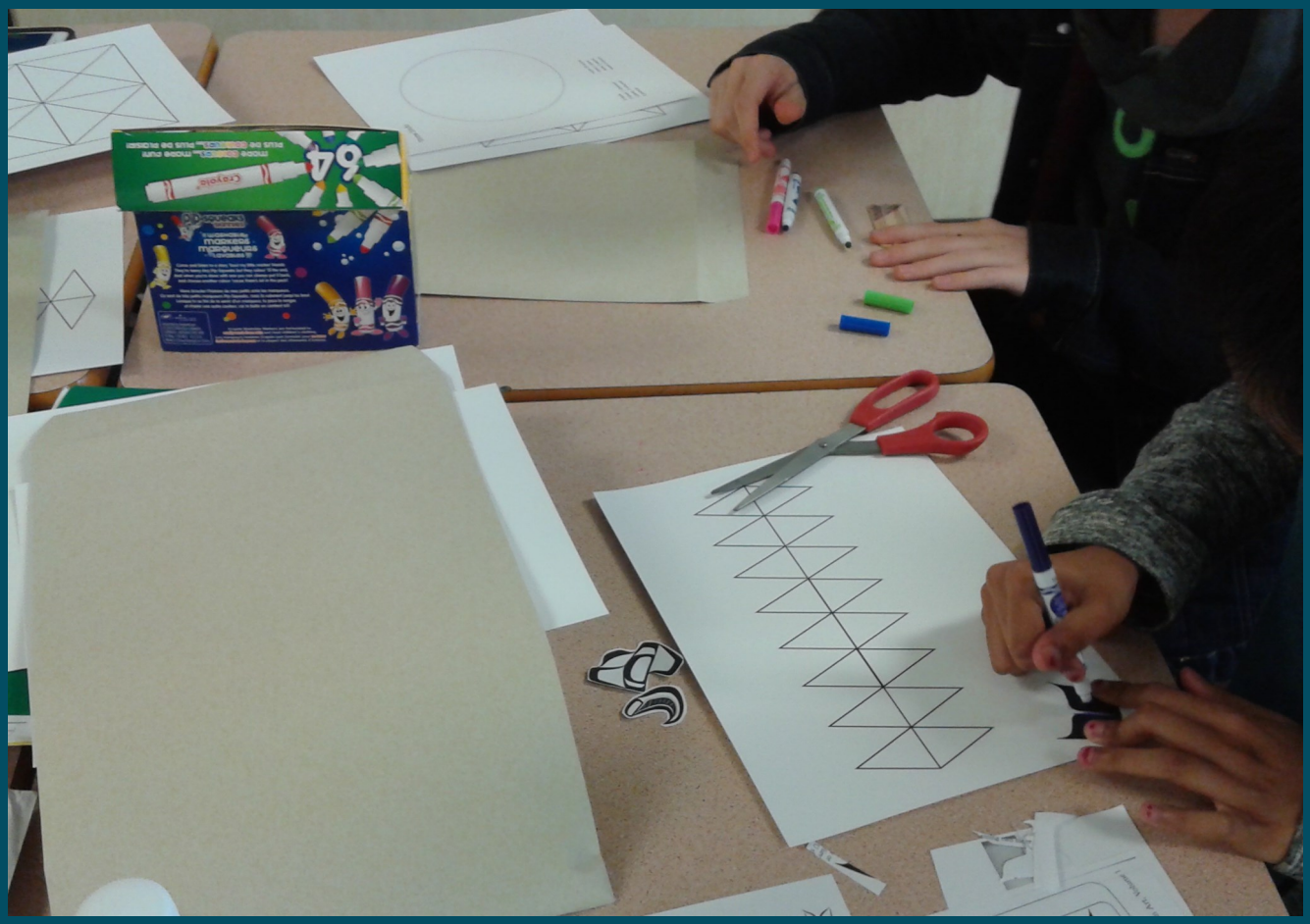


INDIGENOUS LOGIC MATH GAMES

Lori Bernard

Karla Gamble

BOARD OF EDUCATION BURNABY SCHOOL DISTRICT 41

Indigenous Games

Games have played an important part in cultures around the world for thousands of years. Many Indigenous cultures have played games that have been passed down from generation to generation. These games teach cooperation, team work, and social skills. Some games are tied to life skills children need to know as adults and some games are just for fun. There are many physical games but there are also many board games. They generally use very little equipment and are easily transportable.

Games are played across many nations with variations. Many games have been traded and/or given to different nations. As many of the games use symbols language was rarely a barrier. Variations in common games occurred mainly in the materials that were used to play.

Indigenous peoples played three types of board games: games of chance, games of strategy, and lifestyle games based on mathematics. There were many mathematical concepts threaded throughout the games: the idea of patterns, relationship of patterns, numbers and operations, problem solving and critical thinking, and concepts of data management and probability. Games that use point values were ones like Throw Sticks and Bowl and Dice. Ideas of patterns and ideas of probability were seen in games like Hubbub. Data management involved many games like Throw Sticks, Bowl and Dice, and Hubbub. Other games used problem solving skills and critical thinking, such as Picaria.

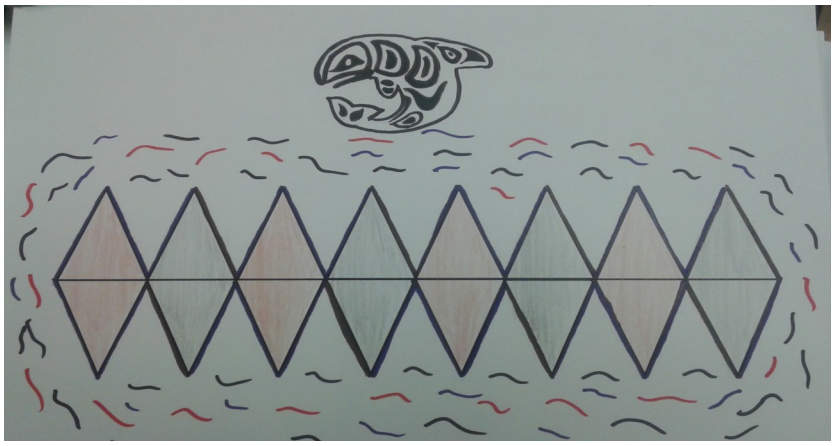
The games included in this resource are games played by Indigenous people all over North America and were chosen for the logic and strategy used to win. They may be used as a stand alone unit or as part of a lesson to incorporate Indigenous worldviews and perspectives into the Mathematics curriculum. We have incorporated them into the Grade 8 and Grade 11 Mathematics Curriculum and this resource is a reflection of that. Possible Mathematics Curriculum connections for other grade levels have also been provided. Grade 8 and 11 Arts Education curriculum connections have been included as you can choose to have students make the game boards.

Contacts **Lori Bernard**, Secondary Mathematics Teacher, Burnaby Schools

lori.bernard@burnabyschools.ca

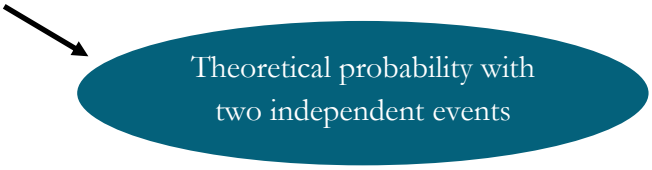
Karla Gamble, Indigenous Enhancement Teacher, Burnaby Schools

karla.gamble@burnabyschools.ca



Grade 8 Mathematics

Content



Curricular Competencies

Reasoning and Analyzing

- Use logic and patterns to solve puzzles and play games
- Use reasoning and logic to explore, analyze, and apply mathematical ideas
- Estimate reasonably
- Demonstrate and apply mental math strategies
- Model mathematics in contextualized experiences.

Understanding and Solving

- Apply multiple strategies to solve problems in both abstract and contextualized situations
- Develop, demonstrate, and apply mathematical understanding through play, inquiry, and problem solving
- Visualize to explore mathematical concepts
- Engage in problem-solving experiences that are connected to place, story, cultural practices, and perspectives relevant to local First Peoples communities, the local community, and other cultures.

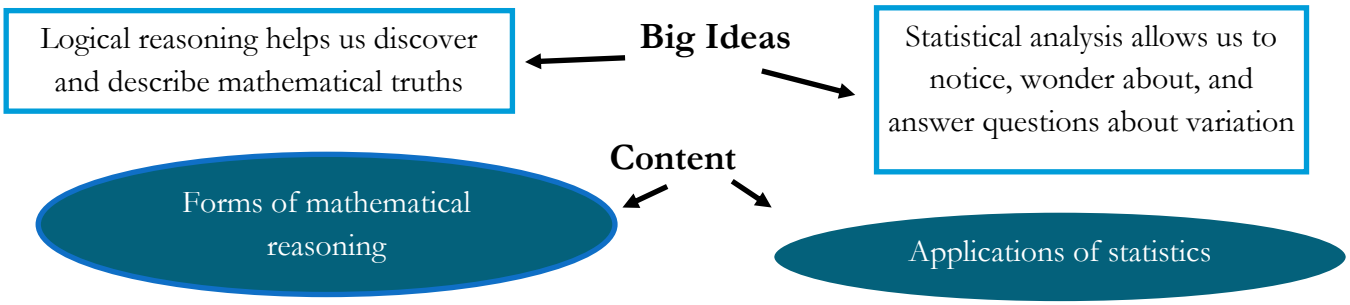
Communicating and Representing

- Use mathematical vocabulary and language to contribute to mathematical discussions
- Explain and justify mathematical ideas and decisions
- Communicate mathematical thinking in many ways
- Represent mathematical ideas in concrete , pictorial, and symbolic forms

Connecting and Reflecting

- Reflect on mathematical thinking
- Connect mathematical concepts to each other and to other areas and personal interests
- Incorporate First Peoples worldviews and perspectives to make connections to mathematical concepts

Grade 11 Foundations of Mathematics



Curricular Competencies

Reasoning and Analyzing

- Develop thinking strategies to solve puzzled and play games
- Explore, analyze, and apply mathematical ideas using reason, technology, and other tools
- Estimate reasonably and demonstrate fluent, flexible, and strategic thinking about number
- Model with mathematics in situational contexts
- Think creatively and with curiosity and wonder when exploring problems

