



PROJECT-BASED LEARNING

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MY BACKGROUND

- **Mathematician**
- **Undergraduate Institution:**
Harvey Mudd College
 - Inquiry-based Learning (Moore method)
 - Essay about a mathematician
 - Senior group project / Senior thesis
- **Teaching Experience:**
 - Binghamton University ('05 – '08)
 - Queens College ('08 – '23)

TYPES OF PROJECTS

Module:

Math 142: Integral Calculus – 3D Printing Module

Math 634: Graph Theory – Research a Mathematician / Mathematical Topic
(Essay / Edit Wikipedia)

Research project:

Math 636: Combinatorics – Research a Counting Question
(Paper, Poster & Podcast)

Fully Project-Based Course:

Math 245: Mathematical Modeling – Group Projects

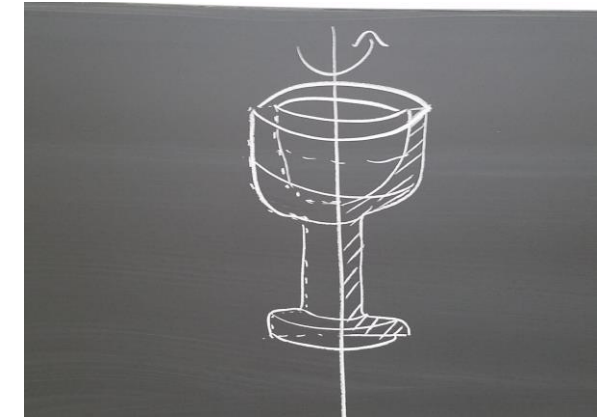
Math 250: Mathematical Computing – Individual Projects

Math 128: Mathematical Design – Individual Projects and Portfolio



THE GOBLET PROJECT (MODULE)

- Use **Calculus** to design a shape that can hold a specified amount of liquid.
- Use **Mathematica** to create a 3D model.
- Use a **3D Printer** to print student goblets.



<https://qcpages.qc.cuny.edu/~chanusa/courses/142/17/project.html>

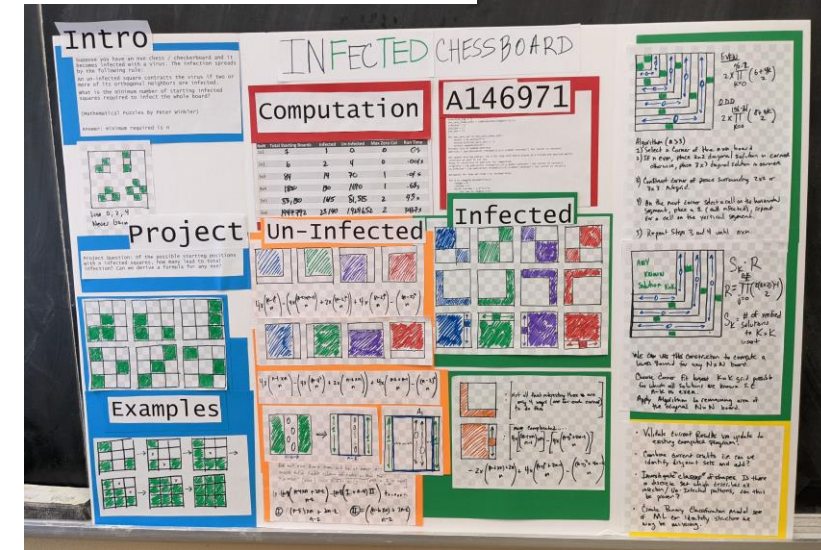
<https://ultimaker.com/learn/integrating-3d-printing-and-the-goblet-project/>

COMBINATORICS (TERM PROJECT)

Ask and answer a counting question.

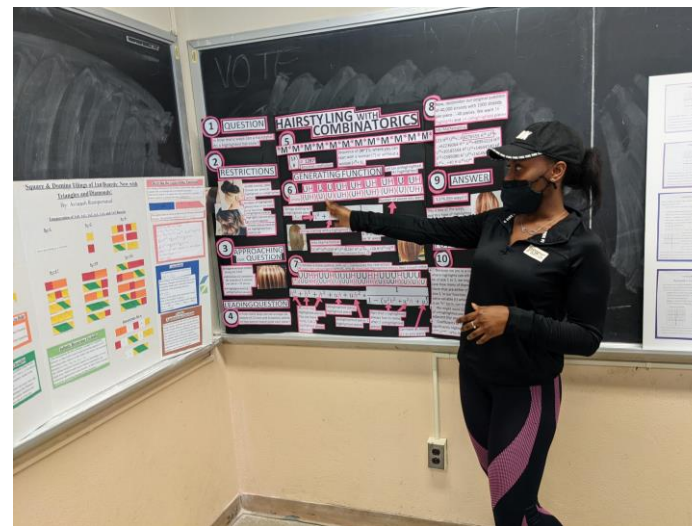
Goal: Apply techniques from the semester.

