

New Roots Mathematical Reasoning II

10th Grade 1st Trimester Overview

Unit Name:

Creation of Complex Systems

Course Overview:

Mathematical Reasoning II is a three trimester course that explores the history of Mathematics with a focus on Geometry. Mathematics is presented in a context that includes discussion of the environmental, social, political and technological resources, needs and constraints that helped, hindered or caused the development of various mathematical ideas and practices.

Grade:

10

Disciplines:

Mathematics

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Overarching Question:

Who am I? Where have we come from?

Essential Question:

Creation of Complex Systems : Why and how did mathematics begin?

Trimester Summary:

This trimester will explore the emergence of mathematics as a language that has evolved in response to interactions of various natural, economic and social systems and environmental conditions that have changed over time.

In the zeroth unit, students will collectively develop a definition of mathematics, answering questions of who, what, when, where, why and how. Students will try to identify geometric shapes and patterns in the local environment by exploring art, architecture and nature.

The first unit, “Time and Tally,” begins with an exploration of prehistoric peoples need to perform basic counting tasks for trade and tracking of seasons. Students will begin to explore how social, economic and environmental factors created initial conditions that required the use of mathematics and a common language of mathematics by which these ideas could be communicated.

In the second unit, “Taxes and Triangles,” students will come to understand that as social systems became increasingly complex, new social organizational structures developed that necessitated

the development of new mathematical tools in order to precisely measure land, build robust shelters and enduring institutional structures as well as perform computations to inform resource allocation, extract taxes, trade and recreation.

The first trimester ends with the third unit, “Square and Circle,” which explores how refinements in basic mathematical methods allowed for greater trade, growth and mobility and created needs for yet more complex mathematical tools.

Suggested Time Allowance:

One trimester (10 weeks)

State Standards:

- A.A. Variables and Expressions
- A.A. Equations and Inequalities
- A.G. Shapes, Coordinate Geometry
- A.M. Unit of Measurement,
- A.M. Error and Magnitude
- G.G. Geometric Relationships
- G.G. Constructions
- G.G. Coordinate Geometry
- G.PS. Problem Solving
- G.RP. Reasoning and Proof
- G.CM Communication
- G.CN Connections

**Education for Sustainability Core Content Standards and Performance Indicators
(Name of Standard, letter and number of Performance Indicator)**

- C: The Dynamics of System Change C1-C17, C48
- D: Sustainable Economics
- F: Natural Laws and Ecological Principles

Learning Outcomes

• **What are the enduring understandings?**

- Mathematics is a human constructed language, which is changing over time
- The language of Mathematics is a tool, which we can use to understand our world and our place in it.
- As with all tools we need to understand the proper and safe use, storage, and maintenance of mathematics.
- “All models are wrong, some are useful,” [George Edward Pelham Box](#)

• **What will students know?**

- Students will know that math is a language.
- Students will know that various environmental, social and economic forces have historically driven the development of mathematics.
- Students will know that mathematics can be used to describe, discuss, measure, simulate and predict the behavior of systems.

• **What will students be able to do (performance tasks/ evidence)?**

- Students will be able to translate real world problems in to the language of mathematics (A.A.1, A.A.4, A.A.5)
- Student will be able to read mathematical statements and relate them to real world contexts. (A.A.2, A.A.3, A.A.6 - A.A.11)
- Students will develop an understanding of geometric shapes and their measurement (A.G.1 – A.G.2)
- Student will develop an understanding of geometric relationships (G.G.1 – G.G.16)
- Students will learn how to construct various geometric objects (G.G.17-G.G.20)
- Students will learn how to make measurements using appropriate units, solve problems involving conversion between various units and assess measurement error (A.M.1 – A.M.3)
- Students will build knowledge of coordinate geometry (G.G.62 – G.G.74)
- Students will build knowledge through problem solving (G.PS.1)
- Students will learn to define and solve problems that arise in mathematics and other contexts and apply a variety of strategies to solve problems and monitor and reflect on the process of problem solving (G.PS.2-G.PS.10)
- Students will organize and their mathematical thinking through communication and will communicate their thinking and reasoning coherently and clearly with peers, teachers and others (G.CM.1- G.CM.6)
- Students will evaluate and analyze the thinking and strategies of others (G.CM.7-G.CM.9)
- Students will use the language of mathematics to express mathematical ideas precisely (G.CM.10 – G.CM.12)

Learning Opportunities Summary:

Table of Contents:

