

Teaching Geometry with The Geometer's Sketchpad®

UCB Extension X307.6– Education (2 semester units)

COURSE DESCRIPTION

This is a professional level, moderated, online course in the use of The Geometer's Sketchpad software for teaching mathematics, particularly high school geometry. In addition to instruction in how to use the software, the course will offer participants pedagogical guidance on how to implement the use of Sketchpad™ in their classrooms and promote a discussion of how dynamic geometry affects the teaching and learning of mathematics. The course runs for six weeks with a scheduled start and end date and is structured into six weeklong units. While participants have flexibility within each week, the course is synchronous, meaning that participants are expected to begin and complete the activities for each week during the week they are assigned. This course is primarily intended for teachers.

COURSE OBJECTIVES

After participants complete this course, they will be comfortable using Sketchpad both as an investigation tool and as a demonstration tool. Participants will be able to:

- Construct geometric figures based on their definitions
 - Design multi-step custom tools
 - Apply geometric transformations
 - Understand the relationship between Euclidean construction and proof
 - Graph functions geometrically and algebraically
 - Produce fractals based on geometric iteration
 - Create demonstrations that involve animation and action buttons
 - Appreciate the pedagogical implications of exploring geometry in a dynamic environment
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INTENDED AUDIENCE

This course is intended for secondary and middle school mathematics teachers and instructors of pre-service teachers. Although the course content focuses on high school geometry concepts, any current or prospective teacher can learn how to use Sketchpad to supplement the middle or high school mathematics curriculum.

PREREQUISITES

Participants should be familiar with middle school or high school geometry concepts. They should also be comfortable using computers and must have access to the Internet and The Geometer's Sketchpad software.

METHODS OF INSTRUCTION

Each week follows the same structure in which participants complete these activities:

- Interact with a dynamic sketch that introduces the week’s mathematical focus
- Watch three videos (approximately 5 to 8 minutes long each) – an interview with a Sketchpad developer, an interview with a classroom teacher that uses Sketchpad, and a screen-capture demonstration of Sketchpad features
- Read six PDF’s of student black line masters of Sketchpad activities
- Complete these six activities offline using Sketchpad
- Participate in an asynchronous discussion forum (as well as an optional scheduled chat)
- Complete a project using Sketchpad
- Reflect by responding to specific prompts in an online journal

GRADE BREAKDOWN

In order to receive credit for the course, participants must complete all weekly activities, turn in all six projects, respond to all six journal prompts, and participate in the class discussion forum at least twice each week. Assessment is project-based and all six weeks are weighted equally.

The two units offered for this course are based upon the expectation that each week will require about five hours of work (at least two hours for online activities – visual media, discussion forums, and the journal – and at least three hours for offline Sketchpad activities and the project).

The moderator will evaluate and provide feedback for submitted work and class participation. Grades will be assigned on a standard percent scale based on the following breakdown:

Activity checks	20%
Journal entries	20%
Discussion forums	20%
Weekly projects	40%

REQUIRED TEXTS AND MATERIALS

All written material will be Sketchpad activities provided as PDF’s from these books:

- *The Geometer’s Sketchpad Learning Guide* by Steven Chanan (2001, KCP Technologies)
- *Exploring Geometry with The Geometer’s Sketchpad* by Dan Bennett (2002, Key Curriculum Press)
- *Exploring Algebra with The Geometer’s Sketchpad* by Chanan, Bergofsky, and Bennett (2002, Key Curriculum Press)

Participants are not required to purchase these books or any other materials (other than The Geometer’s Sketchpad software) in order to take this course.

SESSION-BY-SESSION SUMMARY

Week 1: Geometric Constructions

Using Sketchpad's freehand tools and construction commands, participants learn to construct dynamic sketches of common polygons and explore the relationship between their geometric properties and their construction.

Visual Media:

- “Dynamic Quadrilaterals” JavaSketch
- Interview with Nick Jackiw, “Draw vs. Construct”
- Interview with Thelma Bonilla, “First Experiences with Sketchpad”
- Video demonstration with Janet Bowers, “Constructions with Sketchpad”

Activities:

- Tour 1: Constructing a Square
- Tour 2: A Theorem About Quadrilaterals
- Euclid’s Proposition 1
- Daisy Designs
- Properties of Parallel Lines
- Drawing a Box with Two-Point Perspective

Dynamic Quadrilateral Project:

Construct special quadrilaterals based on their definitions.

Journal Prompt:

Participants are asked to reflect on the difference between a static and dynamic midpoint construction and its relationship to constructing equilateral triangles and daisies.

