

Patterns, Relations, & Functions....Oh My!

Patterns Around Us: Using Navajo Culture and Art to See Math

Priscilla Black

Diné Institute for Navajo Nation Educators (DINÉ)

2021

Author Note:

Priscilla Black, DINÉ Institute Fellow, is a 6th grade teacher at Kayenta Unified School District which is located in Kayenta, Arizona. Correspondence about this curriculum unit can be addressed to dineteachersinstitute@nau.edu

Acknowledgements must be given to the teachers from all over the Diné Institute who supported one another with sharing of cultural and topical knowledge. To Shannon Marie Guerrero providing knowledge and support to our curriculum. To Angelina and Northern Arizona University staff for helping our Fellows create curriculum with great cultural components. Last but not least our families, friends and students for making time for me to follow my dream to teach with our grandparents' philosophy and discipline.

Introduction

Many community members from Kayenta and Shonto, Arizona see me as the teacher who prefers to embed her teaching with her elders' history of Diné living. A person who instills our grandparents' basic Diné way of life into everyday teaching. It is simple but intricate. My parents, aunts, uncles, and grandparents introduced the simple structure of life beginning with greeting the dawn. Acknowledging mother earth is a priority to identify your plan of the day. The next priority is to give your sharp attention to daily chores, animals, and family. The daily routine and chores clarified the foundation of life and helped our next generation to encompass it all like ancestors before. This concept is then reiterated in our daily prayers for all to be blessed. The intricate part of this routine is to find the meaning of each thing by thinking about how to process a job in whatever is to be done. How does this translate to the younger generation? One's navigation of life with such keen awareness can sense the simplicity as an adult. It is this simple and intricate way of living which helped me navigate through an AA degree at Northland Pioneer College, a B.A. with a dual major in Special Education and Regular Education, and a Master's degree in Bilingual Bicultural Education at Northern Arizona University. All these degrees were accomplished while I was working as a paraprofessional for six years with exceptional students and 5 years in the classroom at Monument Valley High School as an exceptional student's teacher. Sharing the parallelism of modern learning and cultural teaching is important to me. As a certified teacher of 25 years and a paraprofessional for 6 years, I am eager to give our younger generation their cultural gift. The gift that we call being Diné, the people.

This curriculum, which involves patterns, is exciting to explore. Many thoughts and possible layout of ideas came about. The first idea was to research how infants learn about patterns. The research behind the thoughts of little babies was too deep to tackle. Next the psychology of how toddlers sort and understand patterns came as an idea to research. Again, the reading became too technical and it made me redirect to how this curriculum should be helpful to middle school students at Kayenta Middle School. Kayenta Middle School serves approximately 135 6th graders. The 135 students are divided up into 6 classrooms. Our state standards require our students to understand Ratios, Algebra, Patterns, Geometry, and some Statistics. I decided that our lessons about understanding patterns and introduction to algebra would be a good place to add this unit about patterns. Culturally, this curriculum will allow our 6th grade students to see some of our traditional regalia and cultural items in nature as patterns. By allowing students to investigate patterns by using their own surroundings, the idea of patterns and algebraic expression will not be so difficult to learn in upper grades.

Context

This year is a rejuvenating year for Kayenta Unified School District in Kayenta, Arizona. The pandemic of Covid-19 has broadened our understanding of what learning means, especially as it relates to enriching opportunities for students. In March 2020, the entire Navajo Nation closed all learning facilities. The community of Kayenta was forced to put a plan in place to protect everyone from Covid-19. The Navajo Nation President, Jonathan Nez, ordered strict curfews and required a lockdown for the entire Navajo Nation. "Shelter in place" was implemented for entire communities surrounding Kayenta according to the CDC recommendation. Unfortunately,

Kayenta was one of the first communities struck hard by the Covid-19 virus. The uncertainty of having the right resources to combat the virus was a significant concern in mid-March 2020.

The Kayenta Unified School District took precautionary action to continue education through virtual learning. Students' and teachers' connections to Wi-Fi were limited. The Navajo Nation and the Kayenta Unified School District tackled the problem by making Wi-Fi available to some students. The company Choice Wireless gave discounts to parents with financial challenges. Kayenta Unified gave wireless hotspot devices and solar rechargers to students who lived too far away from cellular signals and electrical power. Despite the help, the people in the rural communities were not able to use any virtual learning. Some hotspot devices were not able to connect to students' virtual classrooms. Many teachers had to resort to hands-on worksheets and learning packets, which consisted of foundational skills to keep the momentum of minimal learning going. By August 2020, schooling continued with the same learning approach. Plans for a virtual learning atmosphere and short workshops on how to use computers to teach became a priority. Teachers and students had to learn to adjust to receiving learning through electronic devices given by Kayenta schools. Unlike the previous semester, teachers were able to use their classroom resources and technologies from the classrooms. Teaching through zoom, a document camera, and the computer camera were the best tools to teach lessons. This set up for in class learning was soon to be a frustrating method to teach. Teachers quickly learned that to improve student engagement and execute meaningful lessons was the next challenge to conquer. The question of being an effective teacher for all students was an everyday struggle. Teaching students in rural areas without Wi-Fi or an internet connection was an additional challenge.