Unit 0, 1 week: Mathematics - Who, What, When, Where, Why and How Concept Map

- Activity, 1 day: Definitions: Students construct communal definitions for mathematics, algebra and geometry by building concept maps.
- Activity, 2 days: Geometry around the neighborhood: COMAP unit A Guided Tour of Daily Geometry. Students tour the local neighborhood paying particular attention to identifying geometric shapes and patterns. Digital images and sketches are made to record various observations. Using computer software measurements are made of the observed features. When applicable, these images will be used throughout the year to illustrate various geometric properties.
- Activity, 2 days: Geometry in Art: Students visit an art museum looking for geometric shapes and patterns and symmetry (COMAP unit 6657, Symm); tessellations (COMAP unit teach6658, Tessell), weaving, etc . Students explore how various cultures used geometry to define the human form. Using computer software measurements are made of the observed features.
- Activity, 1 days: Students explore the influence of geometry from a variety of cultures: Lusona of Angola (Math Games and Activities from Around the World, C. Zslavskhy); Kolam of India (Mathematics Elsewhere, M. Ascher); COMAP unit 5621 Drawing pictures with one line; Geometry all around us, Designs & Symmetry, Repeating patterns (Math Games and Activities from Around the World, C. Zaslavsky).

Unit 1, 3 weeks: Time and Tally – Prehistoric peoples. Counting, calendars, writing, record keeping

- Activity, I day: History Condensed to a year (COMAP unit HistorN74)

- Activity, 1 day: Sticks and Stones, knots and chords, fingers and toes – Students explore early methods for counting the passage of time and or possessions using simple marks on tally sticks or collections of pebbles and stones. Focus on finger and body counting.
- Activity, 1 day: The first digital computer: A Handy Guide to Simple Computing (COMAP unit 9391)
- Activity, 1 day: The King was in his counting house (COMAP unit 9391)
- Activity, 2 days: Students are presented with the challenge of learning the rules, building a playing surface and finally playing a collection of Mankala like board games that involve transfer of various numbers of playing pieces from one cup to another. (Math Games and Activities from Around the World, C. Zslavskhy and More Math Games and Activities from Around the World, C. Zslavskhy)
- Activity, 3 days: Counting Devices: Inca, Roman, Greek, Chinese – Students are presented with images of a variety of ancient counting devices and asked to speculate about the history and use of each. Students construct counting devices of their own and perform basic computations.
- Activity, 2 days: COMAP unit 5617 : The Abacus: its history and applications
- Activity, 2 days: Indian Rope Tricks: A Number of Knotty Problems (COMAP unit 9391)
- Activity, 1 day: March of Months (COMAP unit 9391)
- Activity, 1 day: Counting the days... A gift from the Gods (COMAP unit 9391)

Unit 2, three weeks: Taxes and Triangles – Ancient Egypt, Babylon, Assyria. Emergence of civilization, earth measurement, scale, architecture, statistics, and taxes.

- Activity, 2 days: Balance and Equality: The emergence of the balance scale. Students will construct a simple balance scale and develop a set of standard weights and measures.
- Activity, 3 days: Measurement of Earth: Students explore maps of the Ithaca area, locate various social, economic and natural systems and make measurements of distance, area and perimeter.
- Activity, 1 day: Learning the Ropes: The Origins of Geometry (COMPAP unit 9391)
- Activity, 2 days: Games and Activities From Around the World: Students explore various three in a row and simple board games from a variety of cultures. Students are challenged to construct their own boards using only compass and straightedge. (Math Games and Activities from Around the World, C. Zaslavsky).
- Activity, 3 days: Ancient Surveying with a Neolithic Toolkit (facweb.cs.depaul.edu/sluecking/pullers1.htm): Using knotted jute chords, poles and heavy stones students will perform basic “measurements of the earth”
- Activity, 3 days: Forest Measurement: Using basic instruments (diameter tape, calipers, Biltmore stick, clinometer) students will measure height, diameter and area of various species of trees.

Unit 3, three weeks: Square and Circle – Mesopotamia. Scales and standard weights, mechanical computation, wheels and pulleys.

- Activity, 3 days: Compass and Straight Edge, Geometric constructions- Students use basic tools of compass and straightedge to create geometric shapes, copy figures exactly and to scale and explore the capabilities and limits of these basic tools.
- Activity, 1 day: Properties of Circles – Students explore properties of circles using software, paper, patty paper and other tools.
- Activity, 1 day: Parallel Lines and Polygons – Students explore properties of parallel lines and polygons using software, paper, patty paper and other tools.
- Activity, 1 day: Properties of Triangles – Students explore properties of triangles using software, paper, patty paper and other tools.