- Propose a question half-way point of semester
- I help hone the question
- They complete the research outside class.



Deliverables:

- Poster
- Presentation
- Write-up
- (Podcast)



MATHEMATICAL MODELING (FULLY PROJECT-BASED)

Use mathematics to understand the real world.

In its most recent incarnation, **Students Learn:**

* The modeling process * Python * Data Viz * (Simple) mathematics

Students **Show Their Comprehension** through three projects:

- Bikeshare model (*learn to debug code, write their reasoning*)
- Population Growth model (*Real world data, model, basic poster, present*)
- Disease Spread model (*develop own model, write well, present to class*)
- (*Increase expectations steadily.*)

These are **Group projects**

- Two or three (no more!)
- Group partners reinforce math and coding skills.



MATHEMATICAL DESIGN (FULLY PROJECT-BASED)

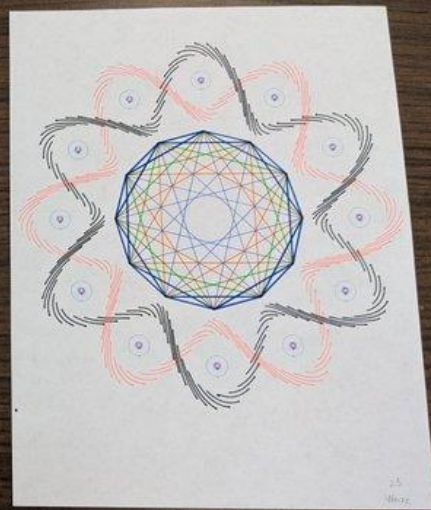
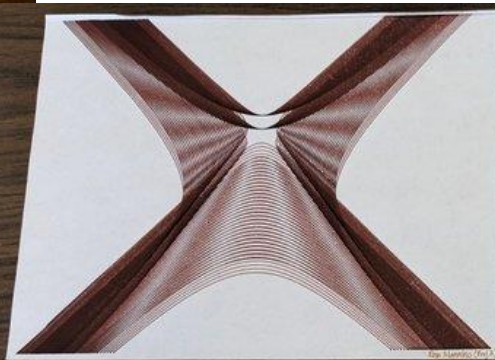
Use making & design thinking to explore the beauty of math

Learning objectives:

- **Desmos:** Multiple types of functions * Transformations * Algor. techniques
- **Process:** Software / Hardware Interface *
- **Intentionality:** Principles of Art and Design * Prototyping / Refining

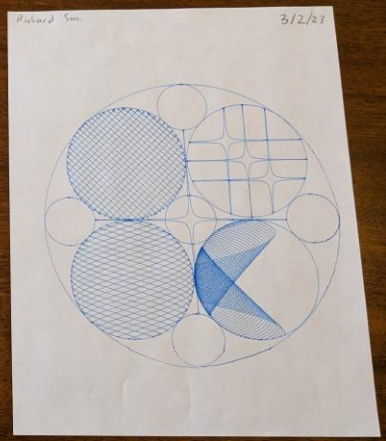
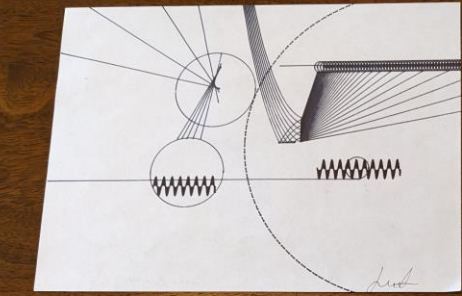
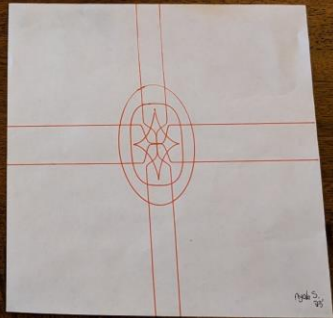
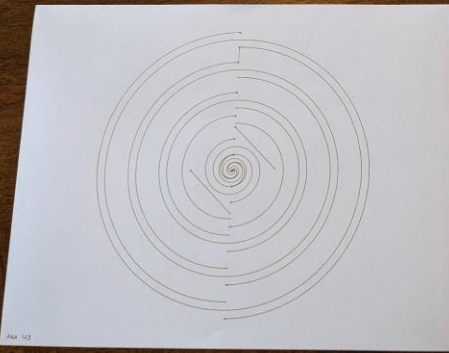
Students grow their **mathematical, making, and artistic skills over time:**

1. Use AxiDraw to create sketch with transformations.
2. Push AxiDraw further – higher math, more advanced materials
3. Broaden possibilities using other machines.
4. Encourage **Individual** projects with a supportive **Group** environment.