In addition to not having internet or Wi-Fi, the Navajo Nation had more significant concerns than anticipated at the beginning of the pandemic. The education of our young Navajo Nation was at stake. In the past, Kayenta Unified School District has had a tremendous K-5 academic system. The students' success showed in post-high school feedback which was completed by selected staff at Monument Valley High School. Currently, Kayenta Unified School District has our Career Technical Education department take time to email teachers and workers at our school for information about previous graduates' success. Through this data gathering, many students are recognized for their accomplishments. Print newspapers from local and surrounding newspaper companies or media publish news about students. Lately, the recognition has simmered down. We get our few success stories on Facebook or local papers. What could be the cause? A combination of factors could be affecting low outcomes. One factor could be getting the message out to students and family members to report success. Another could be the hardship of paying for school and expenses to attend higher education. And still another factor could be a lack of academic preparedness. During staff meetings at our schools, K-8 educators are becoming aware of our low-test scores on the AZ Merit Test. The elementary school has been reported to be an F or D school within the last two years. The middle school has kept their C grade. The skills and drive to achieve a B or A are becoming a challenge.

Rationale

Math skills and math enthusiasm at Kayenta schools need a great deal of attention. The seminar on patterns renewed my thinking and excitement for teaching math at elementary and middle school levels. In the past, I wondered about the method of teaching patterns. One can remember

an elementary teacher preaching and asking questions like, “Patterns are all around us, children. Look at the blocks I have on the table. Tell the teacher about patterns. What comes next in the pattern?” As the teacher shows students the shapes and colors, students are in awe, because colors are exciting and meaningful to children.

In contrast, one has to wonder if teachers use pattern blocks at math stations to keep young children busy during their guided learning at their teacher center station? The next thought is, do teachers understand students’ thinking about patterns and how patterns relate to math? After reading *Helping Children Learn Mathematics*, 8th edition, (2007) teachers might begin to analyze how we as teachers represent or interpret the color and patterns to young learners. Our ambition is to make math fun and to embed math with logic. Our goal is to show students how patterns transfer to application-level, and extend the idea of how a traditional Navajo rug or nature's essence like rows of cornfield creates patterns. By teaching students to look for patterns in nature and surroundings, students can begin to see math in our backyard, in our traditional regalia, and in our daily chores. The final outcome is to make our students aware of math in our everyday life and to raise their awareness and problem-solving skills. If our students can see and organize their math thinking in patterns and algebra, then they will be more prepared to make sense of patterns and math integration to pre-algebra problems.

The children's book, *Celebrate My Hopi Corn* (2016) is an excellent example of how patterns are displayed in our natural environment. Anita Poleahia, and illustrator of Emmett Navakuku, showed mature corn in one row with corn leaves hanging in their natural state. The visual pattern of a short length of leaves to a longer length of leaves from one corn plant to the next makes our eyes look for similarities. Mother Nature displays her patterns in beauty effortlessly. The author and illustrator replicate their visual experience in drawings of buttes and mesas as well. In the background of the land formation of a butte and mesa displays their patterns of thin lines and thick lines of sedimentary rocks. The sedimentary rock shows its layers of sandstone by color and thickness. Comparing one mesa to the next shows an interesting parallel of sedimentary rock history. Indigenous people living in the southwest of Arizona, Utah, New Mexico, and Colorado plateaus are at the advantage of seeing and experiencing patterns. The outdoors are great places to go for searching for nature's patterning. Anita Poleahla and Emmett Navakuku did a great job in creating a book with patterns in such matters.

