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Math Word Problems and the Diné Hooghan

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Introduction

The Hogan (*Hooghan)* is a sacred home for the *Diné* people. Few families reside within a *hooghan* today. They are used for healing ceremonies, weddings, and family gatherings for holidays, birthdays, and storytelling. The word *hooghan*, means "place home." Legends say the *hooghan* was built when First Man and First Woman asked the Bird People, the Water People, and the Insect People to show them how their homes were constructed. These beings said, building a *hooghan* begins with a prayer using corn pollen, to ask permission to the gods to build a home. This initiates the origin of the *hooghan*s.

There are two types of *hooghans*, the male (*bika hooghan)* and female (*biaad hooghan*). The male *hooghan* is an earlier structure. It is based on the forked cedar pole structure, and is used for ceremonial purposes. During the construction, songs of the first *hooghan* are sung. The first *hooghan* was built by First Man. The construction begins as the sun travels though the sky, east, to south, to west, and to the north. The holy people instructed the *Diné* to build all *hooghans* facing east, because this is where creation begins. This also allows the first sun rays to enter into the doorway of the *hooghan*. The sun is known as *Jóhonaa'éí*, his first light rays touches your face and he blesses you because you watched him rise to greet him.

The female *hooghan* is commonly dome shaped, with logs horizontally placed upon one another using smaller and smaller logs of suitable length until the circumference gradually forms a circular dome. Below the dome, vertical logs of the suitable height are used to form the foundation of the *hooghan's* octagonal perimeter. This *hooghan* is more prevalent among the Diné today. The octagonal dome represents the interlocking fingers of the mother's clasping hands over her child in the womb. The opening at the top represents the navel (*ts'ee'*).

This place, *hooghan,*is a dwelling of respect and learning of life. It is considered a living being (*iina*) and when treated with respect, the home place will protect its inhabitants. This is the relationship with the *Diné* and the *hooghan*: the mutual sharing and protection. Today, when a *hooghan* is constructed, prayers are offered to the Holy People asking permission to build a home. The dome of the *hooghan* represents Heaven/Sky (*Ya'aash*) and the floor Mother Earth (*Nahasdzaan*).

There are many concepts and skills in learning and building a *hooghan*. These paragraphs are just a few concepts written about the *hooghan*. The in-depth and detailed teachings will be taught to the students during Social Studies and *Diné* Culture & Language sessions, which is the background information students will need

when reading and solving these math word problems. The mathematics and some algebraic aspects of the *hooghan* suggest numerous geometric examples of word problems for to students to solve while learning about the two *hooghans*. Geometry is the main mathematical subject relevant to hooghan's, but these problems also involve arithmetic and algebra.

Rationale

In the *Diné* culture and language, math is seen and found in most aspects of life, and in the arts and crafts. We see it in the Navajo wedding basket, the cradleboard, in our livestock (horses, cows and sheep), cornfields, the *hooghan*, and more. Although these math concepts are embedded in our culture, our students have only a very basic understanding of their culture and language. They view their culture and language as insignificant and in the end they do not absorb it deeply. When it comes to reading, comprehending and solving math word problems about their culture, our students really do struggle, because they are not fluent in both the *Diné* and English languages and realize it is difficult to read, write, and comprehend math word problems. This puts our students at the midpoint, of no strength in either one.

I know from experience that teaching topics about their culture and language along with content helps students make connections and will make learning more meaningful. Also, frontloading and scaffolding basic math skills like the multiplication and division facts will make solving math problems move a lot smoother when students know the basics. This is important because, when our district teachers review the Arizona State assessment results on solving math word problems we find it as the lowest score. This issue has always been a problem because many of our students are not proficient at grade level, and some students are two to three grade levels below the norm of our state standard math scores.

The students within our three schools and district are 98% *Diné*. However, when I ask my students a class of 28, who is able to speak the *Diné* language fluently, none of my students will raise their hand. Then I ask who is able to understand their language 10 students will raise their hand. I find that these 10 students reside outside our school district boundaries and some of them travel 120 miles to and from school weekly. They begin at 5:00 a.m. and end their day at 6:00 to 7:00 p.m. Despite these disadvantages, some of them understand Diné better than the local ones.