Understanding and Solving

- Develop, demonstrate, and apply mathematical understanding through play, story, inquiry, and problem solving
- Visualize to explore and illustrate mathematical concepts and relationships
- Apply flexible and strategic approaches to solve problems
- Solve problems with persistence and a positive disposition
- Engage in problem-solving experiences that are connected to place, story, cultural practices, and perspectives relevant to local First Peoples communities, the local community, and other cultures

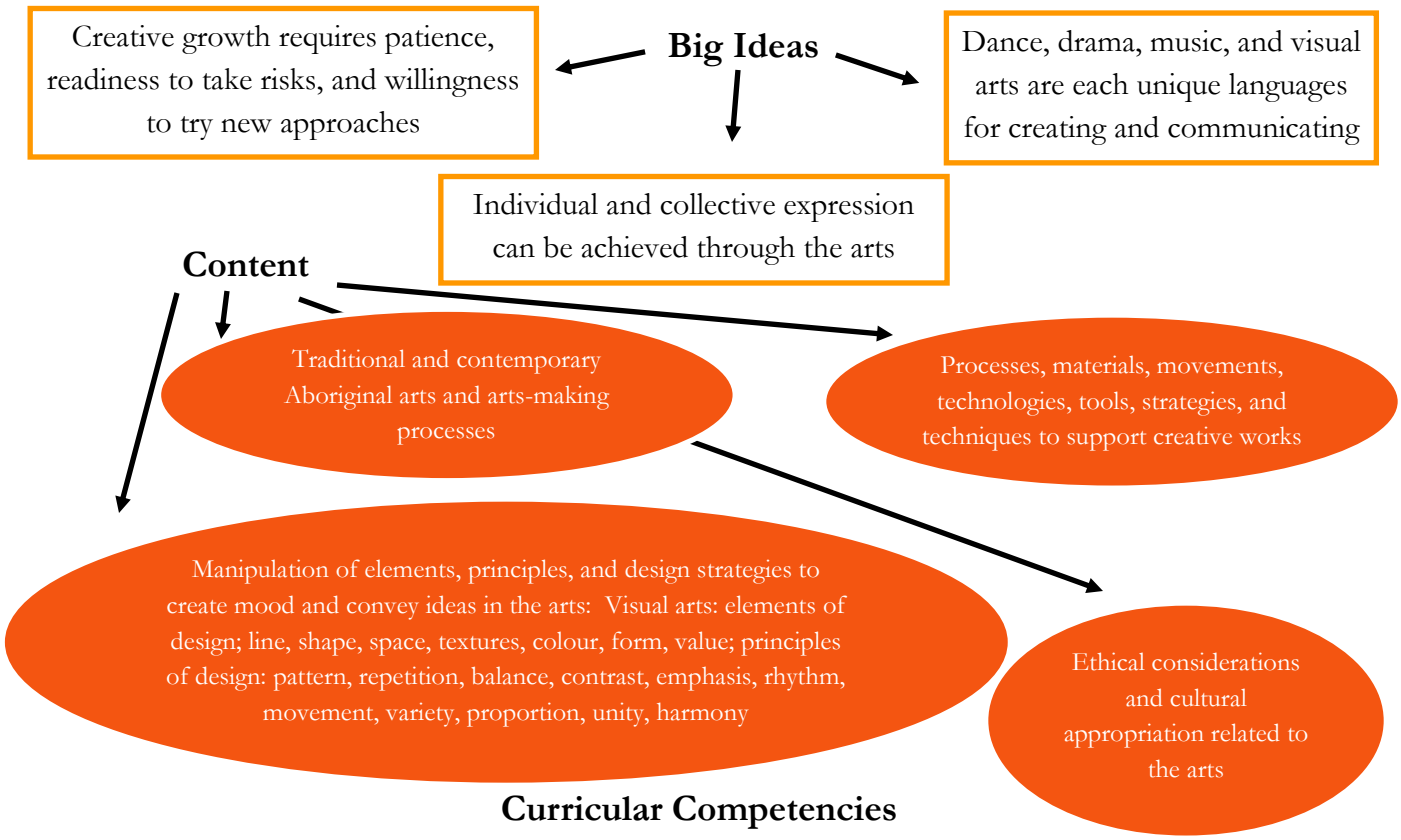
Communicating and Representing

- Explain and justify mathematical ideas and decisions in many ways
- Represent mathematical ideas in concrete, pictorial, and symbolic forms
- Use mathematical vocabulary and language to contribute to discussions in the classroom
- Take risks when offering ideas in classroom discourse

Connecting and Reflecting

- Reflect on mathematical thinking
- Connect mathematical concepts to each other and to other areas and personal interests
- Incorporate First Peoples worldviews, perspectives, knowledge, and practices to make connections with mathematical concepts

Grade 8 Arts Education Cross-Curricular Connections



Curricular Competencies

Exploring and Creating

- Intentionally select and apply materials, movements, technologies, environments, tools, and techniques by combining and arranging artistic elements, processes, and principles in art making
- Create artistic works collaboratively and as an individual using ideas inspired by imagination, inquiry, experimentation, and purposeful play
- Explore relationships between identity, place, culture, society, and belonging through arts activities and experiences
- Demonstrate an understanding and appreciation of personal, social, cultural, historical, and environmental contexts in relation to the arts

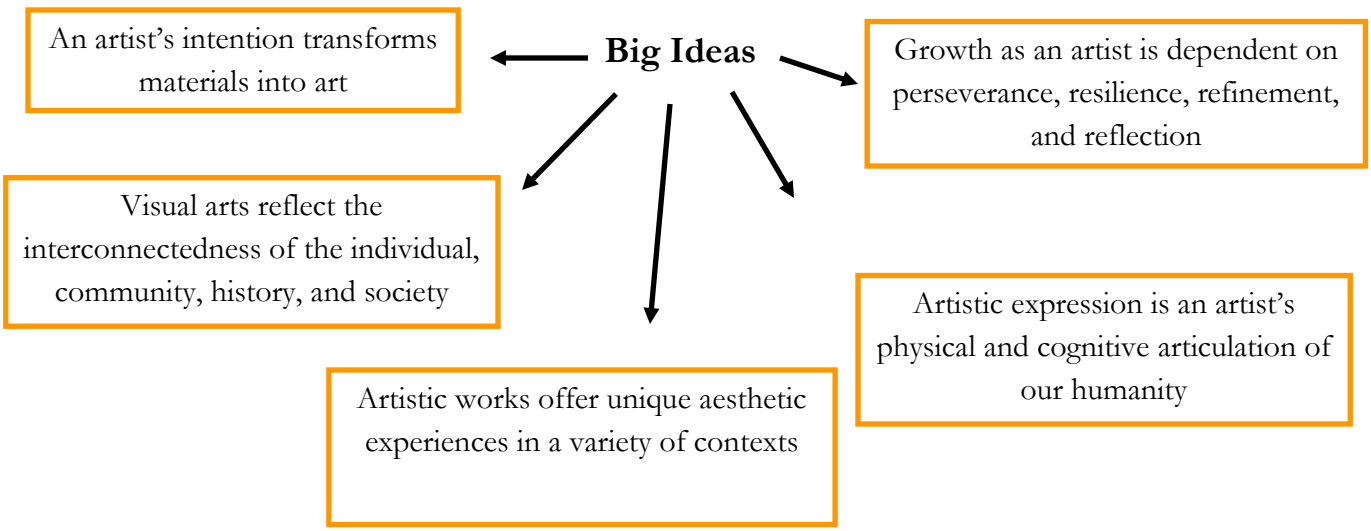
Reasoning and Reflecting

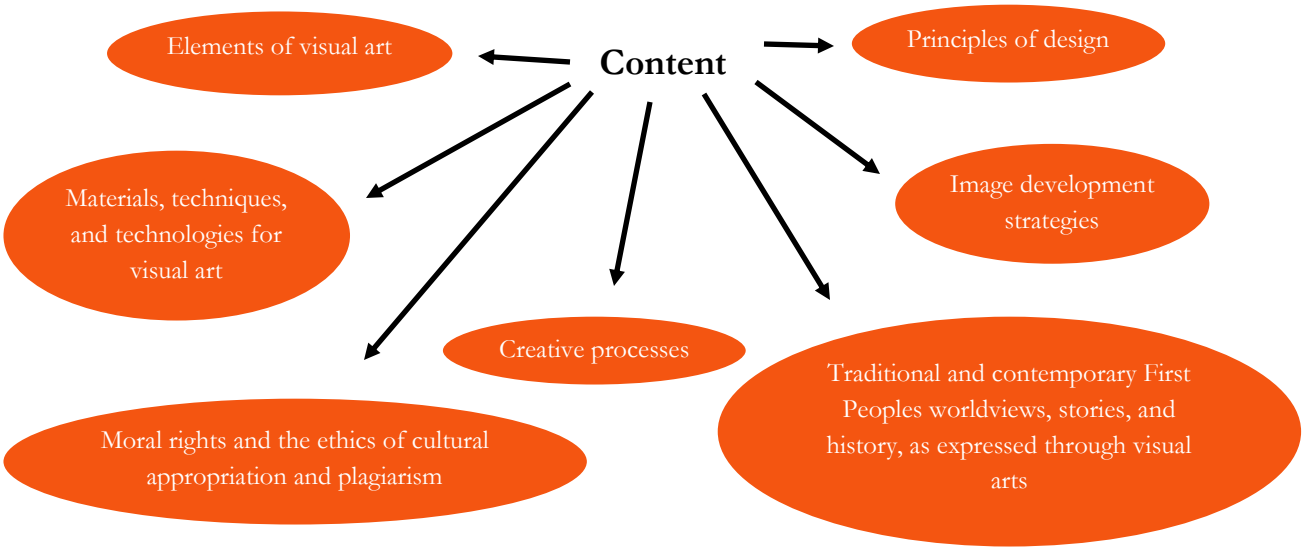
- Develop, refine ideas, and critically appraise ideas, processes, and technical skills in a variety of art forms to improve the quality of artistic creations

Communicating and Documenting

- Adapt learned skills, understandings, and processes for use in new contexts and for different purposes and audiences
- Experience, document, choreograph, perform, and share creative works in a variety of ways
- Demonstrate increasingly sophisticated application and/or engagement of curricular content

Grade 11 Visual Arts: Art Studio Cross-Curricular Connections





Curricular Competencies

Explore and Create

- Create artistic works using sensory inspiration, imagination, and inquiry
- Explore artistic possibilities using a range of materials, processes, and technologies
- Take creative risks to express thoughts and emotions through artistic works