Content Objectives

Our Diné classrooms need to expand our understanding of patterns, and they need to include different teaching approaches to promote a higher level of mathematical understanding. Our Native students on Navajo land have to recapture their inquisitive thinking skills about patterns. As Peter Gardenfors (2007) mentioned, “perception of patterns is one of the most central cognition processes for all humans. However, while relying on patterns increases our efficiency, it can also hamper our ability to approach situations, especially multicultural encounters with an open mind.” Our grandparents were young livestock keepers or children of design seekers. It is only natural to observe and analyze mesas, buttes, and hills for patterns of mother nature. It is natural for young eyes to scope out patterns in how the horse corral logs are patterned to support the interconnecting beams. Sharon Nelson-Barber and Elsie Trumbull Estrin stated, “Many American Indian students have extensive knowledge of mathematics and science knowledge that

is rooted in naturalist traditions common to Native communities and arrived at through observation and direct experience.” Barber and Estrin (1995) The search to see mathematical concepts in natural settings for patterns can help children create patterns. So, this curriculum will show some studies of what “the next level” looks like by using traditional regalia and natural plants or places. Students can explore patterns created in our Navajo wedding basket or Navajo sash belt. Another tool is YouTube to see Native weavers, bead designers, and other artists create their art designs in a time-lapse video. The focus of a time-lapse video is to capture the artist's use number to see the intricate design happen. In this twenty-first century, technology and modern art can merge to help promote understanding in algebra. Also, teaching how patterns work to young learners can help begin to solve some fundamental math sequence problems and confidently use patterns to design potteries, mini rugs, bracelet braiding, beadwork, basket making, and placemats. This curriculum can make pattern books, and its relationship to traditional objects or any natural setting experience to repeating an accomplishment. By creating pattern books with traditional and cultural values, students can begin to own their learning and celebrate their knowledge of patterns.

The book, “Celebrate My Hopi Corn” by Anita Poleahla and illustrator Emmett Navakuku, presents Native lands, plants, and traditional home items in a way that can be a positive factor for Native students. The articles, *Helping Children Learn Mathematics, What Young Children Know and Need to Learn about Pattern and Algebraic Thinking and Functional Thinking as a Route into Algebra in the Elementary Grades* (Ginsburg, 2021), focuses on patterns and understanding math through drawing and printed materials. By gathering information about children's perception of patterns, a teacher can teach patterns with direct association with objects like cornstalk. Allowing children's natural observations will help teachers navigate the process of how numbers can repeat and numbers expressions can be created. Another great example is Native's southwest dry farming fields. The measurement in between each corn by rows and columns. This repeating pattern has the potential to be a great math drawing to present. Children would have to use a deeper depth of knowledge to understand that the repeating pattern is in the distance in between the corn and not the color or amount of corn ears on the cornstalk. The discussion of how mother nature sets up the patterns is a great discussion. This idea brings up the quote, "These are exciting patterns, but let us get back to the mathematics of patterns and algebra in the preschool classroom. The following section describes ways to think about patterns and pattern activities: recognition, replication, extension, creation, and across all of these, generalization of patterns." (Plateas, 2021) The discussion of different types of patterns would help engage students in meaningful ways. This motivational activity can ease students' nervousness towards math ideas.

Many cultural resources come to mind as Plateas' article discusses patterns with replication and creation. The Navajo artist, Sharon Birch's lullaby songs can give one a sense of the ABABA pattern and ABC ab ABC. Most of our lullaby songs had a simple design which most of us listened to growing up. The pattern recognition in our cultural setting has set us up with logical reasoning and investigation for future patterning and algebra expression. This unit will build on those early childhood experience and will help students investigate and create their book build upon patterns in the world around them. Patterns from our environment, cultural regalia and songs from our culture are an excellent place to begin for investigations into patterns for students.

Patterns Around Us: Using Navajo Culture and Art to See Math

Our brain is able to see patterns from the infant stage of life into adulthood. If students can look at a typical item at home and locate the pattern, math is happening before their eyes. A typical person and/or student may not see the academic connection and think math concepts do not exist in everyday items. At the end of this curriculum, students will be able to describe visual patterns in words and pictures. Students can see simple patterns from common objects and see it evolve to a math experience.



The goal is for students to describe patterns they see in their everyday lives, such as in the Hogan pictured here. Students will describe patterns in terms of what they see (stasis) and what would come next (change), (Guerrero, 2021). Specifically, students will take one real-world pattern they see in their daily lives and create a page for a class pattern book. On their page, they will draw (or show a picture of) their pattern, describe their pattern in words, and describe how their pattern might extend beyond what's seen in the picture/diagram. The pages will then be compiled into a class book of patterns.

