A Framework for Fostering Mathematical Creativity in the Undergraduate Classroom

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What is creativity?

- Rhodes (1961) 4 P's of Creativity Definitions
 - Person
 - Product
 - Process
 - "Press" Environment

Which category would you consider your definition of mathematical creativity?



Our definition:

One's process of offering new mathematical solutions or insights that are unexpected with respect to their mathematical background or problems they have seen before (Savic et al., 2017)

- Relative to the student
- Domain-specific to math
- Process-oriented



What is fostering math creativity?

Any pedagogical action in the classroom that can cultivate the mathematical creativity within a student

The action leads to a student outcome (or does it?)



Literature on Fostering Creativity

Cropley (1997, categorized by Soh, 2000) - Nine Principles

- Motivation
- Opportunities
- Independence
- Flexibility
- Frustration

- Question
- Evaluation
- Integration
- Judgment

Sriraman (2005) - Five Principles for Mathematics

- Gestalt
- Aesthetic
- Free Market

- Scholarly
- Uncertainty

But many of these categories either overlap or are difficult to measure...



Our Proposed Dimensions

Latent

 Teaching actions that affect the students' underlying thoughts and actions, which cannot be observed, but which form the basis for student engagement and interaction with mathematical instruction and with their mathematical community

Personal

 Teaching actions affecting or pertaining to the individual student, including assigning tasks, asking questions and communicating directly to an individual. Specifically, these are actions that pertain to teacher-individual student interactions

Social

• Teaching actions impacting the classroom community, such as eliciting interaction and exchange of ideas among students



Latent Dimension

- Sriraman (2005) Point out any connections between disparate ideas in problem solving
- Soh (2015) Encourage students to do things differently although doing this takes up more time

Dr. Tang – "...That's the exam 2 'solutions' and I say solutions in quotes because they're not all 100% correct, okay, but it doesn't matter. You know there are still really good ideas in there and that's what I want you to see."



Latent Dimension

"I think [creativity is] always her goal because I'm sure, and I've come to find that it's very true, that **she genuinely believes that when you incorporate the creativity, it really proves that you have a good understanding of the material**. Because it's one thing to know or memorize the material, but if you're able to get creative with it, then it proves that you know it well enough that you're able to use it in a way other than the, whatever instructed way to do it is."



Personal Dimension

- Sriraman (2005) Assign challenging problems and tasks
- Soh (2015) I leave open-ended questions for my students to find the answers for themselves

Dr. Omar – Portfolio problem assigned with 3 "relatively routine" exercises

Grading focused on students using the CPR on Proving (Savic et al., 2017)

"What were you thinking about during steps, what strategies worked well/didn't work well, how do you feel about the overall process?



Personal Dimension

In reflection to Dr. Omar:

"This was a really hard project for me... I was really proud of myself though. I personally thought up of an idea (the parity of the tilings), and used that to create a cool conjecture. Even though that conjecture turned out to have been done already, I felt like I made a solid step toward what a career research mathematician would do." (Omar et al., 2018, p. 19)



Social Dimension

- Sriraman (2005) Encourage students to debate and discuss the teacher's approaches and the other students' approaches/presentations
- Soh (2015) In my class, students have opportunities to share ideas and views

Social Dimension

Dr. Tang – Not answering questions immediately or asking what others in the class thought

"There were times like 'Well I did this proof, but I'm not sure it's right because of this' and she would respond with 'Well, what do you think class?' And the class would participate in it...And it's just, **using each other and building off of each other** in the class to build what we need, create, **made us creative. It built that creative environment for us.**"



Implications for Future Research

- Investigate specifically what each dimension's effects are on students
- Study what actions in the classroom can be influencing creativity more
- What learning theories can be used to ground each dimension?
- Do students continue their "creativity," or is it subdued in future math courses?



We may not need to create "creativity" so much as generate conditions in which it can flourish. (Tosey, 2006, p. 30)

Thank you!

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