Burning sun
Richard Sun
Date: 3/12/23

Lighthouse
Elena Leung
Date: 3/12/23



June 13, 2023

WHAT I LOVE ABOUT PROJECTS

For the Students

- Active Learning
- APPLY the content
- Authentic selves;
Harness the diversity!
- Accessible for students at
ALL LEVELS of understanding.

For the Instructor

- Non-content-based
Learning Objectives
- A chance for me to learn:
 - Students approach things differently than I would.
 - Each class is different.
 - I get to learn new skills.
- Continual improvement



INTERMISSION

¿ Questions ?

GRADING

A QUICK DETOUR: ALTERNATIVE GRADING

Classic Math Class:

- Material to cover
- Use the lecture format
- Give midterms
- Partial credit 5 pts? 7 pts?
- Use scores to determine grade
- Final grade is weighted average

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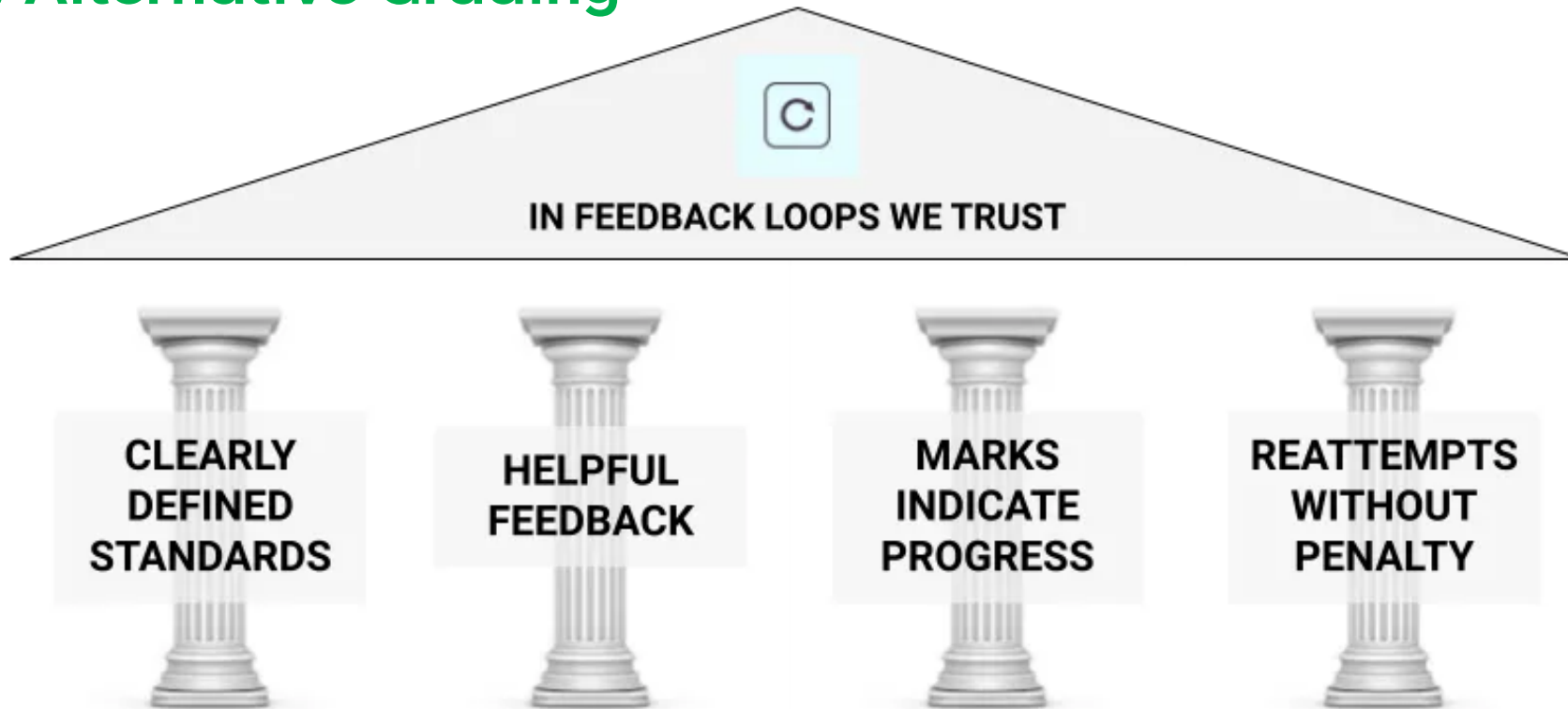
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My Issues:

- Exams are High Stakes
- Focus is on the **grade**, not **learning**
- Grades don't align with mastery
- Exams gauge understanding at a fixed point in time
- **Opaqueness** of the system

A QUICK DETOUR: ALTERNATIVE GRADING

Instead: Alternative Grading



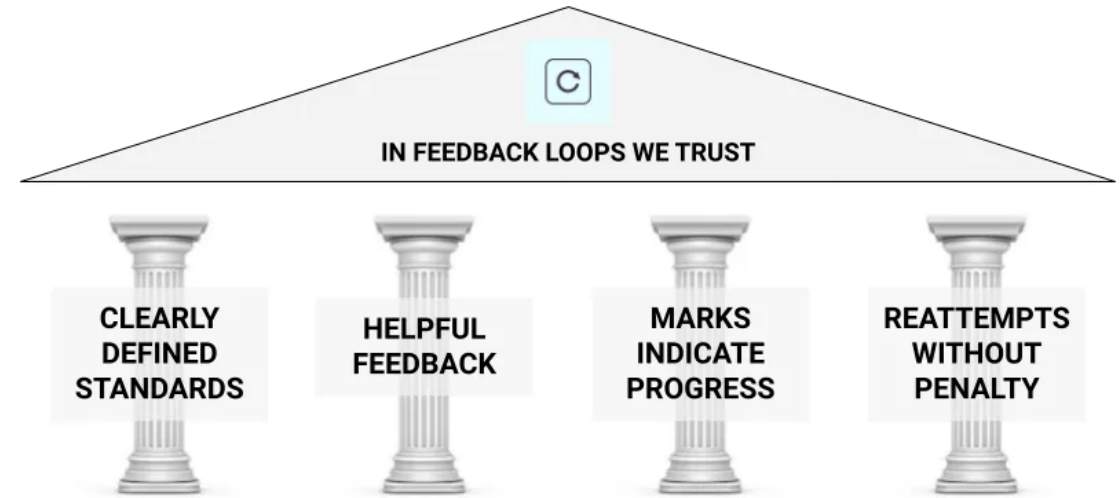
Robert Talbert

<https://gradingforgrowth.com/p/finding-common-ground-with-grading>

A QUICK DETOUR: ALTERNATIVE GRADING

I use Standards-Based Grading:

- **Transparent** list of standards
- More frequent assessments
- Standards scored for mastery
 - Exemplary, Meets Exp., Reassess, Not Assessable
- **Reassessments** available
- **Grade based on mastery**
 - A: 90% Exemplary; all M+
 - B: 80% Exemplary; all M+
 - C: 80% Meets Expectations
 - F: <70% Meets Expectations



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What I love about this:

- Focus is on the **learning**.
- **Growth mindset** – “How do I improve?”
- Non-content-based learning objectives
- Partners instead of Adversaries
- Assessments less stressful
- Where are you at the **end** of term?
- **Higher Expectations** for Students

GRADING PROJECTS

Convey Expectations through List of Standards

Engagement:

- Steady progress; attend class; turn in on time

Intentionality:

- Deliberate creation; matches artistic terms; honed over time

Desmos Notebook Content:

- Use techniques from class? Apply the mathematics we learned?

Desmos Notebook Style:

- Organization & Documentation of File

Process Discussion:

- How did your piece come to be / evolve? What hurdles or successes were there?

Technical Discussion:

- Explain the math, programming you used in technical language

Artistic Discussion:

- Explain the artistic qualities you aimed for in technical language

Writing style and format:

- Use good English, writing flows well, Correct Formatting

ERECT SCAFFOLDING

Provide a transparent timeline.

- **Gain Expertise** by Thursday, February 9.
- **Explore Possibilities** by Thursday, February 16.
- **Peer Review** on Tuesday, February 28.
- **Submit Final Project** on Thursday, March 2.

Give (prompt) **Detailed Feedback**

- Score each standard on an EMRN Scale;
- Grade corresponds to number of each scores

Give an **Opportunity to Revise** to improve scores.

THINGS TO KNOW

- **Build Scaffolding;** Check in frequently
- **In-class work time**
- **Peer Review:** (Gives early deadline; students think about what works and what doesn't)
- **Can be messy** – be flexible (rules; students' lives)
- Bi-modal grade distributions
- I don't know everything.
- Not everything that works for me will work for you.
- It won't be perfect the first time and **that's OK.**

THANK YOU!

Website: qc.edu/~chanusa

- > Courses > Course Archive
- > Research > Talks

**syllabi
slides**



Email: chanusa@qc.cuny.edu

Alternative Grading Community + Slack Channel:
thegradingconference.com/resources/

Grading for Growth: Robert Talbert and David Clark