Communicate and Document

- Document, share, and appreciate artistic works in a variety of contexts
- Demonstrate awareness of self, others, and place through art making

Connect and Expand

- Explore First Peoples perspectives, knowledge, and protocols; other ways of knowing, and local cultural knowledge through artistic works

First Peoples Principles of Learning

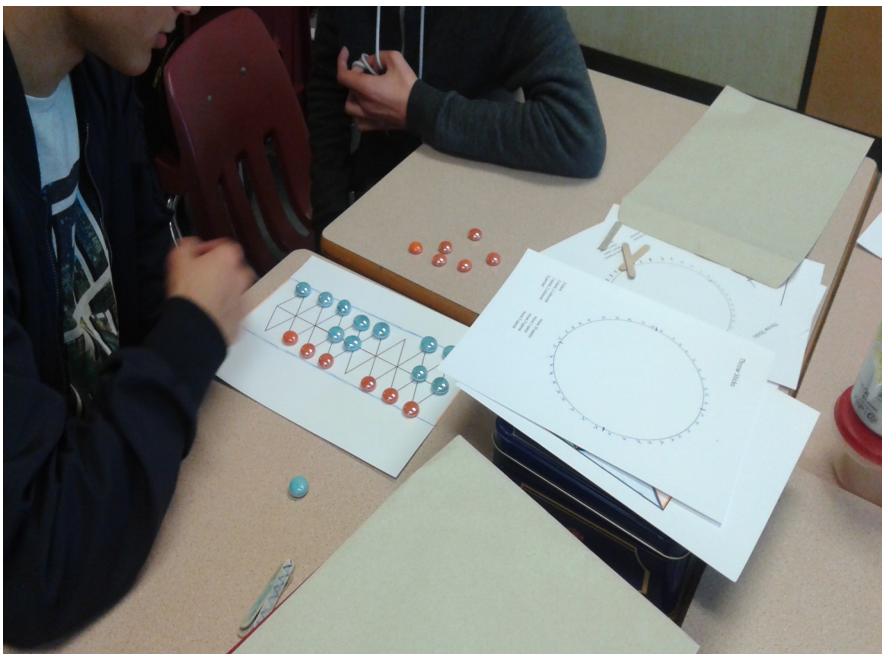
Learning ultimately supports the well-being of the self, the family, the community, the land, the spirits, and the ancestors.

Learning is holistic, reflexive, reflective, experiential, and relational (focused on connectedness, on reciprocal relationships, and a sense of place).

Learning recognizes the role of Indigenous knowledge.

Learning is embedded in memory, history, and story.

Learning involves patience and time.



First Peoples Principles of Mathematical Teaching

Respecting Indigenous Knowledge

1. Build on indigenous knowledge systems.
2. Relate story teachings to mathematical processes (e.g., how characters solve problems).
3. Make connections to a wide range of differing contexts (daily activities, traditional practices, activities in the workplace) and integrate learning related to mathematics and other subject areas in project assignments.
4. Find ways to build learning relationships with the local Indigenous/cultural community (Elders, artists, people in various walks of life, including emergent business and industry).

Respecting the learner

5. Build on what students are already familiar with (both abstract "knowledge" and concrete knowledge).
6. Explore and build on students' interests (asking learners about what is important to them is a good way to identify what context will prove meaningful to them as a basis for learning mathematics).
7. Present mathematics problems of various sorts in various sorts in varied ways (visual, oral, role-play, and experiential problems as well as word and symbol problems).
8. Stimulate students' innate curiosity and desire to explore.

Fostering the development of positive attitudes

9. Communicate a positive and enthusiastic attitude toward mathematics (be willing to take risks and make mistakes and encourage students to do the same).
10. Promote and reward perseverance (give necessary time for difficult problems and revisit them on multiple occasions).
11. Use humour and celebrate successes.

Fostering transformation for both teacher and student (transformative pedagogy)

12. Reflect on and revise your own practice with respect to teaching mathematics (including mistakes).
13. Find ways to build learning relationships with various professional communities where mathematics plays an important role.
14. Share what you are doing as a teacher with other colleagues and use colleagues to support self-reflection.
15. Encourage students to reflect on and be explicit about their own thinking processes and the transformations in their own understanding.

from www.fnesc.ca *Teaching Mathematics in a First Peoples Context*

Possible Mathematics Curriculum Connections K-12

Kindergarten

Big Ideas

- Numbers represent quantities that can be decomposed into smaller parts
- One-to-one correspondence and a sense of 5 and 10 are essential for fluency with numbers
- Familiar events can be described as likely or unlike.ly and compared

Curricular Competencies Reasoning and Analyzing

- Use reasoning to explore and make connections
- Estimate reasonably
- Develop mental math strategies and abilities to make sense of quantities
- Model mathematics in contextualized experiences

Understanding and Solving

- Develop, demonstrate, and apply mathematical understanding through play, inquiry, and problem solving
- Visualize to explore mathematical concepts
- Develop and use multiple strategies to engage in problem solving
- Engage in problem-solving experiences that are connected to place, story, cultural practices, and perspectives relevant to local First Peoples communities, the local community, and other cultures

Communicating and Representing

- Communicate mathematical thinking in many ways
- Use mathematical vocabulary and language to contribute to mathematical discussions
- Explain and justify mathematical ideas and decisions
- Represent mathematical ideas in concrete, pictorial, and symbolic forms

Connecting and Reflecting

- Reflect on mathematical thinking
- Connect mathematical concepts to each other and to other areas and personal interests
- Incorporate First Peoples worldviews and perspectives to make connections to mathematical concepts

Content

- Number concepts to 10
- Ways to make 5
- Decomposition of numbers to 10

- Change in quantity to 10, using concrete materials
- Likelihood of familiar life events

Grade 1

Big Ideas

- Numbers to 20 represent quantities that can be decomposed into 10s and 1s
- Addition and subtraction with numbers to 10 can be modelled concretely, pictorially, and symbolically to develop computational fluency

Curricular Competencies Reasoning and Analyzing

- Use reasoning to explore and make connections
- Estimate reasonably
- Develop mental math strategies and abilities to make sense of quantities
- Model mathematics in contextualized experiences

Understanding and Solving

- Develop, demonstrate, and apply mathematical understanding through play, inquiry, and problem solving
- Visualize to explore mathematical concepts
- Develop and use multiple strategies to engage in problem solving
- Engage in problem-solving experiences that are connected to place, story, cultural practices, and perspectives relevant to local First Peoples communities, the local community, and other cultures.

Communicating and Representing

- Communicate mathematical thinking in many ways
- Use mathematical vocabulary and language to contribute to mathematical discussions
- Explain and justify mathematical ideas and decisions
- Represent mathematical ideas in concrete, pictorial, and symbolic forms

Connecting and Reflecting

- Reflect on mathematical thinking
- Connect mathematical concepts to each other and to other areas and personal interests
- Incorporate First Peoples worldviews and perspectives to make connections to mathematical concepts

Content

- Number concepts to 20
- Ways to make 10

- Addition and subtraction to 20 (understanding of operation and process)
- Change in quantity to 20, concretely and verbally
- Likelihood of familiar life events, using comparative language

Grade 2

Big Ideas

- Numbers to 100 represent quantities that can be decomposed into 10s and 1s
- Development of computational fluency in addition and subtraction with numbers to 100 requires an understanding of place value

Curricular Competencies Reasoning and Analyzing

- Use reasoning to explore and make connections
- Estimate reasonably
- Develop mental math strategies and abilities to make sense of quantities
- Model mathematics in contextualized experiences

Understanding and Solving

- Develop, demonstrate, and apply mathematical understanding through play, inquiry, and problem solving
- Visualize to explore mathematical concepts
- Develop and use multiple strategies to engage in problem solving
- Engage in problem-solving experiences that are connected to place, story, cultural practices, and perspectives relevant to local First Peoples communities, the local community, and other cultures

Communicating and Representing

- Communicate mathematical thinking in many ways
- Use mathematical vocabulary and language to contribute to mathematical discussions
- Explain and justify mathematical ideas and decisions
- Represent mathematical ideas in concrete, pictorial, and symbolic forms

Connecting and Reflecting

- Reflect on mathematical thinking
- Connect mathematical concepts to each other and to other areas and personal interests
- Incorporate First Peoples worldviews and perspectives to make connections to mathematical concepts

Content

- Number concepts to 100

- Benchmarks of 25, 50, and 100 and personal referents
- Addition and subtraction facts to 20 (introduction of computational strategies)
- Addition and subtraction to 100
- Change in quantity, using pictorial and symbolic representation
- Likelihood of familiar life events, using comparative language

Grade 3

Big Ideas

- Development of computational fluency in addition, subtraction, multiplication, and division of whole numbers requires flexible decomposing and composing
- The likelihood of possible outcomes can be examined, compared, and interpreted

Curricular Competencies Reasoning and Analyzing

- Use reasoning to explore and make connections
- Estimate reasonably
- Develop mental math strategies and abilities to make sense of quantities
- Model mathematics in contextualized experiences

Understanding and Solving

- Develop, demonstrate, and apply mathematical understanding through play, inquiry, and problem solving
- Visualize to explore mathematical concepts
- Develop and use multiple strategies to engage in problem solving
- Engage in problem-solving experiences that are connected to place, story, cultural practice, and perspectives relevant to local First Peoples communities, the local community, and other cultures

` Communicating and Representing

- Communicate mathematical thinking in many ways
- Use mathematical vocabulary and language to contribute to mathematical discussions
- Explain and justify mathematical ideas and decisions
- Represent mathematical ideas in concrete, pictorial, and symbolic forms

Connecting and Reflecting

- Reflect on mathematical thinking
- Connect mathematical concepts to each other and to other areas and personal interests
- Incorporate First Peoples worldviews and perspectives to make connections to mathematical concepts

- Number concepts to 1000
- Addition and subtraction to 1000
- Addition and subtraction facts to 20 (emerging computational fluency)
- Likelihood of simulated events, using comparative language

Grade 4

Curricular Competencies Reasoning and Analyzing

- Use reasoning to explore and make connections
- Estimate reasonably
- Develop mental math strategies and abilities to make sense of quantities
- Model mathematics in contextualized experiences

Understanding and Solving

- Develop, demonstrate, and apply mathematical understanding through play, inquiry, and problem solving
- Visualize to explore mathematical concepts
- Develop and use multiple strategies to engage in problem solving
- Engage in problem-solving experiences that are connected to place, story, cultural practices, and perspectives relevant to local First Peoples communities, the local community, and other cultures

