project integrating the geometry concepts learned using graph paper. Students can create a Navajo rug weaving using patterns and explain the transformations.
- Show and tell – students will bring in an artifact and present how the geometry concept they learned is demonstrated in the artifact and the cultural aspects of the art form.

Standards

If this unit plan is implemented as intended, students will be provided the opportunity to learn the rules of transformations to translate, reflect, rotate, and dilate objects both on a coordinate grid and abstractly across a plane (Navajo rug). The unit plan can be used as an additional resource when teaching students about transformations. Students will be given the opportunity to develop their skills within two of the Standards for Mathematical Practices: use appropriate tools strategically (mathematical practice five) and reason abstractly and quantitatively (mathematical practice two).

This curriculum is developed to provide students with a deeper understanding of the math concept of transformations rather than simply memorizing and reciting rules.

The success of the curriculum requires the educator to follow her math curriculum plan and use this unit as an additional resource for cultural relevancy connection which would require it to be implemented by educators who are interested in implementing the ideas that the unit plan is trying to express. However, an educator must also understand that every class is different and

they may need to differentiate the lessons to better meet the needs of their students. The lessons in this unit plan should be used as guides to support teachers who work in states where cultural relevancy is suggested and Common Core Standards have been adopted.

The curriculum and student outcomes will focus on using the common core mathematical standard of: 8.G: Understand congruence and similarity using physical models, transparencies, or geometry software.

CCSS.MATH.CONTENT.8.G.A.1
CCSS.MATH.CONTENT.8.G.A.2
1. Verify experimentally the properties of rotations, reflections, and translations:
a. Lines are taken to lines, and line segments to line segments of the same length.
b. Angles are taken to angles of the same measure.
c. Parallel lines are taken to parallel lines.
2. Understand that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that exhibits the congruence between them.
3. Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.
4. Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them.
The Diné Cultural Standards were developed by the Navajo Tribe to support the instruction and revitalization of the Diné language and culture. The standards are still in the development stages and are used by many schools on the Navajo Reservation. Only a few standards have been created, but they are the very foundation of our tradition (Dine Standards).

Therefore, my unit is created to support my students' development of a concrete understanding of the geometry strands from the Common Core Standards integrated with the cultural relevancy using the Diné Cultural Standards.

Diné Standard Concept 1 - Nitsahakees – Shintsahakees bee adil nishdlii doo bee adaa akonisdzin dooleel - I will engage in activities that will increase my sense of self worth.

Diné Standard Concept 3 – Iina – Bits aadoo bee da iinaanii baa akonisin dooleel – I will implement and recognize the Dine' lifestyle.

Teacher Resources and Reading List

Children Books:
1. *The Magic* Weaver *of* Rugs*: A Tale of the* Navajo by Jerrie Oughton & Lisa Desimini:
2. *Songs from the Loom; A Navajo Girl Learns to Weave* by Monty Roessel
3. *The Goat in the Rug* by Charles L. Blood
4. *Weaving the Rainbow* by George Ella Lyon
5. *Charlie Needs a Cloak* by Tomie DePaolo
Teacher Information

1. *Patterns and Sources of Navajo Weaving* by Bill Hamsen
2. *Teaching Secondary and Middle School Mathematics* by Daniel J. Brahier
3. "Connecting the Art of Navajo Weaving to Secondary Education," *Ohio Journal of School Mathematic*, volume 64, by Mary Kay Kirchner and Reza Sarhangi
4. *The Crossroads of Mathematics and Cultures*

Website Resources

https://www.teacherspayteachers.com

www.commoncoresheets.com

https://www.mathworksheetsland.com

https://tasks.illustrativemathematics.org/content-standards/6/G/A/4/tasks/1985

In researching rug weaving I came across plenty of videos on YouTube, which can be used to illustrate the process of weaving from start to finish. One resource I would recommend because of its authenticity is https://www.youtube.com/watch?v=-8y2zxf4u5c, which doesn't have sound but has the actual process that I remember my grandmother teaching me, long ago.

References

Aronlith,Jr., W. (1994). *Diné Bi Bee Óhoo'aah Bá Silá: An Introduction to Navajo Philosophy* Center for Diné Studies Navajo Community College, Tsaile, Arizona: Diné Community College.

CCSSI (2010). The Standards. Common Core State Standards Initiative. Retrieved from http://www.corestandards.org/the-standards

Demmert, W. (2001). Improving academic performance among Native American students: A review of the research literature. Charleston, WV: Clearinghouse on Rural Education and Small Schools. Retrieved from http://inpathways.net/Improving_Performance.pdf

Envision Math, Grade 6, Pearson Education, Inc. 2107

Harold Carey Jr. (2019) Navajo People – https://navajopeople.org/navajo-rugs.htm

Kirchner, Mary K. and Sarhngi, Rez (2011), Connecting the Art of Navajo Weaving to Secondary Education: Community of Ohio Mathematics Educators. Towson University *Ohio Journal of School Mathematics* No. 64. Retrieved from https://pdfs.semanticscholar.org/525a/7e7a19ff4e2a48e06c2db686b7298d96a09d.pdf

Marzano, Robert. J. & Simms, Julia. A., (2013). *Vocabulary for the Common Core*, Bloomington, IN: Marzano Research Laboratory

Wikipedia contributors. (2019, September 22). Navajo weaving. In *Wikipedia, The Free Encyclopedia*.https://en.wikipedia.org/w/index.php?title=Navajo_weaving&oldid=917245270

Synopsis: The Geometry of Native American Art

This unit takes us into the investigation and connection of how mathematics is involved in the art form of rug weaving. Rug weaving is a complex and ancient craft that is still practiced in today's contemporary art. The art form appears to be simple to most people, but it requires visual thinking and a sophisticated understanding of geometry. My intention is to show that these types of activities can be incorporated into a geometry course as a way of teaching how geometry relates to the Native American art of rug weaving. It is also an avenue to entice students in learning more about their language and culture, by incorporating culturally relevant lessons into any subject.

As part of our school district mandates, mathematics teachers are asked to seek activities that will involve modeling real-world situations using a variety of events, representations and analytical relationships of mathematical concepts. Also mandated is aligning lessons according to the common core math standards. By using the standards and culturally relevant lessons, students are more likely to be motivated and engaged in learning mathematical concepts. The primary focus of this unit is the concept that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations.