CENTER FOR SCIENCE & MATHEMATICS EDUCATION

MANAGING COLLEGE GROUP WORK & CREATING GROUPWORTHY TASKS

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MY BACKGROUND

- Teaching college math since 1989, tenure track since 2001
- Work with ES, MS, HS, 2YC, Univ instructors, pre-service and in-service
- 1993-95. Treisman PDP Workshops

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MATH TEACHER FOLK BELIEFS

MATH TEACHER FOLK BELIEFS 1

I AM THE TEACHER BECAUSE I CAN DO MATH MORE QUICKLY, CORRECTLY AND PRECISELY THAN YOU.

- responsible for creating a learning environment, not defeating students in math showdowns
- very threatening to make mistakes or not know (confirm imposter syndrome)
- incentive to reduce risk, display superiority

MATH TEACHER FOLK BELIEFS 2

MATH IS A LADDER. TEACHING MEANS GETTING STUDENTS "BEYOND" MATERIAL.

- We hate spiraling back and reviewing
- Cultural teacher norm to complain: "*Can you believe students can't do X?*"
- Hard to conceive of college level algebra
  - by definition, it's stuff you "got past" in high school

MATH TEACHER FOLK BELIEFS 2 CTD

MATH IS A LADDER. TEACHING MEANS GETTING STUDENTS "BEYOND" MATERIAL.

- Contrast: English Composition
- Get past essays? Sentences?
- Bigger words, write faster under pressure?

- Want complex, creative argument
- fluent metaphors & representations
- beyond rote recipes (5 para)
- address novel situations
- understand/convince arguments of others

MATH TEACHER FOLK BELIEFS 3

SLOW STUDENTS JUST AREN'T "MATH PEOPLE" OR ARE "LAZY". FAILING A LOT OF STUDENTS MEANS I HAVE "HIGH STANDARDS".

- Fixed / growth mindset
- Self-control is fragile
- Double Marshmallow Test, bad crayons/stickers, 4x wait
  - Suspicion breeds suspicion. It's a trap!
  - https://doi.org/10.1016/j.cognition.2012.08.004
- Belonging - 30% drop in IQ w "alone" prediction

MATH TEACHER FOLK BELIEFS 4

REAL MATH IS INCOMPREHENSIBLE.

- **Research Talks culturally required to baffle.**
  - Talks must lose people in 10:00, 30:00 max.
  - Else, your work is trivial and you are dumb.
    - (Also have to lose people or they might find a mistake.)
  - Baffling = hard math, not horrible communication
- Many of us survived courses where 50+% failed
  - High standards! Proud & survivor remorse.
- In this culture, grad students learn to teach.

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MY METHOD OF GROUP WORK

CLASS OVERVIEW

- Minor setup or debrief or review of last class
- Team problem solving on large surfaces
- Whole class discussions at checkpoints
- More group work / whole class cycles
  - Group work: brain exercise, reorganizing, curiosity, inventing, idea play, prep to understand checkpoint
  - Whole class checkpoints (including wrap up) for closure, academic language, consolidation, status
- Online HW, computer graded, symbolic aerobics.
- (once) flipped class videos - no one watched

LARGE SURFACES

- The groups work at large surfaces.
- Bring breath mints, friendly way to circulate
- Blackboards/Whiteboards
  - When wall space is available, I use static paper which turns walls into whiteboard space.
- Lacking wall space, you can use easels or small whiteboards.

NORMS AND FRAMING

- Tend to model through enforcement rather than have an explicit covenant.
  - Equity of voice
  - Be present
  - Criticize ideas not people
    - Groups leave no one behind, no solo questions
- *"If you solve my task right away, I gave you the wrong task."*
- *"Working out your brain muscles requires resistance. I'm your personal trainer."*
  - I’m not the border patrol trying to catch them.

GROUPING STUDENTS

- Some approaches by others:
- Set roles, like in Complex Instruction.
  - Organizer, reporter, questioner, resource monitor
- Heterogenous or homogeneous “ability” grouping
- My approach
  - Alternate between openly random groups (no more than 4) and letting them pick.
  - I don't do any "ability" based algorithms, on purpose.
    - Student speed depends on the task.
    - Also, toxic to guess you're in the "low" category

SOME OPENLY RANDOMIZING METHODS

- count off modularly to N
- count off by compass direction
- count off and divide by N and find your remainder (hard)
- group by last name, by birth month
- hand out cards when they arrive
- find at least one person you haven't worked with

MANAGING GROUPS OVERVIEW

- Three parallel managements
  - Class progress triage
  - Group equity and integrity
  - Group's task progress

CLASS PROGRESS TRIAGE 1

- Give tasks on worksheets (can pace selves)
  - Sometimes give quiet time to begin on own.
- Send groups to large work surfaces. Scan the room. Listen.
- Classify groups into Done, In Progress, Stuck
  - (Later, different recipes for each)
- Circulate quickly and probe. 1-2 min per group.
  - *"I'll be back in 2 minutes."*

GROUP EQUITY & INTEGRITY 1

- Leave no one behind. No free-riding on dominants.
  - *"Is this everyone's answer? So everyone can explain this?"*
  - Ask a random person to respond, Fickle Pen of Fate
  - Ask a random to continue
  - *"I want you to come to an agreement."*
- No solo questions
  - *"Did you discuss this together?"*
  - *"Is this a group question?" ("Hey, X has a good question I'd like you all to focus on.")*
- *"Let's talk after class."*

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VIDEO EXAMPLE

DAY 1 TASK: FLAG HOIST

TASK 1: FLAG HOIST


Linda Lam
George Bauer
Evelyn Prasad

GROUP EQUITY & INTEGRITY 2

- Spread status, appreciate different strengths
  - Symbolic speed, but also…
  - Graphic skill, synthesizing ideas, facilitating a group, thinking out of the box, communicating well, bravely asking the "stupid" question.
- Don't steal their thunder.
- Why help other students?
  - Employers say *"Students are smart. Can you explain? Can you work with people?"*
  - *"I understood math a lot better once I starting teaching it."*

GROUP PROGRESS: STUCK AND IN-PROGRESS

- Stuck, In Progress, Done.
- *"What have you tried?"*
  - If multiple efforts, try to get group entirely behind a productive one.
  - If promising work, tell them to keep trying that.
  - If lost, encourage. Give a sub-problem or instructive simple example to work out.
  - Last resort, give a direct hint on an approach.
- In-Progress = Stuck, but optimistic and want less help.
  - Same treatment, get them on productive path.

GROUP PROGRESS: DONE

- *"Is this a group answer?"*
- Make sure everyone can explain it. Fickle Pen of Fate. Rotate to continue the answer.
- If multiple answers or group troubles, *"Please get on same page."* Treat as In Progress.
- If wrong answer, *"Isn't it strange that…?"* An absurd consequence of the wrongness. Now In Progress.
- Probe beyond "right". Check that they understand their answer with a followup Q (if time)
- *"Take a minute to pat yourselves on the back." "Do you want a bonus task?" "What would be a good task for you?" Then extension or next task.*

WHOLE CLASS CHECKPOINTS 1

- If <u>most</u> of class is stuck, whole class discussion.
  - *"Let's check in about Problem 2."*
  - (for common pitfalls) *"Why do groups have different answers for part (a)? Who is right?"*
  - *"Look around the boards to see people's graphs."*
  - *"What are approaches we know to find X?"*
  - *"What have people tried?"*
  - *"Can a group that made progress please give a hint?"*

WHOLE CLASS CHECKPOINTS 2

- When most of the class has made enough progress to benefit from a discussion
  - Lock in academic language, a standard approach, or a definition
  - Harmonize multiple approaches and representations
  - Harmonize answers with different conclusions or generality
    - Give status to crazy, creative answers
- *“I’ll wait for four brave volunteers to report.”*
- Volunteer groups if you’re going to give them high status. (Sometimes interesting wrong answers.)
  - Thumb polls & questions. "*How many of you follow this?*"