Through the new experience of creating a page for a pattern book, each student can build awareness and ownership of learning math with cultural awareness. The teacher can compile each page into a pattern book that can be published. This student created book can be the foundation for the class or any elementary classes in understanding change and stasis in patterns. Continuing this activity at a math station for a month will give practices to build their confidence in dealing with math. An extended lesson in growing patterns can make sense for future lessons like patterns and function. A continuous activity of exploring patterns can assist in writing simple algebra expressions like $2n + 2$. The cultural aspect of using traditional beading and rug design can embed repeating pattern activities to teach young children that math is not scary. In

the end, the celebration of students sharing their student-made picture book can show other children that learning about patterns and recursive thinking is fun. The extended lesson of introducing how their new learning connects to another concept called functions will be less scary for 6th grades at Kayenta Middle School. This two-week math unit can be a review in the spring semester for pre-algebra lessons as well. Our legacy to leave such cultural teachings to the next generation might be the key to opening young minds to relearning cultural art and learning math in a fun way. The application level of math can be tied to the abstract of patterns and leaning some foundation for algebra. As one of the fellows of Diné Institute has stated, “I took algebra classes but I did not know how the numbers were connected to real life scenarios.”

Teaching Strategies

At the beginning of the unit, an introduction of patterns will be set up through whole group discussion. The whole group discussion will allow students to define the meaning of patterns or different types of patterns. Before the vocabulary of repeating and stasis patterns are introduced to the entire class, the class will do a nature walk on school campus. While walking around the campus, the teacher will point out the land and rock formation around Kayenta. On the southwest side of Kayenta, the teacher will point out Black Mesa plateau. Teacher will wait for some discussion among the students and take notes of what the students are sharing. As the class positions themselves to the west, the teacher will present the sandstone ridges called Skeleton Mesa. This formation does have some general patterns of coves and ridges that lay upward towards the sky. Again, the instructor can take notes on what the students are sharing among themselves for later reference.

The next observation would be of the rock ridges known around Kayenta. The north sandstone ridges called The Toes can be presented to the students. This observation is important to the unit because the importance of traditional stories. The surrounding land formation is beautiful and its designs are Mother nature’s weaving of the land. This nature walk will conclude the first day. In addition, the teacher will ask students to look for patterns of any objects around the building or at home. Each student will then take pictures of three objects they want to share which have patterns. The following day, students can begin to show their understanding of patterns. Since different students come from different levels of cultural awareness and math awareness, the pictures will help in two ways. First it will help students see that each student has their own idea about patterns. While students are investigating stasis patterns, teacher will ask question to guide their thinking of possible patterns that could appear. Teacher will then lead discussion into possible patterns. This scaffolding technique can allow students to use scratch paper and compare their answers to previous conceived answers. And second, the students can learn together to define repeating patterns and stasis patterns through this exploration learning. While the students are sharing pictures with patterns, the teacher will take note of how much Diné culture each student knows. The teacher will post a KWL chart and begin asking questions such as what do we know about the patterns they have presented. For example, Navajo rug designs? What do you think the designs are for? Does anyone have a family member who weaves rugs and knows the symbolism of the designs? The teacher will take note of what students know in regards to any pictures of arts and crafts design or any traditional regalia. By gauging the ability level of understanding patterns, the teacher can group according to strength in culture and

Patterns Around Us: Using Navajo Culture and Art to See Math

strength in pattern awareness. The teacher's hope is to have a few pictures of land which show some type of pattern.

Once students collaborate on what the pattern is. Teachers will structure a "think-pair-share" to help students share their thoughts. In the beginning of the lesson, ask students to explore the classroom for patterns and discuss the patterns. While the teacher thanks each student's finding patterns, the teacher can probe questions to extend the student's thinking. Prompting questions like, can patterns be in numbers? Would patterns exist in everyday objects or everyday activity? While students are collaborating on possible answers, teachers will post big poster papers for students to write their answers. Teacher should accept all the answers. Some answers might be correct and some answers could need some additional questioning to adjust to the lesson's object, but awareness of students' stress level should be minimized.

During the two weeks, students will be utilizing virtual manipulative applications to show repeating patterns. The virtual application is important to incorporate because our school district might be told to teach online due to the covid-19 pandemic. To start the Virtual Math Manipulative teacher has to log on to www.curious.com. Once you open the application, subscribe to open the virtual manipulative in the "Mathigon." Mathigon will open to another window which will show geometry as a choice. You have to click on geometry. Next, the polygons choice should open shapes that can be used to display patterns on the classroom big screen. Begin the lesson by restating what patterns are and how some patterns have different names. Stasis pattern that shows a certain pattern as it exists. The second pattern is repeating pattern. And, the last pattern would be increasing pattern. The point of this lesson is to make student think of patterns and how it behaves by changing it to different possible patterns. The virtual application can help the student see shapes and pattern easier. As students see patterns, begin to record their feedback and ask them, what would be the next three patterns would look like. By directing them to predict the next three patterns, then the students to use some type of number pattern to see the next three or next ten pattern with ease for other students to see.