- Activity, 1 day: The Three Tools of Euclidean Construction: Students explore the “impossible” tasks of trisecting the general angle (COMAP unit 99267), duplicating a cube and squaring a circle. (COMAP unit 9391)
- Activity, 1/2 days: Thales Measures the Height of the Great Pyramid: Students will use shadows and properties of similar triangle to measure various neighborhood landmarks.
- Activity, 1/2 days: Eratosthenes measures the size of the Earth – Using scale models, students will recreate the measurement of the size of the earth using the tools available to Eratosthenes.
- Activity, 2 days: Platonic Solids – Students explore properties of platonic using software, paper, patty paper and other tools.
- Activity, 1 day Geometry and Perspective Drawing (COMAP unit ComapPO85) Working with the Art teacher students explore perspective.
- Activity, 2 days: Flatland – Students will read a selection from E. Abbots Flatland and reflect on what it would be like to live in a two dimensional world.

Materials/Resources:

Tools:

- Compass,
- Protractor,
- Ruler,
- Patti Paper (Origami paper)

Software:

- Mathematica,
- GeoGebra
- Geometer’s Sketchpad

Activities

- COMAP modules (www.comap.com)

Books:

- Discovering Geometry, Michael Serra
- The Wonderful World of Mathematics, L. Hogben.
- Mathematics for the Million, L. Hogben.
- Cosmos, Carl Sagan
- Reading The Past: Mathematics and Measurement, O.A.W. Dilke
- A History of Greek Mathematics, Volume I, From Thales to Euclid, Sir T.L. Heath
- A History of Greek Mathematics, Volume II, From Aristarchus to Diophantus, Sir T.L. Heath
- Euclid’s Elements, Sir T.L. Heath
- Flatland, Edwin A. Abbot
- Episodes from the Early History of Mathematics, Asger Aaboe
- Mathematics of the Incas: Code of the Quipu, M. Ascher and R. Ascher
- Code of the Quipu: A Study in Media, Mathematics and Culture, M. Ascher and R. Ashcer
- Mathematics Elsewhere: An Exploration of Ideas Across Cultures, M. Ascher
- The Universal History of Numbers: From Prehistory to the Invention of the Computer, G. Ifrah
- The Universal History of Computing: From the Abacus to the Quantum Computer, G. Ifrah

- From One to Zero, G. Ifrah
- The Secrets of Ancient Geometry and its Use, Vol I, Tons Brunes
- The Secrets of Ancient Geometry and its Use, Vol II, Tons Brunes
- Sacred Geometry, Stephen Skinner
- Math Games & Activities from Around the World, Claudia Zaslavsky
- More Math Games & Activities from Around the World, Claudia Zaslavsky
- Multicultural Mathematics: Interdisciplinary Cooperative Learning Activities, Claudia Zaslavsky
- The Rainbow of Mathematics: A History of the Mathematical Sciences, Ivor Grattan-Guinness
- Barron's Review Course Series, Let's Review: Integrated Algebra
- Barron's Review Course Series, Let's Review: Geometry

Links General Resources:

- [Advice on keeping a laboratory notebook](#)
- [New Roots School Google Mail Page](#)
- [COMAP Mathematics Instructional Resources for Innovative Educators](#)
- [Carl Sagan's Baloney Detection Kit](#)
- [Table of Contents - Math Open Reference](#)

Links Digital Manipulatives:

- [Connected Mathematics Project Resources](#)
- [National Library of Virtual Manipulatives](#)
- [SHODOR Interactivate: Home Page](#)
- [Illuminations: Pieces of Proof](#)
- [Illuminations: Web Links - Geometry](#)
- [Geometric Construction -- from Wolfram MathWorld](#)
- [NCTM Illuminations Welcome to Illuminations](#)
- [The Geometry Junkyard Topics](#)
- [The Geometry Junkyard Software](#)
- [The Geometry Junkyard](#)
- [Platonic Solids, Regular Polyhedron, Polyhedra. Interactive animation ...](#)
- [Polygon Classification, Interactive Mind Map.](#)

Links History of Mathematics:

- [What is Mathematics](#)
- [History of Mathematics: Chronology of Mathematicians](#)
- [History of mathematics - Wikipedia, the free encyclopedia](#)
- [History of geometry - Wikipedia, the free encyclopedia](#)
- [History of elementary algebra - Wikipedia, the free encyclopedia](#)
- [Euclid's Elements, Table of Contents](#)
- [Mathematics Archives - Topics in Mathematics - History of Mathematics Resources for teaching history of mathematics](#)
- [Using history to teach mathematics :](#)

Links Ancient Counting and Computing:

- [Abacus - Wikipedia, the free encyclopedia](#)
- [The Abacus: A Brief History](#)
- [Salimis Tablet; Base 60 Calculator?](#)
- [Stephenson AbacusQuipu - Wikipedia, the free encyclopedia](#)
- [Inca & Related Articles in the News ...](#)

- [Despite the general conviction that the data recorded on QUIPUS](#)
- [Nicolino De Pasquale Home Page Quipus](#)
- [KDBHome Khipu](#)
- [khipus: IAP EECS 6.096 WELCOME khipus khipus khipus : IAP EECS 6.096 ...](#)
- [MIT Khipu Research Group](#)
- [Wired 15.01: Untangling the Mystery of the Inca](#)
- [Not just knots: the secrets of khipu](#)
- [Inca Yupana](#)
- [IncaCalculator](#)