All our students are required to complete the state and district math assessments. The results of assessment show that our fifth grade student scores are at the 46%tile and below. I believe the reason is that most schools on the Diné Nation still use a scripted text book as their core curriculum in the humanities, mathematics, and in the sciences. Our district, for example, adopted the Eureka Mathematics Curriculum. My understanding is that the scripts in Eureka Math are for purpose of example, and not intended to limit teachers. However, our administrators insist that teachers follow the scripts. Many of the teachers resist the change and find that students struggle with grade level concepts. Even though many students are not at grade level, we are instructed to teach the model because it is our district's initiative.

Background

My goal in writing this curriculum unit is to embed our culture and language in math word problems, and to strengthen our students' confidence and determination to solve math word problems. During the course of the "From Arithmetic to Algebra" seminar, I have created a math curriculum unit with word problems that will be relevant to our *Diné* children. Most of our students know the basic use and purpose of the two *hooghans*, and how they are used in our culture. However, their knowledge of these cultural features is not very detailed or specific. Our students need to know the culture and language better and also need to develop solid math skills to let them continue learning math. Therefore, this unit will use problems about *hooghan*s to help students learn how to use effective math strategies while learning to read and solve math word problems and eventually become problem solvers.

The word problems will be designed to both deepen my students' ability to do mathematics and to strengthen their knowledge of *Diné* culture and language. The problems will require students to learn a substantial amount of new math vocabulary. A math word wall will be created to assist special education and ELL students in learning the new vocabulary. In addition to vocabulary, students need to know and learn how to comprehend math word problems and solve problems.

There are numerous ways and methods, publishers, administrators and teachers teach students how to solve math word problems. The method Roger Howe explained and demonstrated during his seminars when solving common math word problem, is based on the taxonomies of one-step addition/subtraction problems, and one step multiplication/division problems in Tables 1 and on 2 of The Appendix to the Common Core State Standards in Mathematics (CCSSM). Refer to corestandards.org/Math/ Content/mathematics-glossary/Table-1/[1] The taxonomy is not intended to be taught to students, but is for teachers to use as a frame for writing various math problems.

Below is a table showing example math word problem models for common addition and subtraction problems. Then, the next table is the common multiplication and division examples. I have written problems connecting to the *hooghan's* activities like construction, ceremony preparation, and events surrounding the *hooghan*. The *Diné* words in the math problems are in italic in the front of the English word. I put the *Diné* words first because our children need to read and say their language, even so in mathematics. In a sense, "they will become trilingual," because students will need to read and know the math problems in *Diné* and English and also to know math vocabulary word. This will also be true for Dine teachers and for non-Native teachers. They will also need background knowledge to understand the specific events within the word problems. For my students, this will be supplied in a separate social studies unit.

Furthermore, these problems will vary throughout the school year. I know as a teacher on the Dine Nation, our children need constant practice and review of how to read and solve math problems throughout the school year. The math word problems will become more advanced and difficult as students' progress into the school year. This is when the strategies and classroom activities come into play.