Another strategy incorporated is daily repeating or increasing pattern searches of traditional regalia and land formations around Kayenta. Students will talk with their family about traditional regalia with patterns or talk about rock formations in Kayenta area. The teacher will show some pictures of beaded bracelets, traditional Navajo wedding basket, and a small traditional Navajo rug. The teacher will take a small section of beaded Navajo wedding basket bracelet and draw the design. Once the students see the design, the teacher will ask the students to verbally express what the next two possible designs might be and why. The teacher can ask students for various explanations for how the next few designs would be possible and then leave the design up and display the woven Navajo wedding basket. Again, the teacher can ask questions like, "How does the Navajo beaded wedding basket have a similar type of design as the beaded bracelet? How would you show the beaded Navajo wedding basket design to the real basket woven wedding design?" The teacher can continue similar questioning with other regalia like the mini-Navajo rug design, "Is the top and bottom portion of the rug the same? Is the pattern the same? How could the design be explained to be stasis and repeating patterns?" As students are explaining and discussing, the teacher will use the whiteboard and show the geometric, stripes, and spatial organization of some of these designs, highlighting the geometric shapes from the top to bottom as stasis or repeating. The teacher can keep students thinking by show sections of the design

from top portion of the rug to a comparison to the bottom portion of the rug. The teacher can also place all the regalia on display and allow students to search for patterns in a more holistic sense. Once the patterns are discovered, the teacher can transfer the investigation of visual patterns on artifacts to an exploration of patterns in land formation in the nearby area.

Land formation pattern investigations will be more of a lecture. Students will have a simple coloring worksheet of the painted desert. The simplified coloring worksheet will help students see the objective of mesas and plateaus having patterns. The teacher will show pictures of the Painted Desert and students can use prior knowledge to explain possible patterns within the hills and plateaus. The teacher will ask students to explain the patterns in terms of both stasis and change. Because some of the patterns do not extend, the teacher will discuss with students how they could extend nature's pattern to a repeating pattern. It is this type of thinking that makes our Navajo arts and crafts regalia meaningful. The color that mother nature shows could be the pattern and Mother Nature also designs the distance between each break of formation in the rocks, thereby making patterns, as well. It is possible that this part of the unit could delve deeper into aspects of geology, rock formations and earth science, but for my unit we will not go this deeply into the science of rock formations.

Classroom Activities

This curriculum can be implemented at the beginning of the year or in the second quarter of the school year. This estimation of time of implementation is good because most students are acclimated to school setting and teaching style. The first activity sets the tone for everyone to be successful and be able to search for any pattern. Students will be asked to take a picture of any patterns they see in the world around them, from nature to flooring to pictures or artwork to artifacts and so on. Allowing each student to present any picture or drawing of patterns will be accepted. Virtual students will be able to take pictures with their phone or computer and post their picture in Google Drive. The teacher will set up a "Shared Folder" for participants to upload their pictures. The teacher will allow at least two days to collect photos. During the two days, the instructor will do a virtual tour of the classroom by using a computer camera. Then students will use an application called Google Duo for Android phones and Facetime for iPhone to capture a few patterns of their choice from the surrounding area of Kayenta Middle School. After collecting all the patterns, participants will upload their video or picture to Google Drive, Share Folder. The instructor will share pictures on a big screen instrument called Infocus, a big television screen which could be interactive. The instructor will ask the collector of the video or picture to explain their observation of patterns. Participants will speak to their findings as the audience raises questions or additional observations of patterns in the picture or video.

From Open Explorations to a Class Pattern Book

Analyzing Patterns together can lead to more refined questions and answers about patterns and how they can be defined, described, and extended. One all presentations are complete students can write additional ideas of repeating patterns or stasis patten on poster paper. In the explanation, students will draw the patterns which are being analyzed. Next, the students have to show if the pattern is repeating. Questions during this discussion can be based on describing the patterns as it exists (stasis), how it might repeat or extend (change), and whatever else students

Patterns Around Us: Using Navajo Culture and Art to See Math

might notice about the pattern. A student representative from each group will share their idea to the entire class. This will then lead into the lesson on Navajo arts and crafts regalia, with connections to stasis and how we can extend the pattern to become a growing pattern or repeating pattern. Once students get a good understanding of stasis and repeating patterns in Navajo regalia, the class will begin their own design on eight by ten cardstock card. This cardstock card will be reprinted for our classroom pattern book.

