Discrete Mathematics

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Unit 2: Set Theory and Logic

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

Number and Quantity N-RNB3: Use properties of rational and irrational numbers.
Algebra A-APRA1: Perform arithmetic operations on polynomials.

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

A2: Represent and analyze mathematical situations and structures using algebraic symbols.

21st Century Themes

www.21stcentruyskills.org

_x__ Global Awareness
_x__Financial, Economic, Business and Entrepreneurial Literacy
_x__Civic Literacy
_x__Health Literacy
_x__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* organizing elements into sets helps to order, arrange and classify the world. *EU 2* the study of logic helps one to communicate effectively, make convincing arguments and develop patterns of reasoning for decision making.	**Essential Questions:** *EU1* ● How can set theory be used to make sense of the world around us? *EU 2* ● How can a consumer determine if a company's conclusions are valid or misleading? ● How is logic used in other fields? Why do we need logic?
Knowledge: *Students will know . . .* *EU 1* ● the various methods and notations used to represent sets of objects. ● the methods used to classify sets based on their size and content. ● Venn diagrams can be used to model set operations, subsets, and to solve application problems.	**Skills:** *Students will be able to . . .* *EU 1* ● list sets in descriptive, roster, and set-builder notation form. ● demonstrate the ability to use symbolic notation associated with set theory. ● perform set operations including the complement, intersection, union, difference, and Cartesian product. ● apply DeMorgan's Law. ● use one-to-one correspondence to determine a set's cardinality.

EU 2 ● simple and compound statements can be logically formed by using symbols and operators. ● truth tables are used to determine whether statements and arguments are valid, invalid or logically equivalent. ● the truth of conditional and biconditional statements is essential to understanding logic and real-life documents.	*EU 2* ● convert statements into symbolic form. ● construct truth tables for compound statements. ● use conditional and bi-conditional statements in truth tables. ● prove that statements are tautologies or self-contradictions. ● solve matrix problems by using logic. ● use truth tables to determine if statements are logically equivalent. ● classify arguments as valid or invalid. ● use logical arguments and Euler Diagrams to solve problems. ● design electrical circuits by using logical operators. ● explain the difference between series and parallel circuits.

Stage 2 – Assessment Evidence

Recommended Performance Task: EU 1

The Secretary of State is randomly selecting two countries of the world from the website: https://www.randomlists.com/random-country. As a future ambassador to those two countries, data must be collected about the similarities and differences between the two countries and the United States. A Venn Diagram will be created to analyze the similarities and differences with respect to geography, weather, religion, customs, and two other variables of your choice. As an ambassador from the United States visiting these countries, you need to be prepared to interact with all citizens. To prove to the Secretary of State that you are ready to travel to the countries you must create an accurate Venn Diagram representing all three countries (United States and the two random countries) and present your findings to the class.

Your Venn Diagram:
Includes the names of the three countries and labeled circles A, B and C.
Correctly compares and contrasts a total of six variables (see above) with respect to those countries
Is neatly organized and colorfully constructed

Your Presentation:
Summarizes your data and Venn Diagram by utilizing set theory vocabulary
Explains what this region represents:

$$A' \cup \left(B' \cup C \right)$$

Includes at least 3 important concepts for a visitor to be aware of when traveling to the other two countries

Is 3-5 minutes in length
Is clearly and professionally delivered

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

Tests, quizzes and activities to include

An Essay about Georg Cantor, the originator of set theory
Posters of Venn diagrams with data collected from in-class surveys
Class data collection and organization involving set operations
SAT problems involving unions and intersections
A Ticket to Leave about DeMorgan's Law
Round Robin cooperative learning activity with one member of the group filling in one column of the truth table, and then passing it to the next person to do the next column, and then continue that process
Paired-Verbal Fluency Summarizer on the relationship between set theory operations and logic operators

Stage 3 – Learning Plan

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

Activity 1: NCTM's Life's a Lottery (T)

- Students will apply Venn Diagrams to data regarding lottery winners
- Students will use Logic and Venn Diagrams to analyze advertising effectiveness
- http://www.nctm.org/Publications/Mathematics-Teacher/2006/Vol100/Issue4/Media-Clips_-Life_s-a-Lottery;-Heartburn/

Activity 2: Logic Matrix Problems (T)

- Students will be differentiated based on varying levels of difficulty and solve matrix logic problems
- Students will utilize logic theory and laws to solve puzzles
- http://www.logic-puzzles.org/init.php

Key Vocabulary Includes:

set
elements
members
well defined
description
braces
roster from
natural numbers
counting numbers
ellipsis
set-builder notation
finite set
infinite set
equal sets
countable sets
cardinal number
equivalent sets
one-to-one correspondence
empty set/null set
aleph-null
universal set
subset
proper subset
Venn Diagram
disjoint
complement
intersection
union
Cartesian product
DeMorgan's laws
cardinal number
Aristotelian logic
symbolic logic
connectives
exclusive or
inclusive or
statement
simple statements
compound statements
negation
quantifiers
conjunction
disjunction
neither-nor
conditional
antecedent
biconditional
truth table
self-contradiction
tautology
implication
logically equivalent
converse
inverse
contrapositive
symbolic argument
premise
conclusion
valid argument
invalid argument (fallacy)
law of contraposition (modus tollens)
distinctive syllogism
syllogistic argument (syllogism)
Euler diagram
series circuit
parallel circuit
equivalent circuits

Approximate Timeline: 20 days

Use set theory vocabulary (A)
Categorize sets using set theory vocabulary (M)
Create and use subsets (M)
Use Venn Diagrams to model and perform operations on sets (M)
Verify the equality of sets (M)
Use and apply DeMorgan's Laws (T)
Solve problems by using set theory (T)
Activity 1: Life's a Lottery (T)
Calculate the cardinality of sets (M)
Set Theory Ambassador Performance Task (T)
Use symbolic form to write statements (A)
Explain truth tables for negation, conjunction, disjunction, conditionals and bi-conditionals (A)
Construct truth tables for compound statements (T)
Prove that statements are tautologies or self-contradictions (T)
Activity 2: Solve logic matrix problems (T)
Use truth tables to determine logical equivalence (T)
Explain laws of logic-detachment, contraposition, syllogism (A)
Explain fallacies of logic-converse, inverse, false chain (A)
Use laws of logic and Euler Diagrams to solve problems (M)
Use logic to design electric circuits (M)