Using Fairness as a Theme in General Education Mathematics Courses

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Quantitative Literacy (QL)

- "...an ability to choose and apply mathematical concepts in specific life and work situations that involve quantitative information" (Sikorskii, Melfi, Gilliland, Kaplan, & Ahn, 2011)

Teaching Mathematics for Social Justice (TMfSJ)

- **Students:** "...learners make sense of data in ways that help them see the humanity behind the numbers and to use mathematics as a tool for exposing and analyzing injustices in society..." (Gutiérrez, 2013)

- **Instructors:** "...what are the ethical and moral obligations of...teachers in using injustices as a catalyst for mathematics teaching and learning? Does such an ethical and moral imperative exist?" (Stinson, 2014)

Ethical Teaching:

- Teach the students we have in the communities in which we live.
- Give students a voice so they can take charge of their learning. (Active learning.)
- Prepare our students for the future. (Content is just a vehicle for learning.)

Teaching Ethics:

- Get students to grapple with the messiness of the real world and think about social and political issues.
- Show students that math can be used to make decisions. Include ethical considerations.
- Have students explore their thinking about what "fairness" means in various scenarios.

Main Themes:

- The world is becoming more quantitative
- Mathematics exists in a sociopolitical context
- Mathematics can be used subjectively (so ethics really matters)
- Students should leave college as informed citizens

Setting: General Education Math Courses

- "When is this actually used?"
- Reduce math anxiety and shift disposition towards the subject
- *Last formal mathematics course!*

Math 1030Q: Elementary Discrete Mathematics (UConn)

- General education course satisfying QL requirement
- Akin to "Great Ideas in Mathematics"
- Spring 2018 semester, 85 students, 3 sections, met 3×50 minutes per week, wide range of class years and majors

Motivation

- Supreme Court cases
- 2020 U.S. Census and the following redistricting cycle
- Metric Geometry and Gerrymandering Group (MGGG)
- Natural fit after existing units on voting theory (1.5 weeks) and fair division theory (1.5 weeks)

The Project

- Approximately 4-5 weeks
- Groups of 2-5 students (most groups of size 3 or 4)
- Project had three main parts, each with a group portion and an individual portion
- Project introduced gradually (increasing mathematical content and sociopolitical content)

Sources of Sociopolitical Content

1. Blog post "Privilege and Oppression in Math Ed"

   http://feltonkoestler.wixsite.com/realworldmath/single-post/2017/10/25/

   Privilege-and-Oppression-in-Math-Ed

2. YouTube video on racial and partisan gerrymandering

   https://www.vox.com/videos/2017/7/24/16012440/

   racial-partisan-gerrymandering-redistricting-supreme-court-video

3. ACLU document on the Voting Rights Act

   https://www.aclu.org/sites/default/files/field_document/2010_REDISTRICTING_GUIDE_web_0.pdf

4. *Chronicle* article on Moon Duchin's work with the MGGG

   https://www.chronicle.com/article/Meet-the-Math-Professor/239260

5. FiveThirtyEight article "The Supreme Court is Allergic to Math"

   https://fivethirtyeight.com/features/the-supreme-court-is-allergic-to-math/

Sources of Mathematical Content

1. Simplified grid models for redistricting

2. Exploration of various CT redistrictings using CT map, CT population data, and FiveThirtyEight website

   https://projects.fivethirtyeight.com/redistricting-maps/connecticut/

3. Efficiency gap computations

   https:

   //www.brennancenter.org/sites/default/files/legal-work/How_the_Efficiency_Gap_Standard_Works.pdf

A Simple Grid Example

Task: Create a map containing 5 districts with 10 voters each that is
(a) gerrymandered for Stars (29 on grid)
(b) gerrymandered for Diamonds (21 on grid)
(c) redistricted to be the "most fair" (according to you and/or your group)

RQ1 - **How does students' understanding of "fairness" evolve throughout the course of this project?**

- Simple grid examples (group, individual)
- Eight redistricting options for Connecticut (group)
- Compact redistricting option (individual)
- Efficiency gap formula (group)
- Final definition of fairness and its evolution (individual)

RQ2 - What benefits or challenges (cognitive and/or affective) do students report upon completing this project?