Communicating and Representing

- Communicate mathematical thinking in many ways
- Use mathematical vocabulary and language to contribute to mathematical discussions
- Explain and justify mathematical ideas and decisions
- Represent mathematical ideas in concrete, pictorial, and symbolic forms

Connecting and Reflecting

- Reflect on mathematical thinking
- Connect mathematical concepts to each other and to other areas and personal interests
- Incorporate First Peoples worldviews and perspectives to make connections to mathematical concepts

Content

- Number concepts to 10 000
- Addition and subtraction to 10 000
- Addition and subtraction facts to 20 (developing computational fluency)
- Probability experiments

Grade 5

Curricular Competencies Reasoning and Analyzing

- Use reasoning to explore and make connections
- Estimate reasonably
- Develop mental math strategies and abilities to make sense of quantities
- Model mathematics in contextualized experiences

Understanding and Solving

- Develop, demonstrate, and apply mathematical understanding through play, inquiry, and problem solving
- Visualize to explore mathematical concepts
- Develop and use multiple strategies to engage in problem solving
- Engage in problem-solving experiences that are connected to place, story, cultural practices, and perspectives relevant to local First Peoples communities, the local community, and other cultures

Communicating and Representing

- Communicate mathematical thinking in many ways
- Use mathematical vocabulary and language to contribute to mathematical discussions
- Explain and justify mathematical ideas and decisions
- Represent mathematical ideas in concrete, pictorial, and symbolic forms

Connecting and Reflecting

- Reflect on mathematical thinking
- Connect mathematical concepts to each other and to other areas and personal interests
- Incorporate First Peoples worldviews and perspectives to make connections to mathematical concepts

Content

- Number concepts to 1 000 000
- Addition and subtraction of whole numbers to 1 000 000
- Addition and subtraction facts to 20 (extending computational fluency)
- Probability experiments, single events or outcomes

Grade 6

Big Idea

- Data from the results of an experiment can be used to predict the theoretical probability of an event and to compare and interpret

Curricular Competencies Reasoning and Analyzing

- Use logic and patterns to solve puzzles and play games
- Use reasoning and logic to explore, analyze, and apply mathematical ideas
- Estimate reasonably
- Demonstrate and apply mental math strategies
- Model mathematics in contextualized experiences

Understanding and Solving

- Apply multiple strategies to solve problems in both abstract and contextualized situations
- Develop, demonstrate, and apply mathematical understanding through play, inquiry, and problem solving
- Visualize to explore mathematical concepts
- Develop and use multiple strategies to engage in problem solving
- Engage in problem-solving experiences that are connected to place, story, cultural practices, and perspectives relevant to local First Peoples communities, the local community, and other cultures

Communicating and Representing

- Use mathematical vocabulary and language to contribute to mathematical discussions
- Explain and justify mathematical ideas and decisions
- Communicate mathematical thinking in many ways
- Represent mathematical ideas in concrete, pictorial, and symbolic forms

Connecting and Reflecting

- Reflect on mathematical thinking
- Connect mathematical concepts to each other and to other areas and personal interests
- Incorporate First Peoples worldviews and perspectives to make connections to mathematical concepts

Content

- Small to large numbers (thousandths to billions)
- Single-outcome probability, both theoretical and experimental

Grade 7

Curricular Competencies Reasoning and Analyzing

- Use logic and patterns to solve puzzles and play games
- Use reasoning and logic to explore, analyze, and apply mathematical ideas
- Estimate reasonably

Understanding and Solving

- Apply multiple strategies to solve problems in both abstract and contextualized situations
- Develop, demonstrate, and apply mathematical understanding through play, inquiry, and problem solving
- Develop and use multiple strategies to engage in problem solving
- Visualize to explore mathematical concepts
- Engage in problem-solving experiences that are connected to place, story, cultural practices, and perspectives relevant to local First Peoples communities, the local community, and other cultures

Communicating and Representing

- Use mathematical vocabulary and language to contribute to mathematical discussions
- Explain and justify mathematical ideas and decisions
- Communicate mathematical thinking in many ways
- Represent mathematical ideas in concrete, pictorial, and symbolic forms

Connecting and Reflecting

- Reflect on mathematical thinking
- Connect mathematical concepts to each other and to other areas and personal interests
- Incorporate First Peoples worldviews and perspectives to make connections to mathematical concepts

Content

- Experimental probability with two independent events

Grade 9

Curricular Competencies Reasoning and Analyzing

- Use logic and patterns to solve puzzles and play games
- Use reasoning and logic to explore, analyze, and apply mathematical ideas
- Estimate reasonably
- Demonstrate and apply mental math strategies
- Model mathematics in contextualized experiences

Understanding and Solving

- Apply multiple strategies to solve problems in both abstract and contextualized situations
- Develop , demonstrate, and apply mathematical understanding through play, inquiry, and problem solving
- Visualize to explore mathematical concepts

- Engage in problem-solving experiences that are connected to place, story, cultural practices, and perspectives relevant to local First Peoples communities, the local community, and other cultures

Communicating and Representing

- Use mathematical vocabulary and language to contribute to mathematical discussions
- Explain and justify mathematical ideas and decisions
- Communicate mathematical thinking in many ways
- Represent mathematical ideas in concrete, pictorial, and symbolic forms

Connecting and Reflecting

- Reflect on mathematical thinking
- Connect mathematical concepts to each other and to other areas and personal interests
- Incorporate First Peoples worldviews and perspectives to make connections to mathematical concepts

Grade 10 Foundations of Mathematics and Pre-Calculus

Curricular Competencies Reasoning and Modelling

- Develop thinking strategies to solve puzzles and play games
- Explore, analyze, and apply mathematical ideas using reason, technology, and other tools
- Estimate reasonably and demonstrate fluent, flexible, and strategic thinking about number
- Model with mathematics in situational contexts
- Think creatively and with curiosity and wonder when exploring problems

Understanding and Solving

- Develop, demonstrate, and apply mathematical understanding through play, story, inquiry, and problem solving
- Visualize to explore and illustrate mathematical concepts and relationships
- Apply flexible and strategic approaches to solve problems
- Solve problems with persistence and a positive disposition
- Engage in problem-solving experiences connected with place, story, cultural practices, and perspectives relevant to local First Peoples communities, the local community, and other cultures

Communicating and Representing

- Explain and justify mathematical ideas and decisions in many ways
- Use mathematical vocabulary and language to contribute to discussions in the classroom
- Take risks when offering ideas in classroom discourse

Connecting and Reflecting

- Reflect on mathematical thinking
- Connect mathematical concepts with each other, other areas, and personal interests
- Use mistakes as an opportunity to advance learning
- Incorporate First Peoples worldviews, perspectives, knowledge, and practices to make connections with mathematical concepts

Grade 10 Workplace Mathematics

Big Ideas

- Flexibility with number builds meaning, understanding, and confidence
- Representing and analyzing data allows us to notice and wonder about relationships

Curricular Competencies Reasoning and Modelling

- Develop thinking strategies to solve puzzles and play games
- Explore, analyze, and apply mathematical ideas using reason, technology, and other tools
- Estimate reasonably and demonstrate fluent, flexible, and strategic thinking about number
- Think creatively and with curiosity and wonder when exploring problems

Understanding and Solving

- Develop, demonstrate, and apply conceptual understanding of mathematical ideas through play, story, inquiry, and problem solving
- Visualize to explore and illustrate mathematical concepts and relationships
- Apply flexible and strategic approaches to solve problems
- Solve problems with persistence and a positive disposition
- Engage in problem-solving experiences connected with place, story, cultural practices, and perspectives relevant to local First Peoples communities, the local community, and other cultures

Communicating and Representing

- Explain and justify mathematical ideas and decisions in many ways
- Use mathematical vocabulary and language to contribute to discussions in the classroom
- Take risks when offering ideas in classroom discourse

Connecting and Reflecting

- Reflect on mathematical thinking
- Connect mathematical concepts with each other, other areas, and personal interests
- Use mistakes as opportunities to advance learning

- Incorporate First Peoples worldviews, perspectives, knowledge, and practices to make connections with mathematical concepts

Content

- Experimental probability

Grade 11 History of Mathematics

Big Ideas

- Mathematics has developed over many centuries and continues to evolve
- Mathematics is a global language used to understand the world

Curricular Competencies Reasoning and Modelling

- Develop thinking strategies to solve historical puzzles and play games
- Think creatively and with curiosity and wonder when exploring problems

Understanding and Solving

- Develop, demonstrate, and apply conceptual understanding of mathematical ideas through play, story, inquiry, and problem solving
- Visualize to explore and illustrate mathematical concepts and relationships
- Apply flexible and strategic approaches to solve problems
- Solve problems with persistence and a positive disposition
- Engage in problem-solving experiences that are connected with place, story, and cultural practices, including local First Peoples

Communicating and Representing

- Explain and justify mathematical ideas and decisions in many ways
- Use mathematical vocabulary and language to contribute to discussions in the classroom
- Take risks when offering ideas in classroom discourse

Connecting and Reflecting

- Reflect on mathematical thinking
- Connect mathematical concepts with each other, with other areas, and with personal interests
- Use mistakes as opportunities to advance learning
- Incorporate First Peoples worldviews, perspectives, knowledge, and practices to make connections with mathematical concepts

Content

- Number and number systems: written and oral numbers
- Probability and statistics: Pascal's Triangle, games involving probability, early beginnings of statistics and probability

Grade 11 **Workplace Mathematics**

Big Idea

- Representing and analyzing data allows us to notice and wonder about relationships

Curricular Competencies Reasoning and Modelling

- Develop thinking strategies to solve puzzles and play games
- Explore, analyze, and apply mathematical ideas using reason, technology, and other tools
- Estimate reasonably and demonstrate fluent, flexible, and strategic thinking about number
- Model with mathematics in situational contexts
- Think creatively and with curiosity and wonder when exploring problems

Understanding and Solving

- Develop, demonstrate, and apply mathematical understanding through play, story, inquiry, and problem solving
- Visualize to explore and illustrate mathematical concepts and relationships
- Apply flexible and strategic approaches to solve problems
- Solve problems with persistence and a positive disposition
- Engage in problem-solving experiences that connected with place, story, cultural practices, and perspectives relevant to local First Peoples communities, the local community, and other cultures

