Using Journals and Portfolios in a Modern Geometry Course

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Modern Geometry at Worcester State University

- Elective junior-to-senior level course
- Main audience: future high school teachers
- Combination of Euclidean and non-Euclidean geometry topics
- Use of programs like The Geometer's Sketchpad, Geometry Explorer, and Geogebra

Structure of the Course

- Daily focus of topics:
    - <u>Euclidean topics</u> include axiomatic systems and models, parallel lines and the fifth postulate, triangles and congruence, polygons, area, isometries, straight-edge-and-compass constructions
    - <u>Non-Euclidean topics</u>: brief glimpse into spherical geometry, introduction to hyperbolic geometry
    - <u>Student-generated notes</u> with definitions and theorems for quick reference and discussion

Structure of the Course

- Presentation of problems by students on the board:
  - Weekly problem assignments from textbook "Geometry with Geometry Explorer" by Michael Hvidsten
  - Random selection of presenters
  - One question from peers allowed
  - Expectation of at least two presentations per week/topic
  - Follow-up questions and overall discussion

Structure of the Course

- Weekly labs:
  - Largely taken from course textbook
  - Use of Geometry Explorer or Geogebra
  - Big written component
  - Coverage of extra topics or new perspectives
  - Multi-step, mini-projects
  - Collaborative and challenging
  - Some topics: Ratio Made of Gold; Euclidean Egg; Origami; Special Points of a Triangle; Circle Inversion and Orthogonality

Journals

- Purely mathematical reflections on a week's work and growth in the course
- Informal writing with minimum three large paragraphs
- Necessary elements:
    - <u>Summary</u> of the main mathematical ideas of the week
    - <u>Discussion</u> of at least one proof or problem approach that made an impression
    - <u>Goals, changes, personal reflections or plans</u> for the next week

Journals Continued

- Evaluation
  - Does a journal meet the three-element structure requirement?
  - Does a journal entry point directly to insights and difficulties?
  - Is there effort to use proper grammatical English?
  - Is it done on time?
- Timely feedback to students essential
- Dialog/venue for having issues addressed

Journal Excerpts

- Summary examples:
  - "...There are similarity theorems for triangles, and conveniently they are similar to those for congruent triangles. SAS and SSS make a return for similarity, as do ASA and AAS under the guise of AAA."
  - "... I also learned about Playfair's Postulate this week, which implies Euclid's Fifth Postulate, which in turn implies Playfair's Postulate. Playfair's Postulate deals with the existence of unique parallel lines while Euclid's Fifth Postulate is an anti-parallel postulate."

Journal Excerpts Continued

- Discussion Examples:
  - "… The models of hyperbolic geometry are not terribly counterintuitive, despite the strangeness of hyperbolic geometry that arises from our Euclidean world view. The distance functions are peculiar, but at least we can verify they satisfy the properties of distance functions."

  - ".. To prove Exercise 2.1.2 I needed to use the Exterior Angle Theorem. My initial gut reaction was to use the fact that the measures of the interior angles of any triangle always sum up to 180 degrees, but this fact is not allowed since it is derived from Euclid's Fifth Postulate."

Journal Excerpts Continued

- Goals, changes, personal perspective excerpts:
  - "… The part of the project that I liked the most was the way that the Golden Ratio can be represented both algebraically and geometrically. The connection between these two mathematical fields is one of my favorite things."
  - "… It was not until I created my own labels and redid the construction that I truly saw the consequences of the ASA theorem. I used it to develop my own congruent sub-triangles and to complete the lab. Yay!"

Journals from a Student Perspective

- Provided opportunities to review geometric content
- Enhanced the ability to make connections across topics and problems
- Developed the understanding of difficult concept by having to explain them
- Served as a direct and private communication channel between student and instructor

Journals from an Instructor's Perspective

- Gave almost immediate feedback into students' understanding and general attitude towards the material

- Provided opportunities for private dialog: suggestions, encouragement, and sometimes reproach

- Served as a vehicle for change or evidence things went well in the classroom

Course Structure Revisited

- Exams:
  - Two semester exams
  - Final cumulative exam
  - Choices of results and problems
- Examples of some final exam questions:
  - Define a glide reflection and state one major result (theorem, lemma, or exercise) about glide reflections. Prove your result.
  - Explain the major differences between the Poincare and the Klein models of hyperbolic geometry.

Course Structure Revisited Again

- Final Project:
  - Topic not covered in class
  - Collaborative or individual
  - Presented in front of the class
  - Evaluated by both classmates and instructor
- Examples of Project Topics:
  - Turtle Geometry
  - Semi-regular Tessellations of the Euclidean Plane
  - Frieze Groups
  - Introduction to Fractal Geometry

Portfolios in Modern Geometry

- Final product of each student's "best work" in the course
- Portfolios include:
    - Select Journals
    - All Homework Problems Solutions
    - Project Presentation
    - Select Labs
    - Optionally, exam(s)

Portfolios in Modern Geometry Continued

- Collected at final exam
- Count for 30% of each grade
- Give a balanced view of each student's strengths and accomplishments
- Evaluated on the basis of organization and content
- Very worthwhile in small upper-level mathematics major courses