Supporting unconfident proof writers in IBL Euclidean Geometry

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David Clark
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Context: GVSU

- Large regionally comprehensive state university (~25000 students)
- 300 math majors (~200 pre-service teachers)
- ~210 math minors

Context: MTH 331: Euclidean Geometry

- REQUIRED! For pre-service teaching math majors & minors
- Novice proof-writers: Often first class taken after intro-to-proofs
- Students view proofs as artificial or arbitrary
- Lack confidence in their own mathematical abilities

IBL Structure

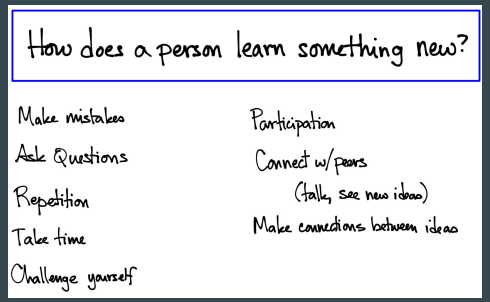
Goals: Experience authentic proof discovery and writing
Move away from "one right answer"
Build confidence in mathematical abilities

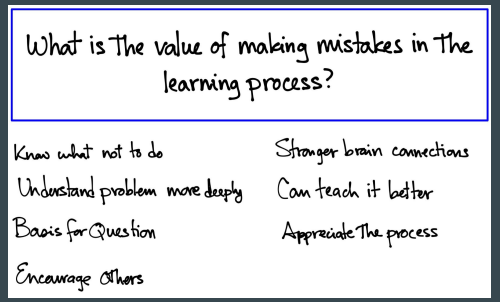
Books: David Clark's *Euclidean Geometry: A Guided Inquiry Approach*
Burger & Starbird's *5 Elements of Effective Thinking*

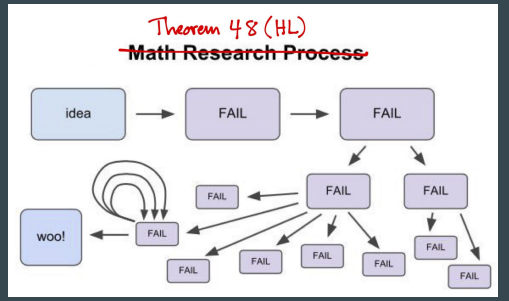
Organization: Daily Prep → Presentations → Homework

Support: Collaboration & Productive Failure

- “Setting the Stage” (Dana Ernst) + **revisit frequently**







- Set presentation tone early: Friendly but convincing
- See multiple approaches, describe failed attempts (and build on them)
- Collaboration everywhere: Prep, discussions, group work at boards, homework
- “5 Elements” readings + “My favorite mistake” reflections

Support: Mastery Exams

- 2-3 midterms, 1 final
- No points!
- Each problem covers one or more **learning objectives:**

  “I can precisely describe isometries to show that two figures are congruent”
  “I can identify, critique, and correct common errors in proofs”

- Graded for mastery on each objective (mastered/not yet)
- Not yet? → Try again on next exam with no penalty
- Exam grade = % of learning objectives *eventually* mastered

Support: Grade Discussions

- Individual grade discussion meetings (Clark Wells)
- Twice per semester, 10 minutes
- Come prepared to discuss specific grade-related prompts, estimate own grade (with my guidance)


David Clark

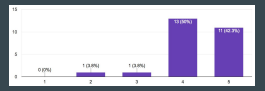

Clark Wells

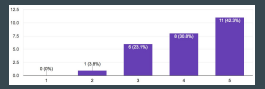
“I felt like he allowed us to fully understand what our grade was representing and gave us the opportunity to discuss the grade we thought we deserved!! (SO COOL)”

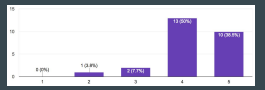
End-of-semester reflections

1 = decreased a lot, 5 = increased a lot, *n* = 26

Confidence in solving difficult mathematical problems	4.3
Confidence in writing proofs	4.1
Confidence in understanding the mathematical work of others	4.2
Ability to learn from mistakes when solving a problem	4.3







"I have learned that making mistakes and discussing those mistakes with other peers helps me understand how to solve the problem better/correctly."

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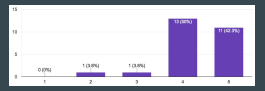

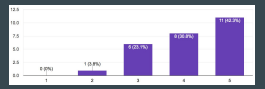

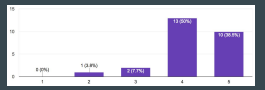

“Everyone has something to offer, whether it be new ideas, comments on existing ones, or help! I liked the collaborative atmosphere.”

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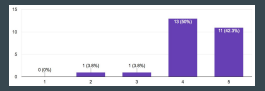

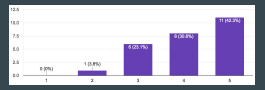

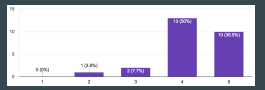

“I feel more confident in this class ... I think that's because we were able to hear how other students did the problems and compare that to our own work ... I definitely view math as more of a collaborative subject now rather than a mostly independent one.”

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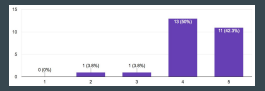

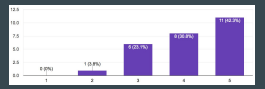

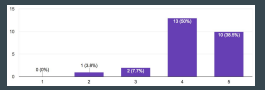

“It involves a lot of mistakes.”

Successes! Students...

- ... develop understanding of value of proofs, axioms, definitions, etc.
- ... become *much* more confident in mathematical abilities (rightfully!)
- ... move from “one right way” to “many possibilities”

My (productive) failures

- I need to sit on my hands and shut up...
- ... but, I should summarize complicated discussions carefully

Inquiries?

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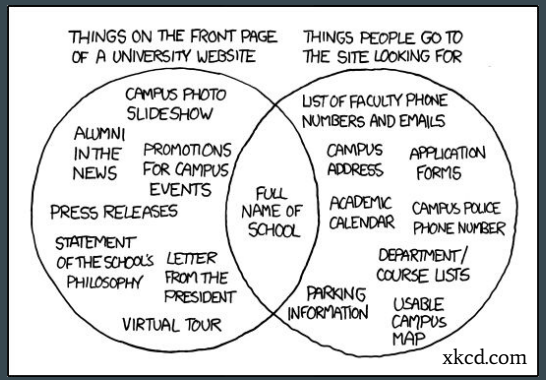
Happy Venn day!



(John Venn born August 4, 1834)