Communicating and Representing

- Explain and justify mathematical ideas and decisions in many ways
- Use mathematical vocabulary and language to contribute to discussions in the classroom
- Take risks when offering ideas in classroom discourse

Connecting and Reflecting

- Reflect on mathematical thinking
- Connect mathematical concepts with each other, other areas, and personal interests
- Use mistakes as opportunities to advance learning
- Incorporate First Peoples worldviews, perspectives, knowledge, and practices to make connections with mathematical concepts

Content

- How probability and statistics are used in different contexts

Grade 12 **Foundations of Mathematics**

Big Ideas

- Probabilistic thinking informs decision making in situations involving chance and uncertainty

- Through explorations of spatial relationships, we can develop a geometrical appreciation of the world around us

Curricular Competencies Reasoning and Modelling

- Develop thinking strategies to solve puzzles and play games
- Explore, analyze, and apply mathematical ideas using reason, technology, and other tools
- Estimate reasonably and demonstrate fluent, flexible, and strategic thinking about number
- Model with mathematics in situational contexts
- Think creatively and with curiosity and wonder when exploring problems

Understanding and Solving

- Develop, demonstrate, and apply conceptual understanding of mathematical ideas through play, story, inquiry, and problem solving
- Visualize to explore and illustrate mathematical concepts and relationships
- Apply flexible and strategic approaches to solve problems
- Solve problems with persistence and a positive disposition
- Engage in problem-solving experiences that are connected with place, story, cultural practices, and perspectives relevant to local First Peoples communities, the local community, and other cultures

Communicating and Representing

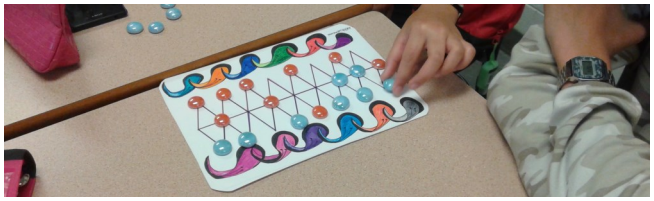
- Explain and justify mathematical ideas and decisions in many ways
- Use mathematical vocabulary and language to contribute to discussions in the classroom
- Take risks when offering ideas in classroom discourse

Connecting and Reflecting

- Reflect on mathematical thinking
- Connect mathematical concepts to each other, other areas and personal interests
- Use mistakes as an opportunities to advance learning
- Incorporate First Peoples worldviews, perspectives, knowledge, and practices to make connections with mathematical concepts

Content

- Odds, probability, and expected value



Resources

Web Resources

Dene Games (Hand Games)

http://www.denegames.ca/dene-games/hand-games.html

Elliot Avedon Virtual Museum of Games (Inuit Games)

http://healthy.uwaterloo.ca/museum/VirtualExhibits/Inuit/english/

First Nations Games of Chance

https://web.uvic.ca/~tpelton/fn-math/

Games from the Aboriginal People of North America

http://mathcentral.uregina.ca/RR/database/RR.09.00/treptau1/

Interweaving Mathematics and Indigenous Cultures

http://math.unipa.it/~grim/AArnason20-24.PDF

Manataka American Indian Council (Native Games)

http://www.manataka.org/page103.html#Introduction%20to

Perpetual Salish: Coast Salish Art in the Classroom

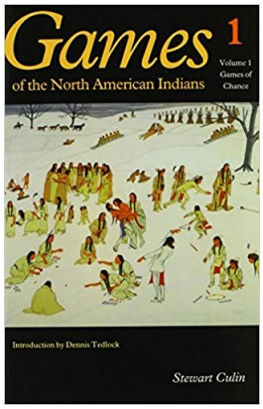
uvac.uvic.ca/gallery/salishcurriculum/

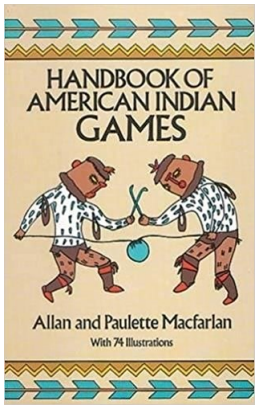
Plum Stone Dice Game

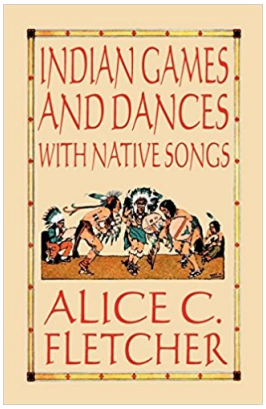
http://www.museum.state.il.us/muslink/nat_amer/post/htmls/activities/re_dice.html

Book Resources

Stewart Culin	Games of the North American Indians, Volume 1: Games of Chance
Alice C. Fletcher	Indian Games and Dances with Native Songs
Allan & Paulette Macfarlan	Handbook of American Indian Games
Jay Miller	American Indian Games





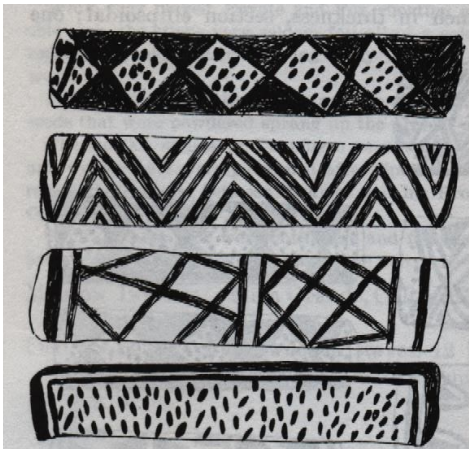


GAME PIECES

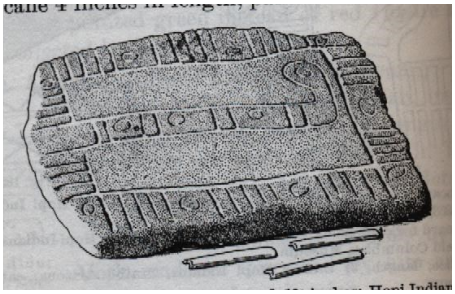
Games are played by many Indigenous people all over North America. Many of the games have been passed down for generations. Games are often similar from nation to nation with variations only in the resources that people had access to create pieces and game boards. Variations do not seem to be a result of language differences.

Game pieces were made from stone, bone, wood, leather, shell, peach and walnut stones, etc.

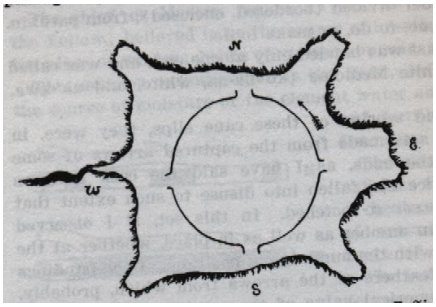
Haida Stick Game (British Columbia)



Mohave Stick Dice (Arizona)



Hopi Stone Board (Arizona)



Zuni Hide Gaming Circuit (New Mexico)

Culin, Stewart. Games of the North American Indians, Volume 1: Games of Chance. University of Nebraska Press. Lincoln: 1992. (pages 162, 206, 216, 261)

Indigenous Logic Math Games Unit Plan

The following is the unit completed in three classes but the time may vary. You may use more time on the design elements of the game boards or you may choose to spend more time on the various assessment strategies. This may also be used as a semester project that the students work on once a week or once every two weeks. Please feel free to adapt this to suit your needs and the curriculum connections you would like to make.

Lesson 1 Introduction

The unit was introduced using a PowerPoint on the role of games in Indigenous societies. This includes a brief description of the types of games played and the mathematical concepts involved. An explanation for the games are also outlined in the PowerPoint but you may print the rules provided in this document for the students.

The students are shown the basic elements of Coast Salish art (place-based learning for Burnaby Schools) and are given supplies to make the various game boards. Perpetual Salish: Coast Salish Art in the Classroom is a good website resource to access for local art design and their elements. This can be found at: http://uvac.uvic.ca/gallery/salishcurriculum/. This is a great opportunity to explore cross-curricular connections to Arts Education.

You may choose to print out copies of the game boards and have the students use Coast Salish design elements on them or you may allow the students to create the boards and then use the Coast Salish design elements . If the students create the boards you can use this as a chance to review perimeter, area, angles, proportional reasoning, and transformations. A simplified version is to use the game boards provided as they are on pages 28, 30, and 32.

Lesson 2 Game Play and Assessment

The students play the three Indigenous games introduced to them. Once they have had a chance to play with all of the games you may use any of the assessment strategies introduced on page 26.

Lesson 3 Game Play and Assessment

The students continue with the assessment strategies for the three Indigenous games and are introduced to Ultimate Tic-Tac-Toe and 99.

Possible Assessment Strategies

Teacher observation of students communicating in small groups.

General feedback on a class discussion of strategies. How did students contribute to the discussion? Did they respect the ideas of their fellow classmates?

Students record strategy sentences (i.e. If this … then that. I noticed that when I did xxxx then xxxx happened.). They record their moves and articulate their ideas.

Students develop a winning hypotheses and try it out a number of times. Pair students with different hypotheses to play against each other and test whether theirs is a winning strategy.

Have a class discussion on winning strategies and develop a TOP TIPS cheat sheet. For instance, 'Does it matter who goes first?'

Have the students create adaptations of the games. They may start out asking 'What if….?' questions to see what happens when you change certain aspects of the games.

Provide a number of natural objects found in their local area and have students work in pairs or small groups to create their own logic and strategy game. The class can create a rubric to help guide the development of their game.

Have the students play the logic puzzle games Sudoku and KenKen.