The next teaching step would be to utilize the information from the poster to be transferred to some type of math. Again, allow the students to show how the patterns can be represented in a variety of ways, using words, pictures, tables, graphs, and other forms of representation. This activity will be used during the exploration and discussion of what pattern comes next and questions that ask, "What would this pattern look like in the tenth term or 100th term?" When students find a pattern, the teacher will associate the numbers to pattern A and to pattern B. A t-chart graph will pair up the numbers as ordered pairs in each column. For example, the first pattern could be a square and the second pattern might be two triangles. Teacher would place the number one in the column of square category. The two triangles would be placed next to the number of square but under the column for triangle. So, the first ordered pair would be 1:2. Once this established, the next row would be 2 square and 4 triangles. This pattern in the t-chart would be a growing pattern. The activity would require the student to find the 10th pattern. This part of the activity will be embedded in the classroom pattern book. As the activity required, the book will have interactive question which asks the reader to predict the 10th term. To help readers, the answers to each pattern, questions and correct answers will be printed on the last page of the classroom book.

Land Patterns and an Introduction to Algebraic Representations

On the fourth day, the teacher will repeat day one but using pictures of cultural items or land around Kayenta, Arizona. After sharing and discussing the patterns of cultural items and pictures of land formation or nature's patterns. Teacher will ask questions such as, "Do you think land formation has repeating patterns? Are Native arts and crafts jewelry meant to have patterns? Do you ever see patterns along the road to Kayenta or any town you are traveling to? Do you see patterns in beaded earrings or bracelets?" If possible, similar investigations into describing the patterns as they exist (stasis) and how they can be expanded (change) will be conducted using multiple mathematical representations.

The next part of the activity is to develop an "input chart" to display their thoughts about land formation, Native arts and crafts, jewelry, and roadside sceneries. As students are explaining their observation of patterns, the teacher will ask the students about how their observations and step number for the patterns they observe can be placed into columns as a more algebraic representation of the patterns they observe. The teacher can point out the traditional basket design on a beaded bracelet to help learners see repeating pattern or stasis design. The teacher will display the traditional black step like design of the beaded bracelet. This picture of my bracelet below is one example of an object that students can look at for pattern identification.



The teacher will lead a discussion on how students can look for both repeating and growing patterns by using a sample piece of jewelry (above). This piece of jewelry represents a repeating pattern because the same number of etching repeats to create a “step design” in the first to the last design. The slanted angle of partial triangles “step design” can also be used as an analysis of stasis (describe as it exists rather than how it extends) because the pattern can be seen as set from one end of the bracelet to the other end of the bracelet. Therefore, the teacher will interpret the entire design as one set and therefore show students how they can describe what they see (stasis) as well as what might come next if this bracelet were extended and made larger (change) (Guerrero, 2021). The development showing my bracelet of repeating etches of the partial triangle and the set of partial triangle design to make a complete set of design as both stasis and change will guide students to their discussion of pattern in their pictures for the picture book.

Book Sharing

After students become aware of repeating and stasis patterns, the teacher will read some culturally relevant books about Navajo and Hopi culture. The first book that I will read is the children’s book called, *Celebrate My Hopi Corn* by Anita Poleahla, and illustrator Emmett Navakuku. As the teacher is reading, questions will prompt student to describe what they see on each page. While the students are responding, the teacher will record student feedback on a poster chart. The teacher will allow at least two to three-minute wait time for responses. Students might give repeating details from the book or begin to see patterns. The teacher will actively appreciate any pattern recognition students share and use questioning to draw out additional details. For time the teacher may limit sharing of observations to three students per page. As the students are sharing, the teacher will draw all three observations on chart paper to demonstrate

Patterns Around Us: Using Navajo Culture and Art to See Math

that even within the same pattern, we may each see, observe or predict different things. After all the designs are drawn, the teacher will highlight appropriate math terms to describe repetitive patterns and how they relate to specific parts of each picture. In addition, the teacher will use a t-chart display or line plot of how the repeating pattern can be shown with numerical representation. This activity will open the main activity, creating a book for our classroom and another 6th grade class.

Planning and creating a class book about Pattern Around Us

This main activity is to create a 20-page book for our class to show an understanding of repeated patterns and stasis patterns that students see in our area of Navajo Nation. The purpose of the book is to show all students and others who may read our book that our beautiful land and traditional regalia are important for personal, cultural and mathematical reasons. The book can teach us, among other things, that our grandparents know and use patterns and functions to create traditional regalia.

The first step in creating the book will be to use the pictures the students shared and analyzed with the teacher and peers as a foundation to drawing a replica of the picture. The free hand drawing of their picture on an eight by ten cardstock paper will be reprinted as a page for our Patterns Around Us. The authenticity of free hand drawing will give each student a sense of homemade product versus a product which is published by a major company.