TYPE / UNKNOWN	Result Unknown	Change Unknown	Start Unknown

add to (also known as change plus)	· Four *(chidí)* trucks were hauling logs for building a *hooghan*. · Then 12 more *(chidí)* trucks joined them. · How many *(chidí)* trucks in all were hauling logs for the *hooghan*?	· Four *(chidí)* trucks were hauling logs for building a *hooghan*. · Some more *(chidí)* trucks joined them to haul logs. · Then were 16 *(chidí)* trucks. · How many *(chidí)* trucks joined the first four?	· Some *(chidí)* trucks were hauling logs for a *hooghan*. · Twelve more *(chidí)* trucks joined them to haul logs. · Then there were 16 *(chidí)* trucks hauling logs. · How many *(chidí)* trucks were hauling logs at first?
TYPE / UNKNOWN	Result Unknown	Change Unknown	Start Unknown
take from (also known as change minus)	· 50 buckets of sand clay were brought to make the base of the *hooghan*. · 47 were used. · How many buckets of sand clay are left over?	· 50 buckets of sand clay were brought to make the base of the *hooghan*. · 3 were left over. · How many buckets of sand clay were used?	· Some buckets of sand clay were brought to make the base of the *hooghan*. · 47 were used. · Now 3 are left. · How many buckets were brought for making the base?
	Total Unknown	Addend Unknown	Both Addends Unknown
Put together/take apart (also known as part-part-whole)	· 7 men and 9 women are in the *hooghan*. · How many adults are in the *hooghan*?	· 16 adults enter the *hooghan* before the songs begin. · 7 are men and the rest are women. · How many are women?	Not commonly used for word problems
	Difference Unknown	Bigger Unknown	Smaller Unknown
Compare (plus fewer/minus greater) How many more? How many fewer?	· The *Tótsonií* family made 25 frybread. · The *Ashįįhí* family made13 frybread. · How many more frybread did the *Tótsonií* family make? · The *Ashįįhí* family made 13 frybread. · The *Tótsonií* family made 25 frybread. · How many fewer frybread did the *Ashįįhí* family make than the *Tótsonií family*?	· The *Tótsonií* family made 12 more fry bread than the *Ashįįhí* family. · The *Ashįįhí* family made 13. · How many fry bread did the *Tótsonií* family make? · The *Ashįįhí* family made 12 fewer frybread than the *Tótsonií* family. · The *Tótsonií* family made 25. · How many frybread did the *Ashįįhí* family make?	· The *Tótsonií* family made 25 fry bread. · That was 12 more fry bread than the *Ashįįhí* family made. · How many fry bread did the *Ashįįhí* family make? · The *Ashįįhí* family made 12 fewer frybread than the *Tótsonií* family. · The *Tótsonií* family made 25. · How many frybread did the *Ashįįhí* family make?

Unknown Product	Group Size Unknown ("How many in each group?" Division)	Number of Groups Unknown ("How many groups?" Division)

equal groups measurement	· There are 12 *(ts'aa')* baskets with four popcorn balls in each *(ts'aa')* basket. · How many popcorn balls in all? · You need ten lengths of logs; each log is 8 feet long. · What is the total length of all these logs?	· If 48 popcorn balls are shared equally in twelve *(ts'aa')* baskets, then how much popcorn will be in each basket? · You have 80 feet of logs and you will cut them into 10 parts. · How long will each part be?	· If 48 popcorn balls are to be packed 4 into a *(ts'aa')* basket, then how many *(ts'aa')* baskets are needed? · You have 80 feet of trunks to cut into logs, and you will cut the logs into 8 foot lengths. · How many lengths of logs will you get?
arrays area	· There are 6 rows of (*łįį'*) horses with 8 in each row. · How many (*łįį'*) horses are there? · What is the area of a 20 foot by 12 feet rectangular (*chaa'oh)* shadehouse?	· If 48 (*łįį'*) horses are held in 6 equal rows, how many (*łįį'*) horses will be in each row? · The (*chaa'oh)* shadehouse has the shape of a rectangle, and has an area of 240 feet. · If one side is 12 feet long, how long is a side next to it?	· If 48 (*łįį'*) horses are arranged into equal rows of 8. · How many rows of (*łįį'*) horses will there be? · The (*chaa'oh*) shadehouse has the shape of a rectangle, and has an area of 240 feet. · If one side is 20 feet long, how long it a side next to it?
compare measurement	· A flee market retailer charges $6 for (*tsint'eesh)* ash in a tin can. · *(Ch'ilawéédh)* tea in a tin can costs 5 times as much as the (*tsint'eesh)* ash. · How much does a can of the *(ch'ilawéédh)* tea cost? · During her Kinaalda, a puberty ceremony, Jolene is required to run east every morning. Each day, Jolene needs to run a longer distance from the *hooghan*. · On the first day, she ran 2 miles. · One the last day of her (*kinaalda)* ceremony she ran 4 times longer. · How many miles did she run on the last day?	· *(Ch'ilawéédh)* tea in a tin can costs $30 and it is 5 times as much as a can of the (*tsint'eesh)* ash. · How much does the (*tsint'eesh)* ash cost? · For each day of her Kinaalda, Jolene needs to run a longer distance from the *hooghan*. · One the last day of her (*kinaalda)* ceremony she ran 8 miles. That is 4 times than she ran on the first day. · How many miles did she run the first day?	· *(Ch'ilawéédh)* tea in a tin can costs $30 and (*tsint'eesh)* ash cost $6. · How many times as much does a can of *(ch'ilawéédh)* tea cost than a can of (*tsint'eesh*) ash? · For each day of her Kinaalda, Jolene needs to run a longer distance from the *hooghan*. · On the last day of her (*kinaalda)* ceremony she ran 8 miles. · On the first day, she ran 2 miles. · How many times longer did she run on the last day?