AWITHLAKNANNAI

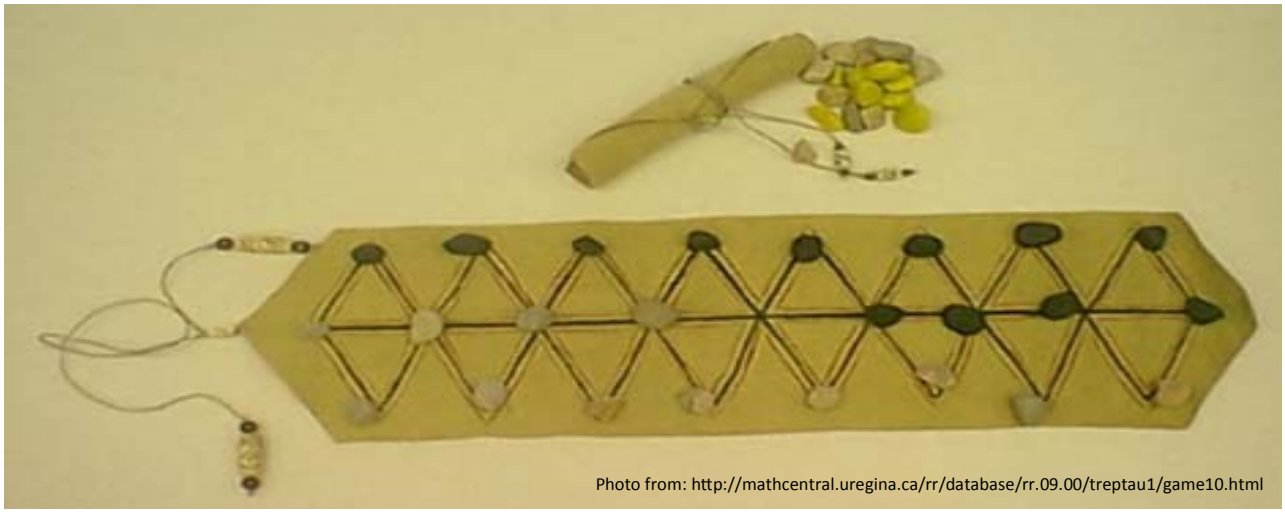


Photo from: http://mathcentral.uregina.ca/rr/database/rr.09.00/treptau1/game10.html

This board game is from the Zuni who are a part of the Pueblo Nation. The Zuni live in the Zuni River Valley in New Mexico and Arizona. Awithlaknannai is a two player strategy game. It belongs to the family of games known as draughts (checkers). There are 25 intersections where you make diagonal moves on the game board.

Goal

The player who captures all of their opponent's game pieces is the winner.

If both players cannot capture any more of their opponent's pieces then the game is either a draw OR the player with the most game pieces left on the board is declared the winner.

Equipment

Game board with 25 intersection points. The middle row has 9 points. The two outer rows have 8 points.

24 game pieces: 12 pieces of one colour and 12 pieces of a different colour. Generally black and white.

Rules

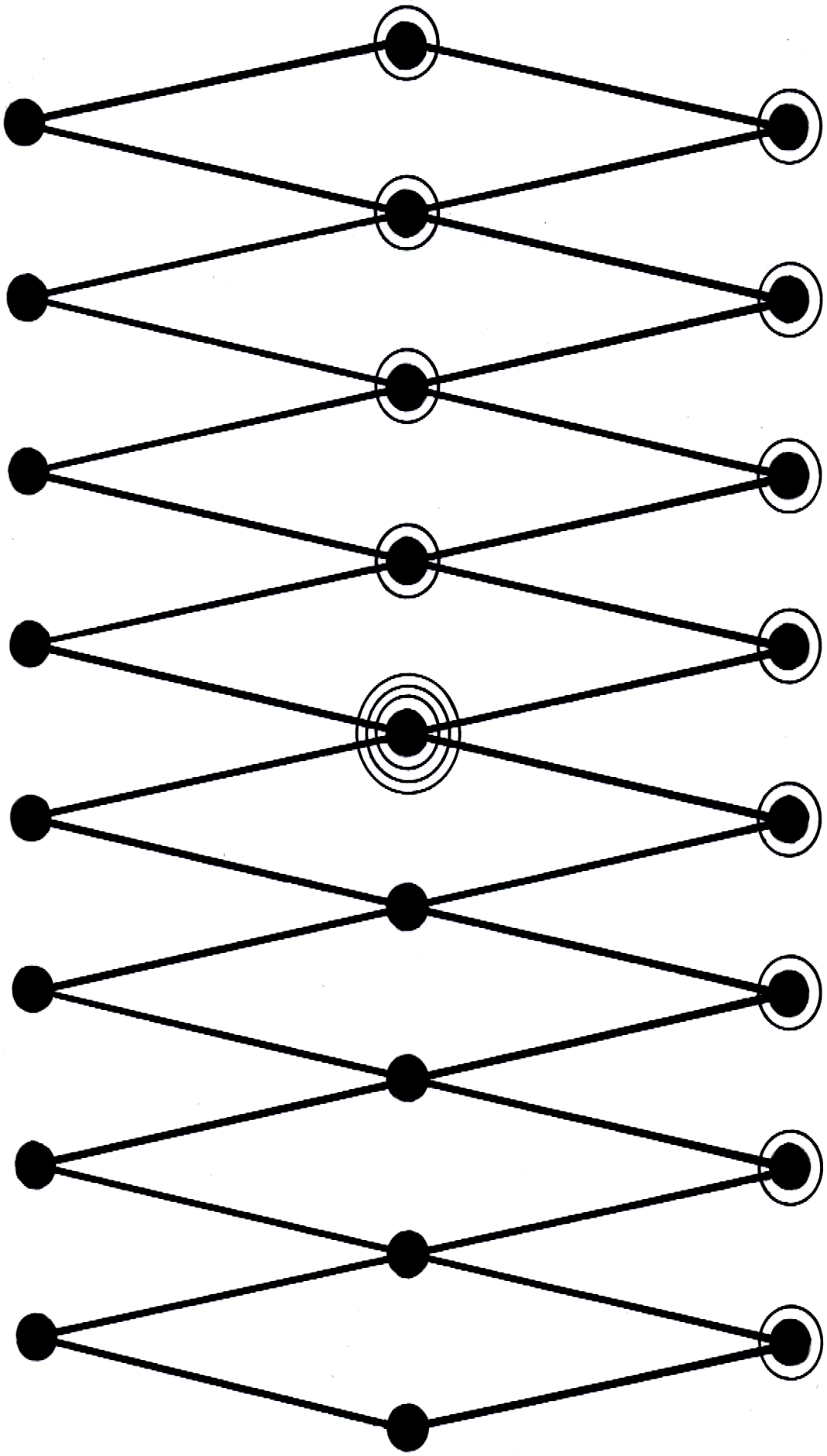
Decide what colour you are going to be and who will be going first. Place the counters on the board as shown in the above picture. Your game pieces should be placed in the row closest to you and the four places in the middle to the right of you. The circle in the middle should be left empty.

The first player moves to the centre point as it is the only one open. Players alternate their turns. Players can move one of their counters to an adjacent point along the line or jump over and capture an adjacent counter of your opponent if the next space is open. You will keep every counter you jump over.

Continue jumping with the counter until there are no more open counters to capture.

If a player can jump but does not their opponent can take their counter.

The winner is the player who has captured the most counters.



PICARIA

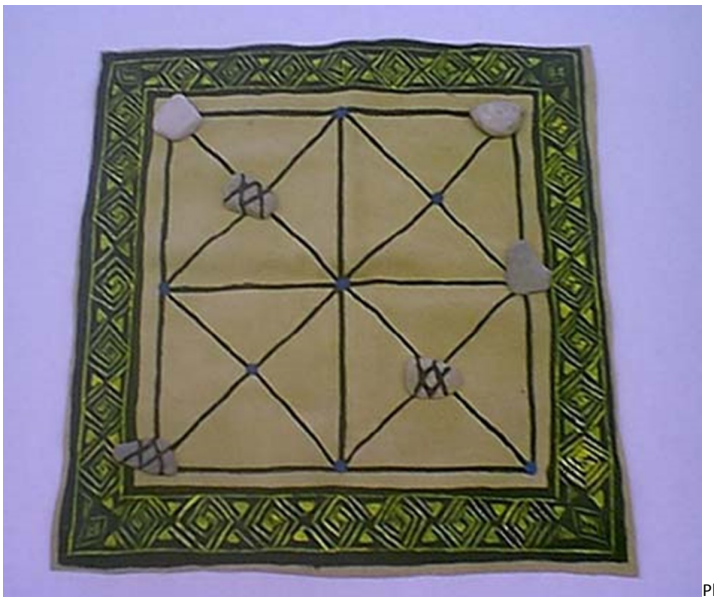


Photo from: http://mathcentral.uregina.ca/rr/database/rr.09.00/treptau1/game11.html

Picaria is a game also from the Zuni of the Pueblo Nation. It is a two-player strategy game. It is closely related to tic-tac-toe which makes it an alignment game.

The main version of Picaria uses 9 intersection points while the second version uses 13 intersection points. We are using the main version of the game board.

Goal

With your game pieces create three in a row either horizontally, vertically, or diagonally.

Equipment

Use a 3 X 3 board: 3 horizontal lines, 3 vertical lines, 2 diagonal lines connecting the opposite corners, 4 diagonal lines connecting the midpoints.

6 game pieces: 3 of one colour and 3 of another colour.