RQ3 - What benefits or challenges do instructors report upon designing and implementing this project?

## Math 114: Judgment and Decision Making (F18, S19, F19)

- Course units on voting theory, apportionment theory, redistricting/gerrymandering, and game theory
- Group project on redistricting/gerrymandering

Changes:

- **Treat redistricting/gerrymandering like any other course unit**
- **Replace FiveThirtyEight redistrictings with "Dave's Redistricting App 2020"** (https://davesredistricting.org/unauth/login.html)
    - Increase authenticity
    - Move students from consumers to producers
- Increase mathematical rigor (weighted grids, compactness tests)
- Add more writing assignments (e.g. prison gerrymandering)

Group Project (S18 Version)

- Serve as a Redistricting Commission for any state.
- Create a map using Dave's Redistricting App 2020. Satisfy various redistricting conditions. Abide by the Voting Rights Act.

(Current Map)
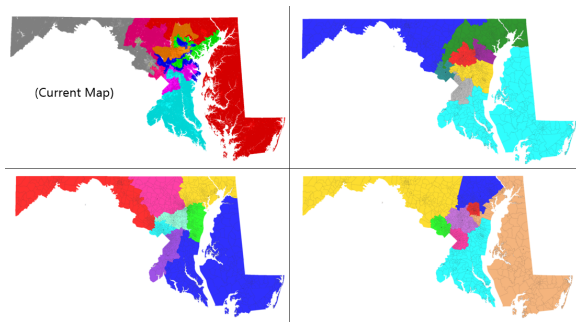
- Write a Proposal Report. Include calculations (and their context), the state's redistricting process, court cases, sociopolitical issues, etc.

5-Week May Term Course (Hopefully May 2020):

- 1 week on voting theory, 1 week on fair division theory, 3-4 weeks on redistricting, all working towards a final gerrymandering project
- **Guest lectures** from professors in math, political science, and criminal justice/legal studies
- **Use "The Redistricting Game"** (http://www.redistrictinggame.org/) and "Dave's Redistricting App 2020".
- **Focus on explicit categories of**
  (a) **math (quantitative/geometric information),**
  (b) **political/partisan contexts, and**
  (c) **racial/social justice contexts.**

  Have students reflect on interconnections among parts (a), (b), and (c) and incorporate ethical considerations.

1. Collect data from courses at Trinity and Elmira.

2. Continue to assess the student/instructor experience and improve the redistricting/gerrymandering unit.

3. Account for new redistricting commissions and Supreme Court rulings.

4. **Kyle F19:** New cross-listed course titled "Mathematics and Redistricting" with CT House Dems as community partner.

5. **Adam S20:** Team teach? Explore local county redistricting? Connect to required student community service?

- Many general education courses are either "great ideas in math" or "math in the modern world" topics courses. A "math, politics, and social justice" or "math of decision making" course can have a more unifying theme and incorporate both course flavors.

- Such a course can show students that mathematics is inseparable from sociopolitical contexts.

- Such a course can show students that mathematics is a powerful tool that can be used subjectively to make important decisions and create change. Ethical considerations really matter! Math can be a tool for activism!

- Such a course can explicitly address a college's mission of creating informed and engaged citizens (especially with community partnerships, service learning, etc.).

Thank You!

Questions?

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Selected References:

(1) Gutiérrez, R. (2013). The Sociopolitical Turn in Mathematics Education. *Journal for Research in Mathematics Education*, 44 (1), 37–68.

(2) Sikorskii, A., Melfi, V., Gilliland, D., Kaplan, J., & Ahn, S. (2011). Quantitative literacy at Michigan State University, 1: Development and initial evaluation of the assessment. *Numeracy*, 4 (2), 5.

(3) Stinson, D. W. (2014). Teaching mathematics for social justice: An ethical and moral imperative? *Journal of Urban Mathematics Education*, 7 (2), 1–5.