The second step will be to add an explanation of the pattern drawn by the student. The explanation should describe the pattern in terms of stasis and/or change and connect the pattern to some type of mathematical representation (e.g. a table, a chart, a verbal/algebraic explanation, etc.) The teacher will review and edit students' sentences about their patterns. The explanation can be written as a poem or in any other format of the student's choice. One of the major books read at 6th-grade level is called *Out of the Dust* by Karren Hess. The layout of the book is awesome. Each page is written in a poetic format. By the time the unit begins, students would have read the book *Out of the Dust*. So, the teacher should not have to teach stanza.

The third step will be to take a picture of a page completed by each student and submit it to the Kayenta Unified School printshop to be printed and bonded as a book.

Student Assessment

The teacher will observe and monitor each lesson of exploring patterns in our class, at home, outside, among land formations, along the road, in traditional attire, jewelry, rugs, pottery, dresses, beaded shoes, etc. Teachers can use an evaluation grid like the one below to quickly make marks or comment. A total of three anecdotal records should be sufficient to gauge understanding of repeating patterns and stasis patterns.

Patterns Repeating Stasis	Have some idea of patterns	Understands and sees patterns	Understands and elaborates their ideas of patterns
---------------------------------	-------------------------------	-------------------------------------	---

Patterns Around Us: Using Navajo Culture and Art to See Math

Visual/picture repeating patterns			
Can see building blocks being organized in a repeating pattern			
Can fill in skip counting problems – 2’s, 3’s, 4’s, 5’s			
Can fill in skip counting with complex rules			
Basic awareness identifies stasis patterns			
Connection of land, jewelry, Navajo regalia patterns to basic repeating pattern			
Student can see Navajo Wedding basket design as a repeating pattern.			
Student can see Navajo Wedding basket design as a stasis pattern			
Can student see patterns and begin to translate the patterns into algebra expression?			

As students are working and discussing patterns, the teacher will walk around and take notes. Students’ reasoning will be recorded and analyzed by asking students to share their step-by-step thinking.

After completing their exploration of finding patterns and analyzing patterns, students will participate in a think-pair-share activity. Students will be paired together and present their findings to each other. Classmates will give at least two statements of patterns occurring in objects or pictures with patterns. After the feedback, the entire class will gather and explain how patterns were connected, repeating, or stasis patterns. Discussion will entail some basic awareness of nature. Word choice of how the mind interconnects with the patterns of their natural surroundings can be recorded. How the physical objects of Native American arts and crafts and land formation patterns relate to everyday life awaken and touch of cultural awareness or allowing the processing of how students see patterns are important during this evaluation. As a teacher, we begin to see how students become observers of cultural regalia and then stop and think. Lastly, the exploration has the presentation of fulfilling the thirst of becoming strong math learners. The table below will be used to assess these key features of each student’s discussion and presentation of the patterns.

During student feedback and think-pair-share, the teacher will take notes on each group’s understanding and/or new learning as a step towards understanding repeating and stasis patterns. The collaboration of how a pattern can be translated to an algebra equation would be the ultimate goal. A teacher made assessment on Standard 6.EE.A.2 would be one of my final assessments. Students will engage in many practices of creating and defining patterns, such as how many guests can be seated at a square table if there are four people total. The next problem would be

solving the amount of people sitting at two square tables connected and drawing a person at the side of the table that is open to sit at. From this activity, students will solve the problem by drawing out the pattern for the 10th pattern and the 100th pattern. After completing the 10th and 100th pattern, students can share their findings on the whiteboard. At this point, the teacher will review lesson 19 from Eureka math of how to figure out an equation for the unknown number in the 10th pattern and the 100th pattern.

And finally, the page students make for the book will also be assessed for student learning. The teacher will look for similar indicators of learning as described above, including types of patterns being describe in the book. Student's drawing must show any of the following pattern, stasis, repeating and growing pattern. If a pattern has a repeating or growing pattern, students need to show a numerical representation to show the mathematical concept. The book will have a glossary page in the back to help students understand mathematical term. This page will be developed and graded by teacher.

Alignment with Standards

This curriculum unit is aligned to the following 6th grade math standards:

6.NS.B Students will practice this standard during finding the ratio or repeating pattern on a t-chart. Finding multiples of two or factoring numbers to find the rules of repeating patterns.

6.EE.A Once the student finds the repeating pattern and finds the 10th pattern or 100th pattern, students will be able to write an algebraic expression. .

6.EE.A.1 Students will check and plug in numbers from the t-chart and verify the numerical expression which involves the whole-number.

6.EE.A.2 Students will be able to write an algebraic expression on the book page with an explanation in simple math language.

a. Students can write an expression with numbers and variables.

b. Students study t-chart and find parts of an expression by using math terms such as sum, term, product, factor, quotient, and coefficient.

