
*Teaching Mathematics
in a First Peoples Context*
Grades 8 and 9

A PUBLICATION OF



First Nations Education Steering Committee
113 - 100 Park Royal South
West Vancouver, BC V7T 1A2

Toll Free: 1-877-422-3672
Tel: 604-925-6087
info@fnesc.ca | www.fnesc.ca

Acknowledgments

This teacher resource document has been developed by the First Nations Education Steering Committee (FNESC) with assistance from the British Columbia Ministry of Education and support from the Education Partnerships Program of Indian and Northern Affairs Canada. FNESC appreciates the support of both the Province and the Government of Canada for this very important undertaking and would like to thank all who participated in the process of developing this resource.

In particular, FNESC acknowledges and thanks Dr. Jim Barta, J. Bradley, Fedelia O'Brien, Dr. M. Jane Smith, Mildred Wilson, and all the other individuals, communities, and organizations who provided the authentic content that enriches the material included in this resource guide.

Writing Team

Karmen Smith-Brillon	Project Manager: First Nations Education Steering Committee
Désirée Marshall-Peer	School District No. 83 (Salmon Arm)
Tianna Smith	First Nations Schools Association (Ladysmith – Stu'ate Lelum)
Kim Linkert	Wsanec School Board
Stacey Brown	School District No. 82 (Coast Mountains)
GT Publishing Services Ltd.	project coordination, writing, editing, and layout

Advisory Team

Melania Alvarez-Adem	Pacific Institute for the Mathematical Sciences (PIMS)
Jo-ann Archibald	UBC Math Consortium
Russ Baker	Consultant
Karmen Smith-Brillon	First Nations Education Steering Committee
Ken Campbell	Curriculum Consultant
Richard DeMerchant	Ministry of Education
Anne Hill	Ministry of Education
Deborah Jeffrey	First Nations Education Steering Committee
Cynthia Nicol	University of British Columbia Math Consortium
Trish Rosborough	Ministry of Education
Denise Williams	First Nations Education Steering Committee

Questions concerning material in this document should be directed to FNESC:

First Nations Education Steering Committee
Suite 113 -100 Park Royal South
West Vancouver, BC V7T 1A2
Phone: 604-925-6087
Fax: 604-925-6097
Toll-Free: 1-877-422-3672
e-mail: info@fnesc.ca www.fnesc.ca

The *Mathematics 8 and 9 (2008)* curriculum document is available online at www.bced.gov.bc.ca/irp/welcome.php



Context

We have all been caught staring out the window on an overcast morning of a fishing trip crossing our fingers for good weather, eagerly scratching a lottery ticket in the hopes we might win, or flipping a coin to make a decision. People have always been fascinated with trying to determine the likelihood of events occurring. Rock, Paper, Scissors is a cornerstone of playground decision-making, and students also love to play guessing games and other games of chance for entertainment. They are often intrigued by the random nature of chance, and this universal interest can be harnessed to teach statistics and probability.

For years, math resources have been introducing probability using illustrations such as flipping coins, spinning wheels, throwing dice, drawing marbles from a bag, and drawing/dealing playing cards. Although these situations lend themselves to teaching the concept of probability, and most students can relate to the items used, Aboriginal guessing games offer a fresh, entertaining, and culturally relevant means of teaching probability. At the same time they can offer a good opportunity to build connections between the mathematics class and the local Aboriginal communities.

Within First Peoples societies, guessing games have historically served many purposes – to entertain, to settle disputes, to pursue financial gain, and as part of ritual activities or family tradition. A quick online search can yield information on many First Peoples games, including the Coast Salish version of Lahal (alternatively Slahal or Bone Game), a guessing game that has been played for hundreds, if not thousands of years in many BC First Nations. This unit outlines an approach to using Lahal as a basis for teaching Grade 8 Statistics and Probability. It starts by introducing the game and teaching the general rules. Students then play the game and generate data (i.e., keeping track of both the guessing and the outcomes) for later analysis.

Learning outcomes addressed:

- D1 critique ways in which data is presented
- D2 solve problems involving the probability of independent events

Introduction to the Game of Lahal

The challenge of this unit is to introduce a potentially unfamiliar game. Yet the rules of play and the techniques are quite simple, and there are many resources online and in this unit. The optimum way to introduce this lesson is to have a local Elder or someone from the Aboriginal education department in your district demonstrate the game. Lahal can be taught in a single lesson and there may be some parents available to come in as volunteers to drum and sing. The power of the drumming and singing makes the game come to life for students. You can also consider bringing in other classrooms or even staff to play a game. The inclusion of Lahal in a school-wide assembly or cultural day would be invaluable to both Aboriginal s and non-Aboriginal learners. You may even consider recording the event for use in future classes when volunteers may be unavailable. Certainly, it is a wonderful way to start as it will provide context for the students and help them appreciate the significance of the game, as well as the wonderful songs, strategy, and traditional gesturing associated with Lahal.