Content and Objectives

I will use the taxonomies of one-step addition/subtraction problems and one-step multiplication-division problems, included in the CCSSM as corestandards.org /Math /Content/mathematics-glossary/Table-1/[2] to guide my writing and discussion of word problems. I will begin with the one-step types. I would allow time for student to become comfortable with the different types of one-step problems, and then another period of time dealing with two-step problems and figuring out how to decompose them into one-step problems before going into the three-step problems and more. Students need to get to the point where they can deal with multi-step problems fairly readily. The key is getting them used to reading the problem carefully and figuring out what it

is saying. My overall goal is that my students will practice a mixture of varied problems. All problems will have a strong cultural aspect, and will especially involve the *hooghan*. In this way, my students will begin to see how home and family are valued at school, and how mathematics fits into these aspects of life, and helps to understand math problems and culture.

As students learn the process of math problem solving, they need to understand that there is no single process that works all the time. There are various strategies and skills they can learn to use to be able to read various problems and to understand how each problem is slightly different. The most important practice to develop is the habit of reading the problem carefully and thinking about how the different parts are related. The practice of problem solving is crucial because when problems become difficult they require specific analysis and breakdown in certain situations. As the problems are solved, students will need to understand how they solved the math problems; this is when thinking about thinking comes into play. The cognition, to be able to explain orally or in writing how the word problem was solved, and to ask if it is correct, are skills I want to emphasize. This is when everyday life and home activities make the connections between cognition and context when using culture and language.

After my students, have gained some familiarity and comfort with word problems, I hope to introduce some of the more formal aspects of arithmetic, to strengthen their abilities to work with symbolic expressions, and to prepare them for dealing with algebra. Students learn to substitute variables while writing equations and this increases the rigor and the pedagogy of the mathematical thinking. So, for students to be able to work successfully with math word problems, we need to be strategic in teaching appropriate classroom techniques to assist and build on these linkages. By emphasizing the home and school connections for students in my problem sets, I want to make students feel successful and take ownership in deciphering the mathematics. We will build bridges when the instructional objectives are for children are useful for them, and will promote their enduring understanding.

The challenge of solving math word problems for elementary teachers is the need to be pedagogically sound when teaching the arithmetic and algebraic solutions. I hope that using the table created above will assist teachers in thinking about the appropriate problems and working through the process of solving the steps. The practices of problem solving in various ways will become a smooth process for elementary teachers to get comfortable and confident in math.

Below are word problems with arithmetic solution, then the algebraic solution. This is how Roger Howe's seminar, "From Arithmetic to Algebra" modeled the applications.

Problems: The arithmetic solution, then the algebraic solution. First is Roger Howe's example problem,[3] then addition problems are shown as examples, like One-Step Equation, Additive with result unknown, change unknown, and then start unknown.