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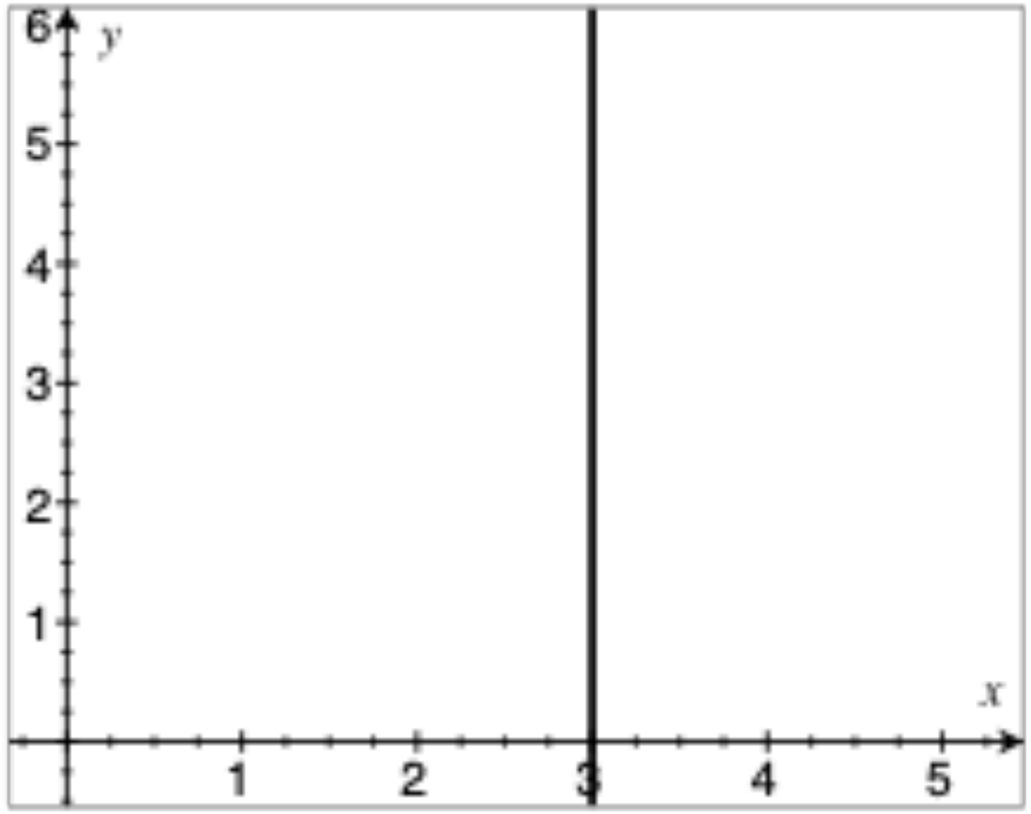
VIDEO EXAMPLE