Rules

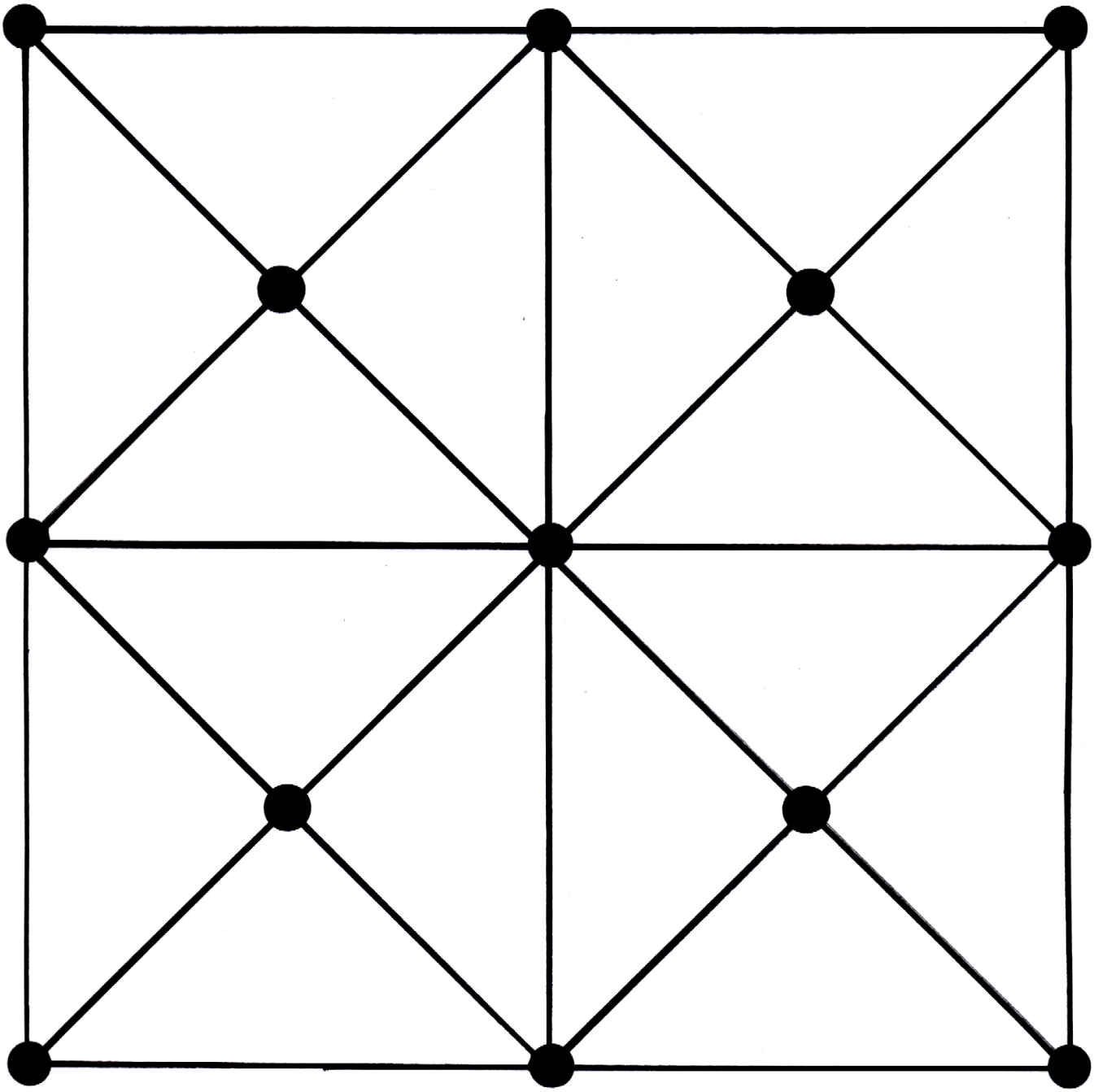
Decide what colour you are going to be and who will be going first. The game board will be empty until the first player takes their turn.

Drop Phase: Players alternate their turns. You may place a game piece on any vacant point on the board EXCEPT for the intersection point in the very centre. You cannot move your pieces until you have dropped all 3 onto the board.

Move Phase: After all 3 of your pieces have been placed on the board you can move, one piece per turn, one space at a time following the pattern on the board (including the centre intersection point).

The player who creates 3 in a row, either in the drop phase or move phase, wins the game.

At the beginning of the game you may decide what happens when one player cannot make a move. You may choose to call the game a draw OR you may say that the player loses the game.



Throw Sticks

Throw Sticks or Stick Games have been played by many Indigenous peoples. This version is from the Chiricahua Apache from Southwestern New Mexico and Mexico.

Stick games involve probability, patterns and relations, numbers operations (place value), and data management.

Variations in this game occur in how many sticks are used, scoring, how many players, and who plays. For the Chiricahua Nation only women played this game.

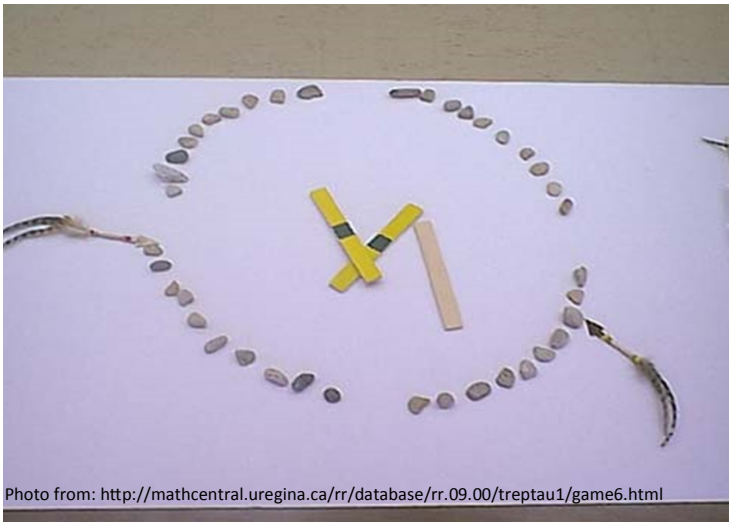


Photo from: http://mathcentral.uregina.ca/rr/database/rr.09.00/treptau1/game6.html

Goal

The winner is the person whose counting stick has gone around the entire circle.

Equipment

Arrange forty stones in four groups of 10 in a circle. You will need a marker of some kind to indicate your place around the circle. Three sticks with one side painted and one side blank.

Rules

Place your marker in the starting position. Your opponent will place their marker at the opposite side. Decide if you are both going in the same direction OR if one will go clockwise and one counter clockwise. Decide who will go first.

Toss the 3 stick dice in the centre of the circle. Move your place marker according to the points indicated by the dice.

Each stone counts as one space or one point.

If you land on or pass the other players' marker then they must go back to their starting position.

The winner is the player who makes it around the circle back to their starting position.

3 blank sides = 10 points

2 blank sides and 1 painted side = 1 point

1 blank side and 2 painted sides = 3 points

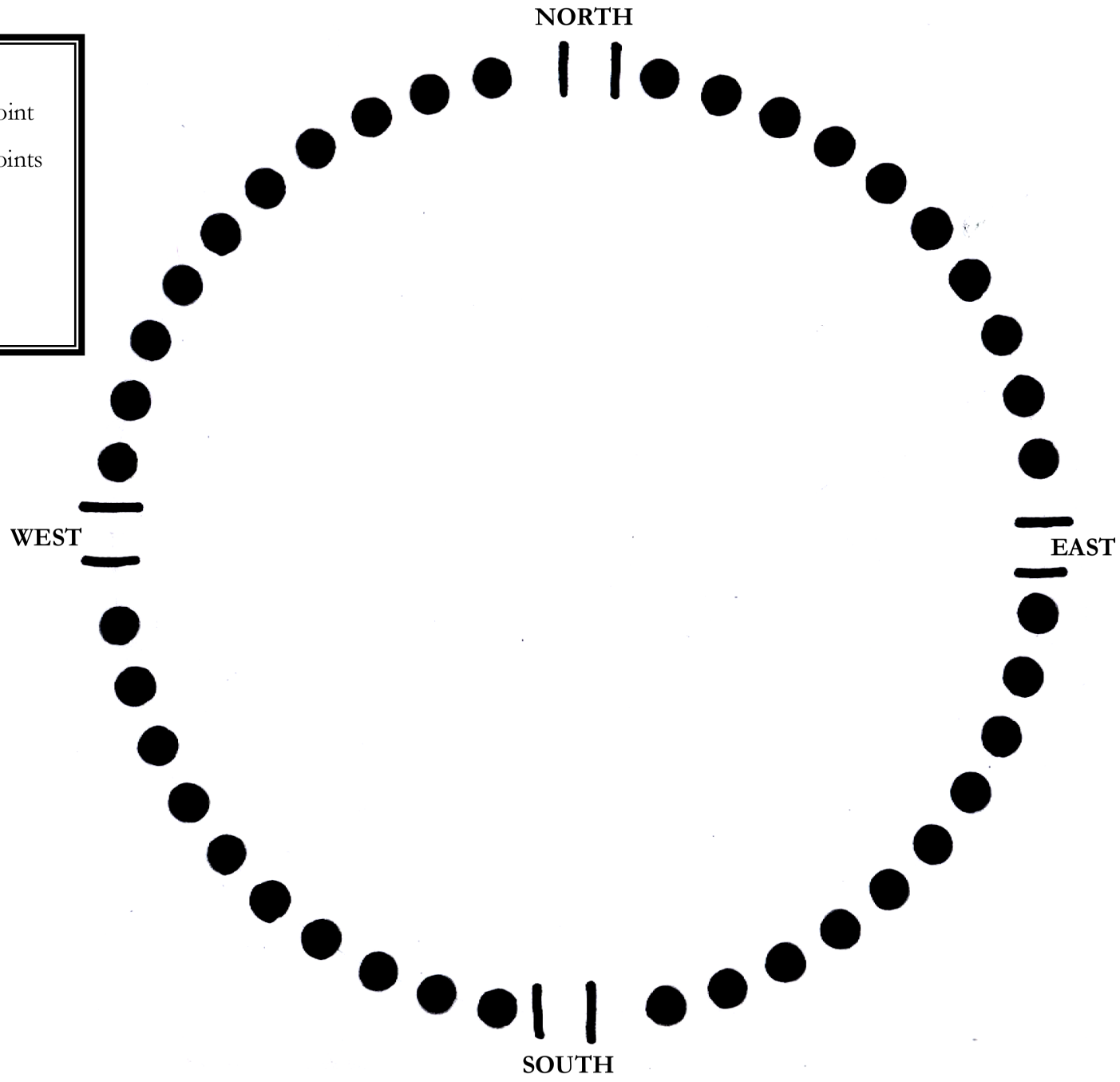
3 painted sides = 5 points

3 blank sides = 10 points

2 blank sides and 1 painted side = 1 point

1 blank side and 2 painted sides = 3 points

3 painted sides = 5 points



Theoretical Probability of Throw Sticks

Theoretical Probability of Two Independent Events

Theoretical Probability:

$$\frac{\text{Number of Favourable Outcomes}}{\text{Number of Possible Outcomes}}$$

Theoretical Probability with Two Events: When two events are independent of one another the probability of one event that occurs does not affect the probability of another event that occurs.

3 blank sides = 10 points

2 blank sides and 1 painted side = 1 point

1 blank side and 2 painted sides = 3 points

3 painted sides = 5 points

Questions to Ponder:

What is the probability of getting three blank sides in a throw?

What is the probability of getting one blank side and two painted sides in a throw?

What is the probability outcome of the two events?

Record the number of times that each probability occurs in 20 throws. Use tally marks.

3 blank sides	2 blank sides & 1 painted side	1 blank side & 2 painted sides	3 painted sides

Using your results calculate the probability of each event. Calculate the class probability results. Compare your probability results with the class probability results. Are they different? Why?

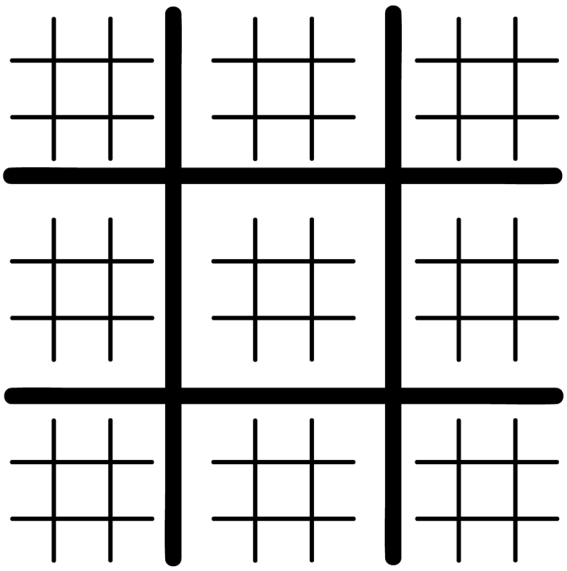
Using the results, what is the probability statement for getting three blank sides in a throw? What is the probability statement for getting one blank side and two painted sides in a throw?

Is it likely or unlikely that you can win the game in 20 throws?

Logic Games

Ultimate Tic Tac Toe and 99 are played in the Logic Games Unit along with the Indigenous games.

Ultimate Tic-Tac-Toe



This game is played with the normal 3x3 grid of Tic Tac Toe but each square is also a 3x3 grid. There are 81 squares to play in.

Each small square is known as a **local board**.

The grid as a whole is known as the **global board**.

If a move is played that wins a local board by normal Tic Tac Toe rules then that local board is won.

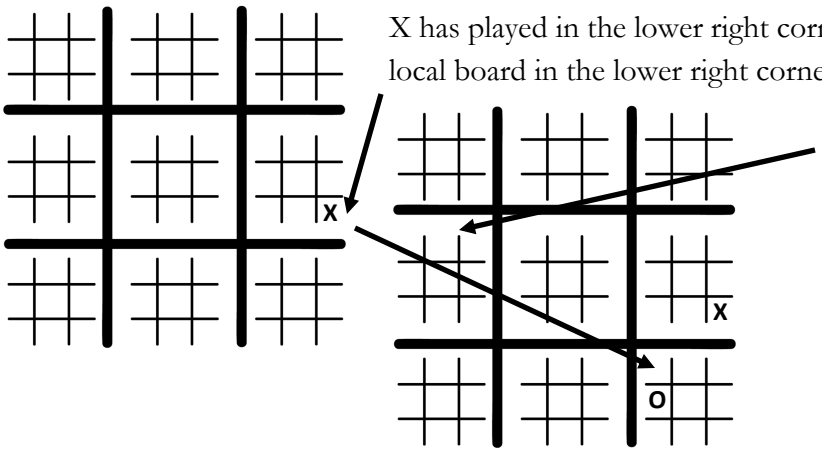
Normal rules: Players alternate (X and O). Three in a row wins.

Ultimate Tic Tac Toe: Win three local boards in a row.

Rules

Determine who will be X and who will be O. X plays first and can play anywhere they would like on the global board.

O has to play in the local board corresponding to the move of X. X follows the same rule.



X has played in the lower right corner. O will have to play in the local board in the lower right corner, in any square.

X will now have to play in the middle left local board. They may play in any square in that local board.

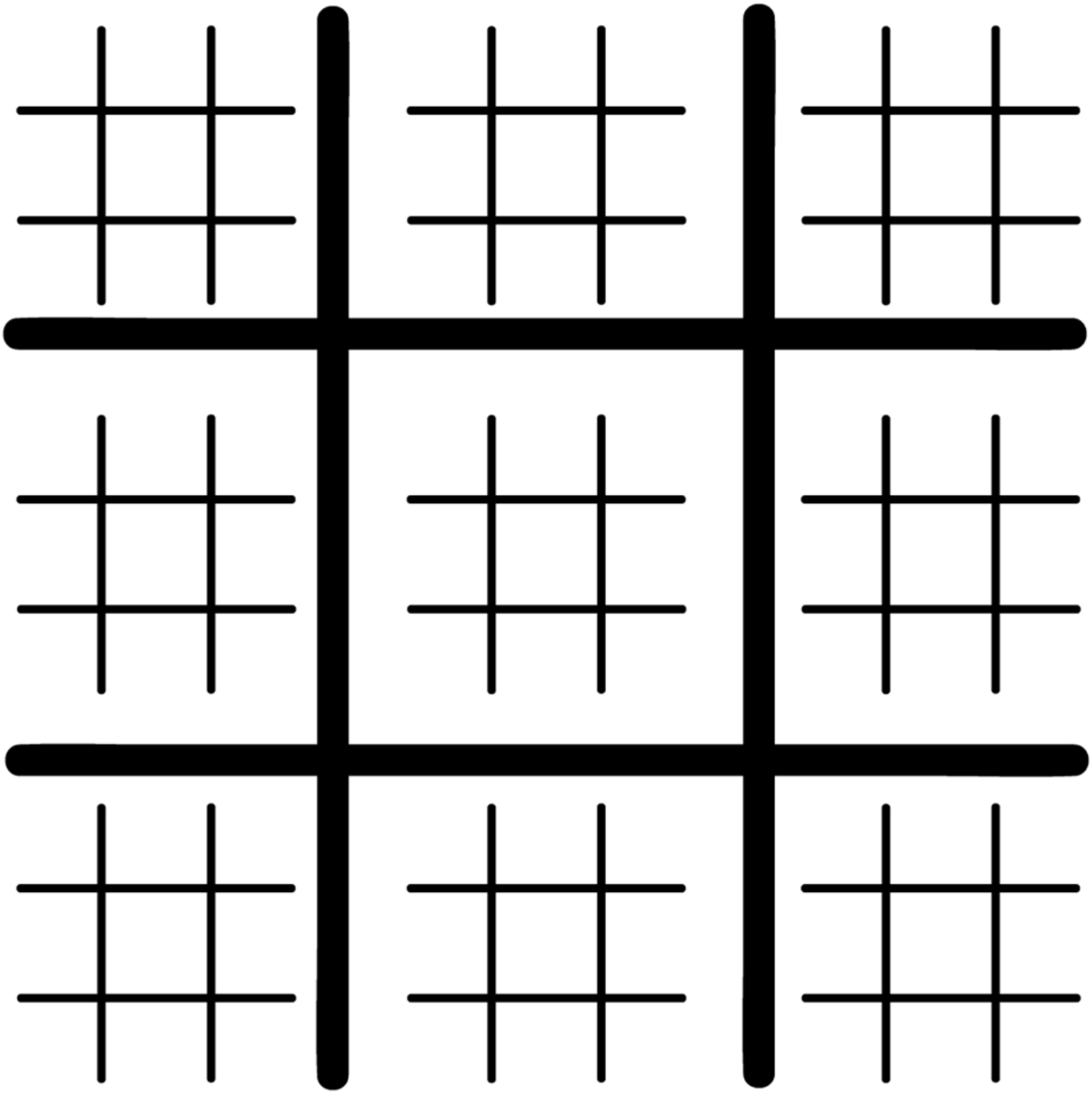
If you are sent to a square that is filled, or has been won, you can play anywhere on the board.

First player to place 3 in a row in a local board wins that square. Once that local board has been won no more moves may be played in that board.

The Game ends when a player wins 3 in a row on the global board or there are no more moves to make.

A tutorial on Ultimate Tic Tac Toe: The Rules by Mind Your Decisions is available on YouTube at: https://www.youtube.com/watch?v=37PC0bGMiTI.

Ultimate Tic-Tac-Toe



99

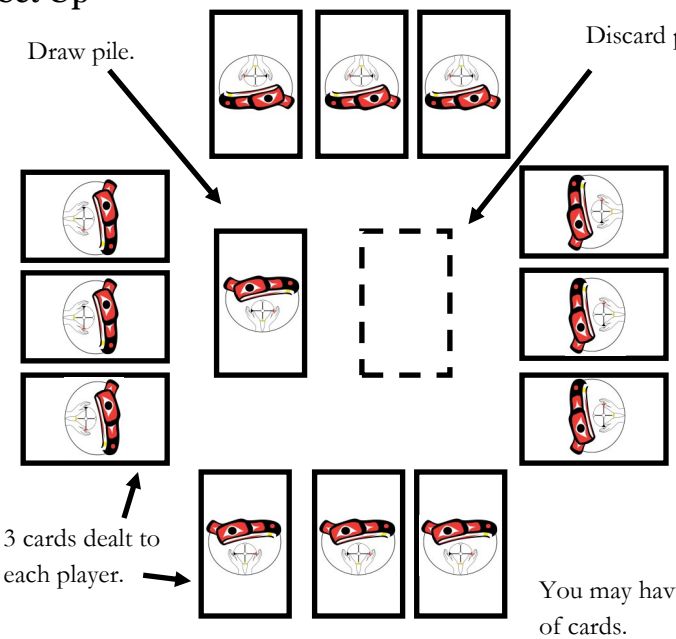
Goal

To be the last player left with a token.

Equipment

Standard deck of 52 cards 3 tokens for each player

Set Up



Card Values

Ace:	1 or 11 (value decided by player)
2-3, 5-8:	face value
4:	0 and the order of play is reversed (except when there are only two players)
9:	skip the next player
10:	Minus 10
Qs & Js:	10
Kings:	keeps the total at 99 no matter the previous deck total

You may have as many players as you would like and may also use 2 decks of cards.

Rules

3 tokens are distributed to each player. The dealer deals 3 cards to each player. Player to the left of the dealer plays first.

The first player chooses a card in their hand and places it on the discard pile. They call out its value and draw a new card.

The next player to the left places a card on the discard pile and adds its value to the previous card for a new total. They then draw a new card.

★ If a player forgets to draw a new card before the next player takes their turn then they must remain one card short for the rest of the hand. They play from the 2 cards they have and pick up 2 new cards to make 3 in their hand.

The game continues until a player cannot play without making the running total greater than 99. The last player who cannot play a card loses one of their tokens. Cards are collected and a new hand is dealt.

Players who have 0 tokens are no longer playing in the game. The last player with tokens win.

Strategy: To collect a hand that can allow you to play as long as possible once 99 is reached.

A tutorial on How To Play 99 from gathertogethergames.com can be found on YouTube at: https://www.youtube.com/watch?v=4NqsqryYfQQ.