If volunteers are not available, you could have students watch a short video of the game (http://wn.com/Lahal_A_Close_Look_at_the_Bone_Game) and research the game online using sources such as the following:

- ◆ [www.aboriginalsd33.bc.ca/information/cultural-activities](http://aboriginalsd33.bc.ca/information/cultural-activities)
- ◆ [www.4directions.org/resources/features/si99/instituteprod/slahal/](http://4directions.org/resources/features/si99/instituteprod/slahal/).

Once they understand how the game works, students could work in groups to build their own game using sticks, and then spend time playing the game and recording both guesses and outcomes to build a database for analysis. Students can begin by playing the game and making observations about how frequently they guess the correct position of two, one, or none of the solid bones. They can follow this up by keeping tallies of their results to determine an experimental probability for each outcome (see the Tally Sheet handout provided). Another alternative is to have students play a simplified version online (at http://secwepemc.sd73.bc.ca/sec_village/Lahal_game.html), and use the results for data, though this loses a lot of the cultural context. Similarly, there exist other First Peoples games of chance that can be used as a basis for teaching probability, including the Stick game described further on under the heading, "The Stick Game Alternative."

Finding the Probability in Lahal

Finding the mathematics within the game of Lahal is fun and challenging for the students. Activities for stimulating discovery and enhancing understanding include having students

- ◆ work in groups to practice guessing with the bones (listing possible outcomes), collecting data (using the Tally Sheet), and generating summaries of the results
- ◆ create tree diagrams (Because Lahal is a guessing game, the students can begin by listing all possible guesses and bone locations. Breaking down the possibilities in this way allows them to analyze the concept of probability in a way that will make sense to them.)
- ◆ calculate the probability of events happening using the probability formula and an understanding of independent events.

Definitions and Probability Formula

To help students connect their Lahal playing (and data gathering) to the mathematical concepts involved, review the "Probability Terminology" handout with them, and encourage them to use the appropriate probability terminology in discussing their results. In addition, you may find it helpful to introduce the following formula, which can be found in most textbooks and is valuable in explaining how mathematicians find the probability of an event.

Probability of an Event	
$P(A) =$	$\frac{\text{number of ways event } A \text{ can occur}}{\text{total number of possible outcomes}}$

Independent Events

Independent events: Two events, A and B, are independent if the fact that A occurs does not affect the probability of B occurring.

Some examples of independent events are: the probability of rolling a six on a die and then drawing a heart from a deck of cards. These events are independent, where one does not influence the other, and the probability can easily be calculated. Although this unit deals with Lahal, other examples include:

- ◆ Landing on heads after tossing a coin **AND** rolling a 5 on a single 6-sided die.
- ◆ Choosing a marble from a jar **AND** landing on heads after tossing a coin.

- ◆ Choosing a 3 from a deck of cards, replacing it, **AND** then choosing an ace as the second card.
- ◆ Rolling a 4 on a single 6-sided die, **AND** then rolling a 1 on a second roll of the die.

To find the probability of two independent events that occur in sequence, find the probability of each event occurring separately, and then multiply the probabilities (fractions). This multiplication rule is defined symbolically below.

Multiplication Rule 1 When two events, A and B, are independent, the probability of both occurring is:

$$P(A \text{ and } B) = P(A) \times P(B)$$

Now we can apply this rule to find the probability for particular Lahal outcomes. Students can be challenged to work in groups to work on calculations in groups.

In this ancient guessing game there are two sets of bones with one person holding one set and a second person holding the other. There is one solid coloured bone (white bone) and one with markings on it. Remember, the guesser is attempting to guess which hand the white bone is in, but for both people. The possible outcomes are as follows:

- ◆ Person one has the white bone in either the left hand or the right so this results in a $\frac{1}{2}$ probability or a .5 (50%) chance of getting it correct.
- ◆ For person two, the probability of guessing where the second set of bones is hidden is the same as for the first person; they are independent events and the probability is also $\frac{1}{2}$, .5 or 50%.