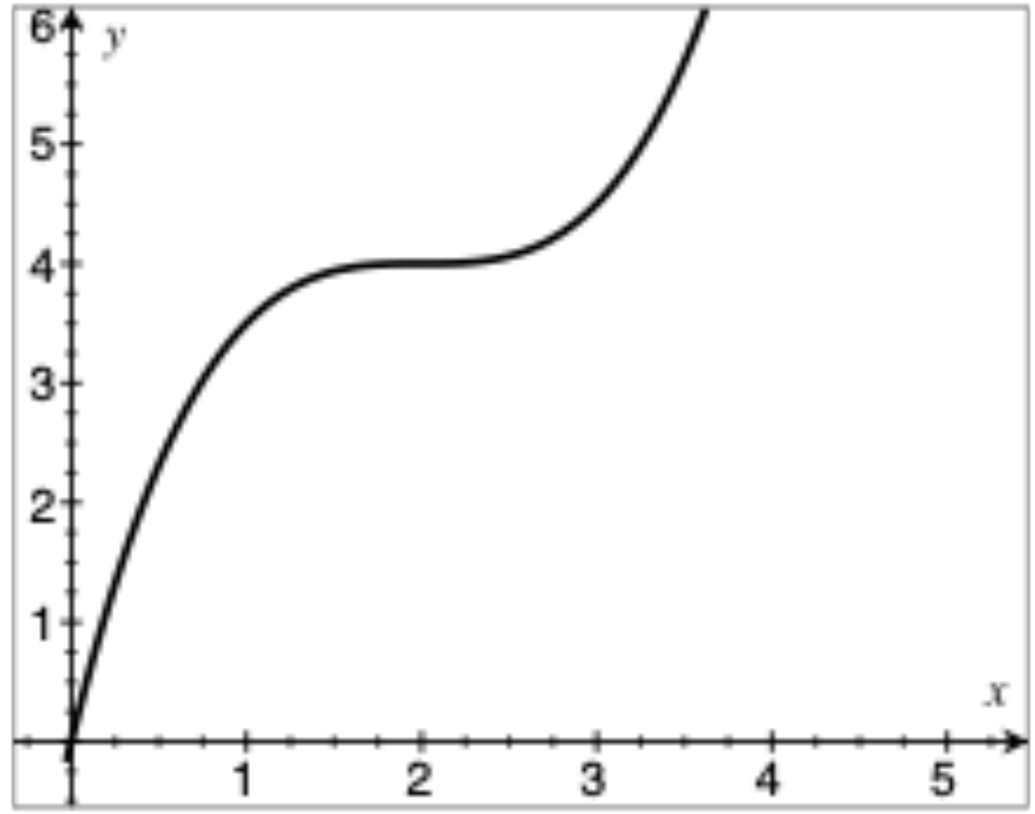
FLAG HOIST PART 2

WHICH IS THE MOST REALISTIC FLAG HOIST?

(C)



(D)



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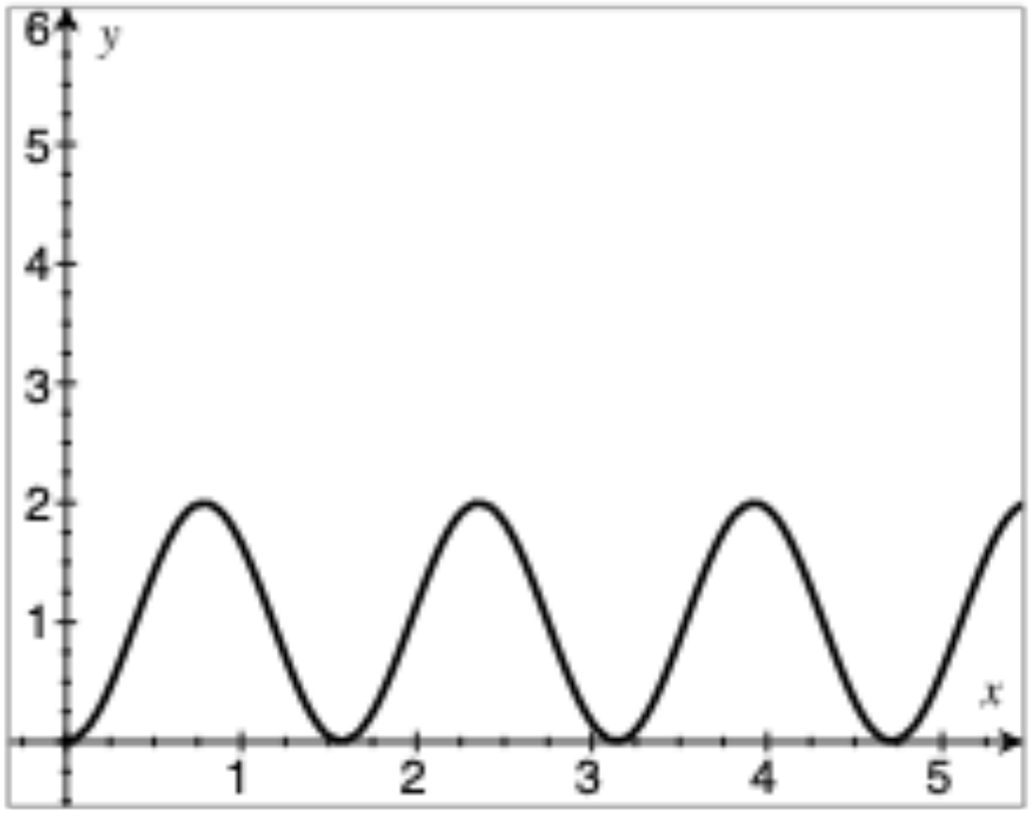