Links Ethnomathematics:

- [A Course in Multicultural Mathematics](#)
- [Native American Geometry](#)
- [Geometry Step by Step from the Land of the Incas, Intro, Cuzco, Machu ...](#)
- [MATHEMATICS OF EGYPT - Mathematicians of the African Diaspora](#)
- [Mathematicians of the African Diaspora presents THE ANCIENTS](#)
- [Geometry and algebra in ancient civilizations](#)
- [Archaeoastronomy](#)
- [Anasazi Calendar " theAbysmal](#)
- [III Lesson Plans: Inca Builders](#)
- [Machu Picchu Science Lessons : Yale Peabody](#)
- [Machu Picchu Social Studies Lessons: Yale Peabody](#)
- [Speechless maths](#)
- [Egyptian Papyri](#)
- [Introducing Geometry with a Neolithic Tool Kit](#)
- [Resources TODOS: Mathematics for All](#)

Links Regents:

- [New York State Regents Exams New York State Library](#)
- [NYSEDBoard of Regents](#)
- [Oswego City School District Regents Exam Prep Center](#)
- [NYSED Regents Exams](#)
- [NYSED Office of State Assessment](#)
- [JMAP HOME - Math Regents Exams Integrated Algebra, Geometry, Trigonometry worksheets answers lesson plans New York Math A B Ste](#)

Links Forest Measurement:

- [.: Farm Forest Line - Tree and forest measurement .:](#)
- [Forest Measurement Guide](#)
- [Project Learning Tree - Curriculum:Exploring Environmental Issues ...](#)
- [Project Learning Tree - Curriculum:Global Connections: Forests of the World](#)
- [Learning Tree Teaching Tools](#)
- [Part Three: Forest Measurements](#)
- [Lesson 4: Forest Measurement 101](#)
- [S&W Report - Biltmore Stick](#)
- [ForestMeasurementTape.pdf](#)
- [RNR: "Forest Measurements" Lesson Plan](#)
- [ncforestry Documents\Camp\Curriculum](#)
- [Forest mensuration By Bertram Husch, Thomas W. Beers, John A. Kershaw](#)

- [Free ebook Tree and Forest Measurement](#)
- [Forestry Suppliers, Inc. 800-647-5368](#)

Links Software:

- [Wolfram MathWorld The Web's Most Extensive Mathematics Resource](#)
- [GeoGebra lessons](#)
- [Cabri: maths software for students. 3D geometry and algebra software ...](#)
- [Home - The Geometer's Sketchpad Resource Center](#)
- [Polya and GeoGebra](#)

Links Problem Sets / Skill Building:

- [Exeter Mathematics 1](#)
- [Exeter Mathematics 2](#)

Links Geometry in Art and Architecture

- [Geometry in Art & Architecture Unit 6](#)
- [Goemetry in Art and Architecture Syllabus](#)
- [Geometry in Art & Architecture Unit 1](#)

Assessments:

Unit 0:

- Students will create a series of concept maps that help to define mathematics, algebra and geometry.
- Students will produce an original work of art that utilizes geometric shapes and patterns
- Students will analyze geometric structure in architecture and art and produce annotated images illustrating the various geometric features.

Unit 1:

- Students will undertake an investigation of various ancient counting devices and build replicas of their own.
- Students will develop a deeper understanding of ancient counting devices by engaging in and developing games based on similar principles and perform basic geometric constructions using compass and straightedge.
- Students will develop an understanding of the relationship between physical and symbolic computation and how the tool of algebra evolved from the need to formalize the notions of equal to, greater than and less than.
- Students will review basic algebra methods and techniques.

Unit 2:

- Students will construct simple balance scales and develop standard units of measure for weight and volume.
- Students will perform basic measurements of satellite images and maps of the Ithaca area and develop understanding of notions of distance, area, perimeter
- Students will perform “earth measurement” using ancient techniques and develop and practical and intuitive understanding of these procedures and the need to creating short cuts to improve these processes.

- Students will use basic tools and simple geometric relationships to measure the heights of landmarks at a distance (trees, buildings, monuments, etc) as well as measure the diameter and area of circular objects (for example trees, telephone poles, lamp posts, etc.)

Unit 3:

- Students will use basic tools (compass and straightedge) and complex tools (geometry software) to explore geometric relationships and geometric constructions.
- Students will construct parallel lines, triangles, polygons and circles of various descriptions and describe their properties.
- Students will recreate historic measurements (ex. Thales, Eratosthenes) and compare their results with various other techniques.

Glossary: