Discrete Mathematics

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Unit 3: Combinatorics, Counting and Election Theory

Transfer goal: Students will be able to independently use their learning to construct valid conclusions, effectively communicate those conclusions and critique the reasoning of others.

Stage 1 – Desired Results

Established Goals

NJ Student Learning Standards for Mathematics
http://www.state.nj.us/education/cccs/2016/math/hs

Statistics and Probability S-ICB: Make inferences and justify conclusions from sample surveys, experiments, and observational studies.
Statistics and Probability S-CPA: Understand independence and conditional probability and use them to interpret data.

NCTM Principles and Standards of School Mathematics
www.cssu.org/cms/lib5/VT01000775/Centricity/Domain/32/CSSUMathCurric

D1: Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.
D4: Understand and apply basic concepts of probability.

21st Century Themes

www.21stcentruyskills.org

_x__ Global Awareness
_x__Financial, Economic, Business and Entrepreneurial Literacy
_x__Civic Literacy
___Health Literacy
___Environmental Literacy

	21st Century Skills *Learning and Innovation Skills:* _x__Creativity and Innovation _x__Critical Thinking and Problem Solving _x__Communication and Collaboration *Information, Media and Technology Skills:* _x__Information Literacy ___Media Literacy ___ICT (Information, Communications and Technology) Literacy *Life and Career Skills:* _x__Flexibility and Adaptability _x__Initiative and Self-Direction _x__Social and Cross-Cultural Skills _x__Productivity and Accountability _x__Leadership and Responsibility
Enduring Understandings: *Students will understand that . . .* *EU 1* combinatorics is used in many instances from determining the number of possible pizza toppings to launching spacecraft. *EU 2* voting and apportionment methods are important to a democratic society.	**Essential Questions:** *EU1* ● How does the number of possible outcomes in an even affect the occurrence of the event? *EU 2* ● How can there be different outcomes when votes are cast the same way?
Knowledge: *Students will know . . .* *EU 1* ● outcomes of events can be counted using combinatorics. ● the proper counting technique to use in different situations.	**Skills:** *Students will be able to . . .* *EU 1* ● apply the counting principle, tree diagrams, combinations and permutations to determine sample spaces.

EU 2 ● outcomes of elections and preferences can be determined by utilizing a variety of mathematical techniques. ● determining allocations can be done fairly by using mathematical principles.	● use permutations and combinations to calculate probabilities of compound events and to solve problems. *EU 2* ● explain and use voting methods to determine outcomes of elections and sort preferences. ● synthesize voting criterion flaws and explain Arrow's Impossibility Theorem. ● explain apportionment and the use of quotas. ● use apportionment methods to determine allocations. ● explain the quota rule and apportionment paradoxes.

Stage 2 – Assessment Evidence

Recommended Performance Task: EU 2

The United States Census is conducted every ten years to collect data about citizens of the United States as well as to make decisions about apportioning representatives to the U.S. Government. As the principal of James Woods High School, you want to fairly apportion student representatives on a committee regarding the use of cell phones at your school. The committee should be representative of your student body population to make sure all voices are heard. The superintendent requires a written proposal about how students will be selected for the committee. In order for the proposal to be accepted, it needs to:

include two different ways of partitioning the student body population and describe the benefits and disadvantages of using these partitions;
include how to fairly apportion a total of 11 representatives on the committee from those partitioned groups by using at least 2 different apportionment methods correctly.
explain how apportionments would change, and which apportionment flaws would be present using your methods, if the superintendent decided to allow for 12 representatives on the committee;
be typed in a 12-14 font, single spaced.

Other Evidence: *Tests, Quizzes, Prompts, Self-assessment, Observations, Dialogues, etc.*

Tests, quizzes and activities to include:

research report/presentation on how voting and apportionment are used for the Academy Awards, Nobel Prize, Heisman Trophy etc.
applying voting methods to school officer elections
correlate voting and apportionment methods to the history of the United States (elections, apportionments to congress, etc.)
using voting methods to determine winners of an election or to sort preferences
explaining voting flaws
using graphic organizers to synthesize voting and apportionment methods
calculating quotas for real world situations

Stage 3 – Learning Plan

Suggested Learning Activities to Include Differentiated Instruction and Interdisciplinary Connections: *Consider the WHERETO elements*

Activity 1: Too Many Choices (M)
Students will use the TiNspire to investigate the fundamental counting principle, combinations and permutations.
Students will find patterns and make predictions.
Students will apply counting rules to solve problems.

https://education.ti.com/en/activity/detail?id=B0BB51FEAF984B2ABD18633537D39CD7

Activity 2: A Nuclear Dilemma (T)
Students will explore the concept of group-ranking, approval voting, and weighted voting as it relates to election theory. Students will be able to individually employ, and justify, a method for determining a group-ranking and apply Arrow's Conditions to their method. Students will work in small groups to arrive at a consensual weighted voting system and be able to explain, and justify, this system to the rest of the class.

http://www.colorado.edu/education/DMP/activities/election/ddpact02.html

Key Vocabulary Includes:

experiment	preference table
ample space	plurality method
sample point	Borda count
tree diagram	plurality with elimination
counting principle	runoff election
permutation	pairwise comparison
combination	method
majority	

Approximate Timeline: 9

Activity 1: Too Many Choices
Use tree diagrams and the Counting Principle to determine a sample space. (A and M)
Use permutations to determine the number of outcomes of an event. (A and M)
Use combinations to determine the number of outcomes of an event. (A and M)
Synthesizing voting Methods: Majority, Plurality, Borda Count, Pairwise Comparison and Plurality with Elimination (A)
Using voting methods to determine the winner of an election/preference of choices (M)
Explaining the flaws of voting: majority criterion, head-to-head criterion, monotonicity criterion, irrelevant alternatives criterion (A)
Applying voting methods and flaws of voting methods to real world situations (T)
Activity 2: A Nuclear Dilemma (T)
Explaining the apportionment vocabulary of quotas and devisors (A)
Using Hamilton's, Jefferson's, Webster's, Adams' and the Huntington-Hills' methods of apportionment (M)
Explaining the Alabama, Population and New-states apportionment paradoxes (M)