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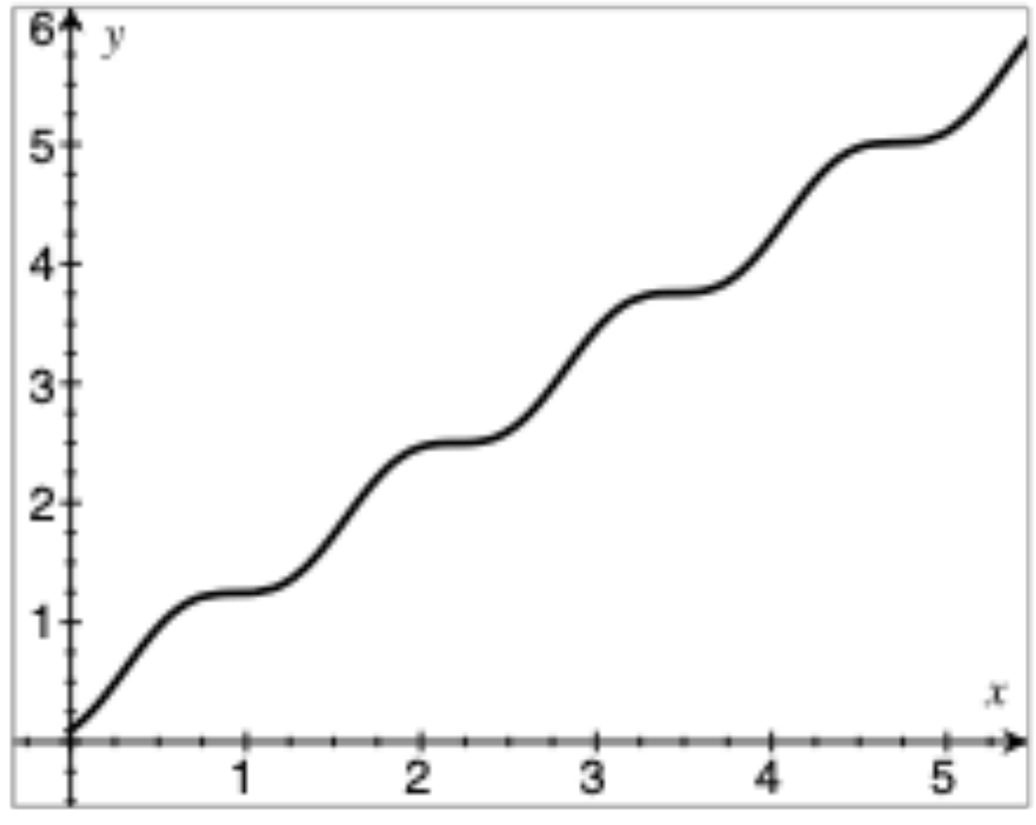

SCANNING THE ROOM & TAKING HANDS

GIVE STATUS TO CREATIVE, CRAZY ANSWERS

FLAG HOIST GOALS

- ➤ Draw a proper graph (height as function of time)
- ➤ Verbal argument *attending to features of graph*
- ➤ Care around Academic language
  - ➤ Constant / non-constant, Slope and Increasing/decreasing, Concave down/up
- ➤ Connect physical intuition, common sense
- ➤ Feel brave diving into non-rote problem
- ➤ Accept inventive, crazy answers
- ➤ Work together better, establish norms
  - ➤Four hands, give reasons, convince each other

- ➤ Want complex, creative argument
- ➤ fluent metaphors & representations
- ➤ beyond rote recipes
- ➤ address novel situations
- ➤ understand/convince arguments of others

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GROUPWORTHY TASKS

ROUTINE TASKS

- Bore the quick and give them oversize status
- Depress the slower
- Make group work forced and artificial
- Not inspire argument / convincing

A GROUPWORTHY TASK

- has a "mysterious" part that is mathematical.
- is hard.
- has little visible scaffolding.
- has multiple ways to start.
- has multiple ways to be solved.
- has interesting partial solutions.
- has natural extensions.
- encourages getting your hands dirty with data.
- gives teachers information about student thinking.
- is open enough to let students be ingenious.

WAYS TO CREATE A GROUPWORTHY TASK

- Un-structure a scaffolded task. Take the scaffold and turn them into pocket hints.
  - Flag hoist hints: “now estimate the slope at three points”, “describe what the hoister is doing at t=0, 2 and 4.”
- Ask them to interpret, or decide something due to a calculation (most realistic, speeding ticket)
- Convert between representations
  - Graphs, tables, verbal, symbolic, kinesthetic
  - Good side-effect: Easy to scan the room
- Routine tasks, prematurely. Before official algorithm.
  - Then mini-lecture the routine recipe.

MORE ON RICH, GROUP WORTHY PROBLEMS

- Hsu, E., Kysh, J., and Resek, D. (2007). Using Rich Problems for Differentiated Instruction. New England Mathematics Journal, 39, 6--13.
- http://bfc.sfsu.edu/papers/HsuKyshResek-RichProblems.pdf