One-Step Equation, Additive			
The Problem	Arithmetic Solution	Algebraic solution	Explanation

· J. had some model trucks. · Today, he bought four more. · Now he has seven trucks. · How many trucks did he have?	· If J. ended up with seven trucks · after buying four new trucks, · then before he bought the new trucks, · he had 7 - 4 = 3 trucks	· Defining the variable. · Let t be the number of trucks J. had. · Writing the equation. · 4 + t = 7. · Solving. · t + 4 = 7 ⇧ (t + 4) − 4 = 7 − 4, · or · t = 3.	Thinking about your thinking

TYPE / UNKNOWN: add to (also known as change plus)

The Problem	Arithmetic Solution	Algebraic solution	Explanation
· Four *(chidí)* trucks were hauling logs for building a *hooghan*. · Then 12 more *(chidí)* trucks joined them. · How many *(chidí)* trucks in all were hauling logs for the *hooghan*?	· 4 *(chidí)* trucks are hauling logs · 12 more *(chidí)* trucks join them · How many *(chidí)* trucks in all 4+12=? Change plus; result unknown	· Defining the variable. · Let t be the number of all the *(chidí)* trucks. · Writing the equation. · 4 + 12 = t. · Solving. · 4+ 12 = 16	Thinking about your thinking

Teaching Strategies

The four main strategies I will implement are the Eureka Math models, the Polya Method, "I Do, We Do," and the Guided Language Acquisition Design vocabulary model. Other strategies like using frame of writing or reading skills are additional components students will need to learn to use while learning math word problems. These researched based strategies help students apply and analyze math situations.

The strategy Eureka Math utilizes is the Read, Draw, Write method. The modules or booklets states, "students draw and label models to reason abstractly and quantitatively about the relationships in the problem. The models help the students attend to precision in modeling and solving the equation. In other words, the end results of teaching a systematic approach to problem solving."[4] This coming school year will be our second year in using the Eureka Math Curriculum. The six modules have a teacher editions and student booklets. The text is scripted and has timed activities. Many of the word problems are intended for whole class discussion and students use whiteboards to show their work then will transfer their work into the workbook.

One of my objectives for teaching math problems is to help my students become problem solvers. Polya's four-step approach to problems solving[5] is another research based strategy for students. These steps can be written on a chart displayed in the classroom, Polya's strategies make similar connections to other scaffolding strategies.

First: Preparation: Understand the problem

At this stage of problem solving is for students to think about the meaning of the vocabulary, ask questions, rephrasing, and analyze the specific example about the problem.

Second: Thinking Time: Devise a plan

Make a plan, use a system, draw or sketch, and understand the problem

Third: Insight: Carry out the plan

Jot down key ideas, and try them out. If it does not work, try again – persevere.

Fourth: Verification: Look back.

Check, is your result reasonable. Check again, correct errors immediately. Can your reasoning be used on other problems?

The "I Do, We Do, You Do," strategy is taught in three steps. This strategy works very well when students are learning mathematics.

The first is "I Do It." During this step, the teacher models the new concept. Students are attentive. I usually say, "Give me your eyes and ears, and watch and listen." Pencils are down, and student's position of their body is facing me while I explain and model the new concept.

The second step of the strategy is "We Do It." This is when the teacher models the correct way to understand the new concept. Students work through example problems together. It allows more learning time to go deeper into the content or process and have peer interactions while learning.

The third step is, "You Do It." When students get to this step, they are confident and have a direction. This is when they show their level of understanding of the new concept taught. They practice this skill independently.

The Guided Language Acquisition Design (GLAD) uses a vocabulary model known as the Cognitive Content Dictionary.[6] This vocabulary strategy involves students in metacognition, builds academic vocabulary, and promotes comprehension. The teacher models the CCD on a chart of a chosen word that is the signal word for the day. This is when students hear the teacher say this word throughout the day. The chart explains where the word came from and why the class needs to learn it. Students predict the meaning of the word, and a gesture is used to connect to the word. The actual dictionary definition and a sketch of the word are written on the chart. Then, as a team students discuss and share an oral sentence using the word.