The multiplication rule is used to calculate the probability of guessing the locations of both sets of bones:

$$P(A \text{ and } B) = P(A) \times P(B)$$

$$\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$$

You can explain to your students that the probability of them guessing the location of both white bones in one guess is $\frac{1}{4}$, .25, or 25% of the time.

Class Discussions

As students present their results from playing multiple rounds of Lahal, class discussions will help reinforce the math concepts involved. These discussions should also cover the difference between experimental and theoretical probability and the various factors that make the game of Lahal somewhat more than an exercise in pure, theoretical probability. For example, students might be able to recognize the impact of human factors such as the following on their success in the game:

- ◆ good observation skills
- ◆ skill in hiding the bones
- ◆ ability to control one's body language
- ◆ ability to interpret the body language of others
- ◆ ability to apply psychology in game situations
- ◆ other contextual factors such as singing and drumming.

Collecting and Displaying Data

Statistics lie in the collecting and organizing of data. The information gathered can then be interpreted and used to make predictions. Accordingly, once students have gathered and recorded their game-playing data on a tally sheet (see handout), you can have them work in groups to decide how they would like to display the data in graph form (e.g., circle graphs, line graphs, bar graphs,

double bar graphs, pie graphs, pictographs). Students can then determine the strengths and limitations of each graph as they work on displaying their data in different ways.

Students should be encouraged to design and create graphs using online resources (e.g., www.nces.ed.gov/nceskids/createagraph/) or spreadsheet programs such as Excel. Discuss with them the advantages and disadvantages of each form of data graphing for the data they have gathered.

Getting Creative with the Data

Although Lahal seems like a very simplistic game, there can be much more to it than mere guessing. Once students have mastered the initial concept, they could be challenged to get creative and come up with more data that will help them analyze the game on a deeper level. The following are some examples students can try.

Influence of gesturing

Students may find it interesting to try and quantify the effect of gesturing on an individual's ability to guess correctly, or how the guesser can influence the person hiding the bones to provide hints or "tells" as to where the solid bone is located. Challenge them to come up with a way to collect data that would help determine who is the most talented at gesturing and reading "tells." This may involve a number of experiments where players are allowed to close their eyes and not be influenced by gesturing. This could be a fun way to play the game and determine if different factors, such as losing the sense of sight, will change the results.

Gender

Some Elders and experienced players believe that gender may influence ability in the game. Students could create tally sheets that track the guesses of male vs. female players.

Age

It is possible that age and experience could affect the results. Students can tally and organize data based on this criterion as well.

Time taken to guess

The time needed by a guesser to read the situation and make a guess could affect success. Students could compile and analyse result records that note whether guesses take less than five seconds, five to ten seconds, etc.

The Stick Game Alternative

Although games of chance that are played in local First Peoples communities (e.g., Lahal) provide the best opportunity to establish a First Peoples context for learning about statistics and probability, there are several games of chance associated with a wide range of aboriginal societies throughout North America that can be used to teach probability. Online descriptions of some of these can be found at www.mathcentral.uregina.ca/RR/database/RR.09.00/treptau1/index.html. Simpler in many ways than Lahal, the stick game described there can provide a valid alternative to Lahal for this unit. Activities involving the stick game could include

- ♦ having each student create a set of sticks (put designs on popsicle sticks) as explained online at www.mathcentral.uregina.ca/RR/database/RR.09.00/treptau1/game7.html (depending on the time available and your other instructional plans, you could cover some Grade 8-9 Shape and

- Space learning outcomes as well by having students learn more about design traditions within a local First Nation and use tessellations and symmetry in their stick designs)
- ◆ forming groups of three and having each group play the game, record their outcomes, and calculate scores using the supplied handout, "Playing the Stick Game"
 - ◆ reviewing the "Probability Terminology" handout with them, and explaining Independent Events and the probability calculation formulae, as suggested earlier in relation to Lahal
 - ◆ covering the difference between theoretical and experimental probability by having students independently complete the instructions on the "Theoretical Probability" and the "Stick Game Tally Sheet" handouts and then discussing the concepts, as suggested earlier in relation to Lahal
 - ◆ challenging students to draw conclusions from their sticks game activities by responding to the supplied handout, "What's Fair?"