6.MP.3 Construct viable arguments and critique the reasoning of others. Mathematically proficient students construct mathematical arguments (explain the reasoning underlying a strategy, solution, or conjecture) using concrete, pictorial, or symbolic referents.

Arguments may also rely on definitions, assumptions, previously established results, properties, or structures. Mathematically proficient students make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. Mathematically proficient students present their arguments in the form of representations, actions on those representations, and explanations in words (oral or written). Students critique others by affirming or questioning the reasoning of others. They can listen to or read the reasoning of others, decide whether it makes sense, ask

questions to clarify or improve the reasoning, and validate or build on it. Mathematically proficient students can communicate their arguments, compare them to others, and reconsider their own arguments in response to the critiques of others.

This curriculum unit is also aligned to a number of Diné cultural standards:

Students will focus on a pose question to keep discussion focus. Students will follow rules for productive discussion, and review key ideas expressed with multiple perspectives. Students and teacher will engage in meaningful discussion to assist in diverse thinking. 6.SL.1

4th – 6th grade Oral Diné Language standards, concept 3-Iina states that our students will utilize Diné language to present information in a variety of situations. Teachers will identify each traditional regalia in Diné language and students will learn to pronounce it and use the Diné word in context.

4th – 6th grade Diné Culture standards: Students will develop an understanding of the Diné way of life. Concept one states a student will explain the significance of his or her cultural possessions. It is important to have traditional regalia in possession because it identifies each person of their identity.

Resources

Barber-Nelson, Sharon, Estrin, Elsie T. Bring Native American Perspectives to Mathematics and Science Teaching. Theory in Practice. 2009;10:174-185. Doi: 10.1080/00405849509543677

Blanton, Maria L. (http://link.springer.com/chapter/10.1007/978-3-642-17735-4_2). STEM Department, the University of Massachusetts at Dartmouth, Dartmouth, USA. Functional Thinking as a Route Into Algebra in the Elementary Grades. 2011

Bonocina S, Krizman J, Wite-Schwoch T, Nicol T, Kraus N. How Rhythmic Skills Relate and Develop in School-Age Children. Glob Pediatr Health. 2019;6:2333794X19852045. Doi: 10.1177/2333794X19852045

Caglayan, Gunhan. Visualizing number sequences: Secondary preservice mathematics teachers' constructions of figurate numbers using magnetic color cubes. ELSEVIER. 2014;07:110-128. <https://dx.doi.org/10.1016/j.jmathb.2014.06.004>

Copley, Juanita V. 2010. The Young Child and Mathematics. National Association for the Education of Young Children.

Faulkner, Valerie N. The Components of Number Sense: An Instructional Model for Teachers. Sage Publication. 2009;vol41;5: 24-30. Doi: 10.1177/004005990904100503

Patterns Around Us: Using Navajo Culture and Art to See Math

Garden, Peter. Understanding Cultural Patterns. Lund University. 2007;10. Doi: 10.1525/california/9780520254343.003.003

Ginsburg, Herbert P. What Young Children Know and Need to Learn About Pattern and Algebraic Thinking. DREME. 2021. Stanford University. pp 1-4. (<https://dreme.stanford.edu/people/herbert-ginsburg>)

Miendlarzewska EA, Trost WJ. How musical training affects cognitive development: rhythm, reward, and other modulating variables. *Front Neurosci*. 2013;7:279. Doi: 10.3389/fnins.2013.00279

Morin, Amanda. Fun Ways to Teach Kids About Patterns: Learning about patterns can hone problem-solving skills. Very Well Family. Updated on September 17, 2020.

Using Picture Books: Counting. <https://dreme.stanford.edu/people/colleen-uscianowski>

Platas, Linda M. (<https://dreme.stanford.edu/people/linda-platas>). Project of the Development and Research in Early Math Education (DREME) Network. 2021

Reys, Lindquist, Lambdin, and Smith. (2007). Patterns, Relations & Functions (chapter excerpt) Chapter 14: Algebraic Thinking (p.335-342) *Helping Children Learn Mathematics*, (8th edition).

Turner, Erin E., Drake, Corey. A Review of Prospective Teacher's Learning About Children's Mathematical Thinking and Cultural Funds of Knowledge. 2015;07:32-46. Doi: 10.1177/0022487115597476

Using Picture Books: Counting. (<https://dreme.stanford.edu/people/colleen-uscianowski>), Colleen Oppenzato (<https://dreme.stanford.edu/people/colleen-oppenzato>), & Herbert P. Ginsburg (<https://dreme.stanford.edu/people/herbert-ginsburg>)

https://www.youtube.com/results?search_query=How+do+toddlers+learn+patterns+nuerological+ly