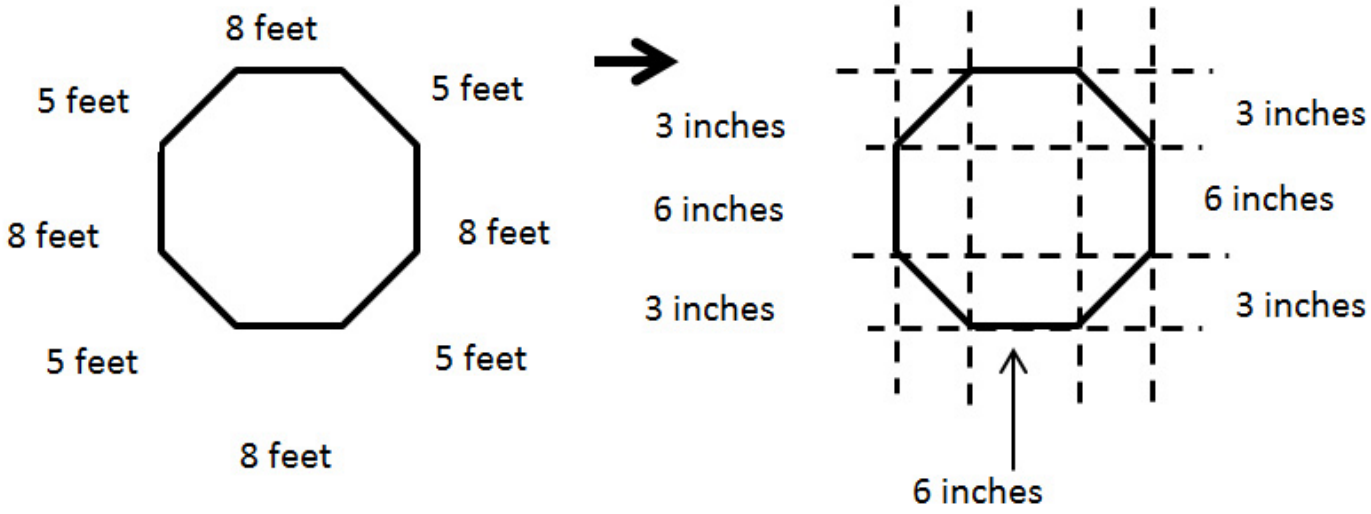
Classroom Activities

I will begin with the *hooghan* because it has multiple connections with math concepts and skills. The explanation of the construction, including its historical and cultural context, will provide our students with a solid background understanding of the *hooghan*. Number and operation of fractions, measurement and data of geometry, classifying two-dimensional figures into categories based on their properties using ratios, meaning things like isosceles and equilateral triangles, and squares versus rectangles and exchange of money will be

integrated into the discussion of the male and female *hooghans*.

Towards the end of my unit, students will construct a miniature model of a *hooghan nimaz,* female *hooghan*. They will scale down a model to of an actual octagon *hooghan*. For example, if a side of an octagon is 5 feet and if the scale factor for the drawing is 1/16, then the sides of the drawing of the octagon will be 8 feet scaled down to 6 inches. The measurements in the corners (5 feet) are the dimensions of the square that has the slanting sides of the octagon as a diagonal. The actual *hooghan* radius from the center to the angle of each corner is 10 feet. Then the small scale of the *hooghan* on a 1 to 16 scale it would be 7 ½ in inches.

This activity is a good home-school connection activity for students and parents. Students will keep a daily math journal while constructing their *hooghan* at home and at school.



During the course of teaching, my unit includes examples of addition and subtraction problems of one-step and two steps; I will teach math word problems, some are for whole class discussion, team-task discussion, and independent problem solving. These problems fit the "I Do, We Do, You Do," strategy. Some examples from my collection of word problems are included below. In addition to these problems, added *hooghan* math word problems which are not in this unit will be taught.

Example Problems

1. The male *alchi' adeez'a*, forked hooghan has been a home for the Dine people use since the early 1400's and the female *hooghan nimaz,* hooghan was use first during the early 1800's. Approximately how many centuries older is the *alchi' adeez'a*, male hooghan?
2. The male *alchi' adeez'a*, hooghan has been a home for the Dine people use since the early 1400's and the *hooghan nimaz,* female hooghan was used starting in the early 1800's. Approximately how many times older is the male *alchi' adeez'a*, hooghan?
3. The male *alchi' adeez'a*, hooghan has three main posts constructed to hold the foundation, whereas the female hooghan has eight posts. How many more posts are used in the *hooghan nimaz*, female hooghan, than in the male?
4. The male *alchi' adeez'a*, hooghan has three main posts constructed to hold the foundation, whereas the

hooghan nimaz, female hooghan has eight posts. How many times more posts are used in the *hooghan nimaz*, female hooghan, than in the male?

5. It takes a 5 day week, of 8 work hours each day, to chop and haul 500 cedar logs to construct a *hooghan nimaz*, female hooghan. Whereas the male *alchi' adeez'a*, *hooghan* take 2 ½ days. What is the difference in the number of hours required for chopping the logs for the two *hooghans*?
6. Constructing a *hooghan* takes many hours and numerous logs and thousand pounds of dirt. It takes about four days to haul all the cedar logs needed and about 2 days to haul the dirt. When working continuously, the completion of the *hooghan* will take two weeks. What is the total number of hours from the beginning to completion of a *hooghan*?
7. Four workers are needed to strip the cedar bark off the logs. There are 500 logs, how many logs will each worker strip?
8. Some men were stripping barks off the cedar logs. 8 men were stripping the logs. Then 12 men came to help strip logs. How many men are stripping logs now?
9. Some cedar logs need to have notches so the logs connect at the end of each post. Two men chopped notches into the logs. The first man is able to chop notches onto 8 logs per hour and the second man is able to chop 12 logs per hour. What is the total number of notched logs they can complete within eight hours?
10. The distance between neighboring posts when constructing the *hooghan nimaz*, female *hooghan's* base, is measured in 8 feet intervals. There are 8 posts in all, what is the total perimeter of the *hooghan*?
11. Between each neighboring pair of posts in the *hooghan nimaz*, female *hooghan* there are 15 logs. What are the total number logs between the eight main posts?
12. The ceiling of the *hooghan* is built into levels. The first level is constructed onto the vertical posts. The first level has 8 main beams and additional 32 beams to form the first level of the ceiling. How many logs are needed for the first level?
13. Two men worked 8 hours every day for 2 weeks and 3 days to complete a conical roof of a female *hooghan*. How many hours did it take for the two men to complete the roof?
14. The central height of a female *hooghan* is 12 feet and the central height of a male *alchi' adeez'a*, *hooghan* is 15 feet. What is the difference in height between the two *hooghans*, expressed in inches?
15. The interior perimeter of a female is 2 times larger than the perimeter of the male *alchi' adeez'a*, *hooghan*. The male *hooghan* has an interior perimeter of 32 feet. What is the female *hooghan's* interior perimeter?
16. A sand and clay mixture is used to cover the outer section of the *hooghan*. It takes about 2/3 of a bucket of sand and 1/3 bucket of clay dirt to make a mixture in one bucket. A five gallon bucket is used to measure the amount of sand and clay. About 150 buckets of the mixture is needed to cover the first layer of the *hooghan*. How many gallons of sand and clay mixture are needed?
17. Mud clay is used to seal the holes and cracks between the logs. A bucket carries 25 pounds of mud clay. To seal the holes and cracks, 30 buckets are filled with clay. What is the total number of pounds of clay they contained?
18. Two men begin to seal the cracks and holes on the lower portion of the *hooghan*. The first man begins on the outside and the second man begins on the inside of the *hooghan*. The interior used 11 ½ buckets of clay, and the exterior used 18 ½ buckets. How many more buckets of mud clay were used on the exterior?
19. The distances between two *hooghans* are determined by where a clan family resides. When two clan families conduct a 3-night ceremony known as *Ndaa'*, the families live 15 miles apart from each other. The families determine the midpoint between the two *hooghans*, and this is where the second night of ceremony is conducted. How far from the two *hooghans* does the second night ceremony take place?