Other Probability Situations with First Peoples Relevance

To reinforce students' understanding of probability calculations (or conduct assessment of their learning), challenge them to apply their understanding to other probability situations such as

- ◆ the likelihood of catching a specific species of salmon in a river that supports multiple species (You could provide students with a ratio or percentage of each species in a river and ask students to determine probability of not only catching a Coho for example, but the probability of catching five Coho in a row – independent events).
- ◆ the birth of baby animals in the wild (You could come up with challenges such as having students determine the probability of a moose having a female calf or having a female calf two years in a row.)
- ◆ scoring in a lacrosse game (You could provide questions such as "If Kevin scored 12 times out of his last 50 shots on goal, what is the probability that he will score on his next shot? Answer: $12/50 = .24$ or 24% so the probability of scoring on his next shot is .24").

Lahal Tally Sheet

What is it?	A tally sheet is a simple data collection form for observing how frequently something occurs.
Who uses it?	Researchers, statisticians
Why use it?	To easily and efficiently collect and organize data
When to use it?	To collect data on the frequency of certain events, such as a student's guesses, in the game of Lahal.

How to use it for Lahal

1. Review the steps of the game.
2. Make a list of events and possible outcomes. Only information you intend to use should be included.
3. Decide on the number of events (guesses) you would like to observe.
4. Record your observation of every event (guess) by a check in the corresponding cell of the sheet each time that the event occurs.
5. Total the results at the end, and use the data to create graphs such as circle graphs, line graphs, bar graphs, double bar graphs, and pictographs.

Events (guess results)

Team members (names)	Both solid bones correct	One solid bone correct	None correct
1.			
2.			
3.			
4.			

Probability Terminology

	Definition	Example
Experiment	An experiment is a situation involving chance or probability that leads to results called outcomes.	In Lahal, the experiment is the guess (trying to find the white bone).
Outcome	An outcome is the result of a single trial of an experiment.	The possible outcomes are guessing both correctly, one correctly, or none.
Event	An event is one or more outcomes of an experiment.	One event is taking one guess.
Independent Events	Two events, A and B, are independent if the fact that A occurs does not affect the probability of B occurring.	In the stick game, a play of 4 sticks up followed by a play of 4 sticks down.
Probability	Probability is the measure of how likely an event is.	The probability of guessing where both bones are is 1 in 4 ($1/4$); guessing one right is 1 in 2 ($1/2$)

Playing the Stick Game

You will need a set of 4 sticks (e.g., popsicle sticks), coloured or patterned on one side and plain on the other. The patterned side is the "up" side when you are playing the game.

Hold the sticks in one hand, and let them fall to the table. In taking turns play continues until the first person reaches a tally of 50 points. Keep track of the score in the table provided. The first person to reach 50 points wins.

Scoring

- ◆ All 4 up 5 points
 - ◆ 3 up and 1 down 2 points
 - ◆ 2 up and 2 down 1 point
 - ◆ 1 up and 3 down 2 points
 - ◆ All 4 down 5 points

Search and Discuss: *Combinations vs. Arrangements*

Just from experience playing the game, about how many different *arrangements* of the sticks did you see? Describe some of the *combinations*.

Theoretical Probability

Fill out the table on the right with all the possible results from four sticks. The first three results have been done for you. Every line must be filled in.

Note: Make your work easier by using a pattern. Some mathematicians use a "Tree Diagram" to make sure all the possibilities are found. If time allows, work on a separate sheet and draw the tree.

Find the frequency of the combinations:

All 4 up: _____

3 up and 1 down: _____

2 up and 2 down: _____

1 up and 3 down: _____

All 4 down: _____

Now find the theoretical probability of each combination:

All 4 up: _____

3 up and 1 down: _____

2 up and 2 down: _____

1 up and 3 down: _____

All 4 down: _____

Stick Game Tally Sheet

Now “throw” (or drop) your set of sticks 50 times, and use the blank column in the table below to keep a tally of all the outcomes occurring.

Outcome	# of Occurrences
All 4 up	
3 up 1 down	
2 up and 2 down	
1 up and 3 down	
All 4 down	

Based on your 50 “throws,” what is the experimental probability of each outcome?

All 4 up: _____

3 up and 1 down: _____

2 up and 2 down: _____

1 up and 3 down: _____

All 4 down: _____

What's Fair?

1. Based on what you have learned about the sticks game (especially the scoring system) and about theoretical and experimental probabilities, is the sticks game fair? Why or why not?
 2. Create your own fair system of scoring:

All 4 up: ____ points

3 up and 1 down: _____ points

2 up and 2 down: ____ points

1 up and 3 down: ____ points

All 4 down: ____ points

3. Justify the fairness of your scoring method for the game of sticks. (Be ready to defend and demonstrate your answer.)