Week 2: Geometric Tools

By focusing on a series of constructions of triangle centers participants learn how to create custom tools in Sketchpad as well as action buttons and animations.

Visual Media:

- “Triangle Centers” JavaSketch
- Interview with Nick Jackiw, “Sketchpad’s Design”
- Interview with Mary Wiltjer, “Student Learning with Sketchpad”
- Video demonstration with Janet Bowers, “Custom Tools”

Activities:

- Tour 3: String Art
- Tour 4: A Bestiary of Quadrilaterals
- Altitudes in a Triangle
- Medians in a Triangle
- Perpendicular Bisectors in a Triangle
- Angle Bisectors in a Triangle

Euler Segment Project:

Use custom tools to investigate the relationships between triangle centers.

Journal Prompt:

Participants are asked to reflect on how Sketchpad’s design make it an effective tool for learning mathematics and how custom tools fit into this design philosophy.

Week 3: Transformational Geometry

By focusing on a variety of activities involving reflections, translations, rotations, and dilations, participants investigate how to use Sketchpad to explore and apply transformational geometry.

Visual Media:

- “Ferris Wheel” JavaSketch
- Interview with Nick Jackiw, “Transformational Symmetry”
- Interview with Karen Wyatt, “Fostering Student Creativity with Projects”
- Video demonstration with Janet Bowers, “Tour 6: Building a Kaleidoscope”

Activities:

- Tour 5: Reflection + Reflection = ?
- Tour 6: Building a Kaleidoscope
- The Burning Tent Problem
- Symmetry in Regular Polygons
- Tessellations That Use Rotations
- Similar Polygons

Ferris Wheel Project:

Create an animation of a Ferris wheel.

Journal Prompt:

Participants are asked to reflect on the relationship between transformational geometry and topics that are traditionally emphasized in high school.

Week 4: Geometric Proof

By focusing on activities that involve polygons and circles that are the givens for formal proofs, participants explore how the dynamic nature of Sketchpad can support and reconceptualize traditional approaches to proof.

Visual Media:

- “Cyclic Quadrilaterals” JavaSketch
- Interview with Nick Jackiw, “Dynamic Geometry”
- Interview with Ralph Pantozzi, “A Metaphor for Thinking”
- Video demonstration with Janet Bowers, “Proof with Sketchpad”

Activities:

- Triangle Congruence
- The Isosceles Right Triangle
- The 30-60 Right Triangle
- Tangents to a Circle
- Tangents Segments
- Arcs and Angles

Properties of a Rhombus Project:

Use converses of rhombus properties to construct quadrilaterals, and then determine the validity of the converses and how the quadrilaterals behavior reveals their construction.

Journal Prompt:

Participants are asked to reflect on the relationship between dynamic geometry and proof and how Sketchpad can help students help develop their ability to construct a proof.

Week 5: Coordinate Geometry

By focusing on a variety of activities from algebra to trigonometry, participants learn how to use Sketchpad's coordinate geometry environment and dynamic function plotting capabilities.

Visual Media:

- “Geometry of a Parabola” JavaSketch
- Interview with Scott Steketee, “Sketchpad’s Supportive Environment”
- Interview with Bill Marthinsen, “A Different Level of Investigation”
- Video demonstration with Janet Bowers, “Dynamic Functions”

Activities:

- Tour 7: Algebra Potpourri
- Slopes of Parallel and Perpendicular Lines
- Trigonometric Ratios
- A Sine Wave Tracer
- Parabolas in Standard Form
- A Rectangle with Maximum Area

Parabola Project:

Construct a parabola based on its geometric definition and relate this to its algebraic representation.

Journal Prompt:

Participants are asked to reflect on the similarities and differences between Sketchpad’s graphing capabilities and that of a graphing calculator, as well as how they handle errors.

Week 6: Dynamic Geometry

Participants focus on the concept of dynamic geometry as a unifying theme of the course and are introduced to the use of iteration in Sketchpad to create fractals.

Visual Media:

- “Fractal Dimensions” JavaSketch
- Interview with Nick Jackiw, “Danny Constructs an Oval”
- Interview with Selim Tezel, “A Tool for Student Inquiry”
- Video demonstration with Janet Bowers, “Iteration”

Activities:

- Tour 8: Constructing a Snowflake—Iteration
- Creating a Hat Curve Fractal
- The Square Root Spiral
- The Golden Rectangle
- Areas of Regular Polygons and Circles
- Proportions with Area

Final Project:

Create a dynamic sketch with animation that can be used as a demonstration in a geometry class.

Journal Prompt:

Participants are asked to reflect on what dynamic geometry means to them and how the dynamic nature of Sketchpad change the way students can learn and understand geometry.