20. During a ceremony 8 women sit on the north side of the *hooghan* and 11 men sit on the south side of the *hooghan*. The patient and the medicine man sit on the east side. What is the total number of people in the *hooghan*?
21. 12 women were sitting on the north side of the *hooghan*. After the third song is sung, some women left the *hooghan* to prepare the meal. There were 8 women still in the *hooghan*. How many women left the *hooghan*?
22. Certain prayers and songs are performed in the *hooghan* between when sun sets and the early dawn. How many hours is this when the sun sets at 9:50 p.m. to early dawn at 3:30 a.m.?
23. Four trucks travel to Black Mesa to get cedar logs. It takes 6 hours to chop and haul the cedar logs into each truck. What is the total number of minutes to load logs into one truck?
24. Four short logs are used make a square frame of the smoke hole. Then 16 shorter logs are added to cover gaps around the frame of the smoke hole. How many logs are used to frame the smoke hole?
25. Three main cedar posts are used to form the perimeter of the *male alchi' adeez'a*, *hooghan*. Then 20 additional posts are added between each of the 3 posts. How many posts are added?
26. A boy is carrying an arm load of wood for the fire in the *hooghan*, four arm loads to the main cooking fire, and three arm loads to the fire for boiling water. How many trips did he make from the wood pile to the three fire sites?
27. 11 horse riders came from the east and 21 horse riders came from the south. How many more horse riders came from the south than the east?
28. *Bit'ahnii's* water tank has 30 more gallons than the *Tódích'íi'nii's* water tank. *Tódích'íi'nii's* have a 25 gallon water tank. How many gallons does the *Bit'ahnii'* have?
29. *Tódích'íi'nii's* have 30 fewer gallons of water in their tank than the *Bit'ahnii'*. *Bit'ahnii's* have 55 gallons in their water tank. How many gallons do the Tódích'íi'nii' have?
30. At the end of the Ndaa ceremony, 150 bags of yarn were purchased. Each bag contains 100 skeins. If the skeins are distributed among 10 families, how many skeins will each family receive?

Resources

Tools and materials students need when constructing their *hooghan*. A sturdy base for a platform for the *hooghan*, a durable cardboard, Popsicle sticks or dowel sticks measured and cut to scale, wood glue, hot glue gun and sticks, sand, Elmer's glue, ruler, sand dune sand, containers, plastic utensils, plastic table cloth and buckets for the sand.

Appendix – State Standards

Arizona's College and Career Ready Standards – Mathematics, 5th grade

Students formulate and apply volume as an attribute of three-dimensional space. They understand that volume can be measured by finding the total number of same-size units of volume required to fill the space without gaps or overlaps. They understand that a 1-unit by 1-unit by 1-unit cube is the standard unit for measuring volume. They select appropriate units, strategies, and tools for solving problems that involve

estimating and measuring volume. They decompose three-dimensional shapes and find volumes of right rectangular prisms by viewing them as decomposed into layers of arrays of cubes. They measure necessary attributes of shapes in order to determine volumes to solve real world and mathematical problems.[7]

5.NF.A.2.& 6 Solve word problems involving addition, subtraction, multiplication of fractions referring to the same whole, including cases of unlike denominators, e.g., by using visual fraction models or equations to represent the problem. Use benchmark fractions and number sense of fractions to estimate mentally and assess the reasonableness of answers.

5.NF.B.7.B Solve real world problems involving division of unit fractions by non-zero whole numbers and division of whole numbers by using visual models and unit fractions to represent the problem.

5.G.B.4. Classify two-dimensional figures in a hierarchy based on properties.

Dine Culture and Language Standards:

Hooghan t'aa al'aan bee da'iinaanii shil beehozin dooleel. I will identify the basic structures and teachings of various hogans. *Iinists'aa'go binahji' binashidi'neezta'igii choosh'ii dooleel*. I will listen to and apply Dine teachings.[8]

Social Study Standards for background knowledge for the history, but not for this math unit.

Biography for Teachers

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Endnotes

1. http://www.corestandards.org/Math/Content/mathematics-glossary/Table-1/
2. http://www.corestandards.org/Math/Content/mathematics-glossary/Table-1/
3. Howe, Roger. Sample Math Problems
4. Howe, Roger. From Arithmetic to Algebra
5. Polya's four-step approach to problems solving

6. Cognitive Content Dictionary
7. Arizona's College and Career Ready Standards – Mathematics, 5th grade, azed.gov/standards-practices/k-12standards/mathematics-standards/
8. Kayenta Unified School District and Culture Center Navajo Language and Culture Curriculum 2012