

EXPLORING THE INTERSECTION OF FOSTERING MATHEMATICAL CREATIVITY AND INQUIRY TEACHING

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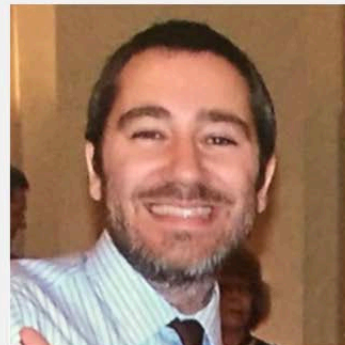
CREATIVITY RESEARCH GROUP²



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WHAT IS CREATIVITY?

- Over 100 definitions (Mann, 2006)
- **A process** of offering new solutions or insights that are **unexpected** for the student, **with respect to his/her mathematics background** or the problems s/he has seen before (Savic, et al., 2017)

TEACHING FOR CREATIVITY

Sririman (2005) conjectured 5 Principles to maximize creativity:

- Gestalt
 - Opportunities to engage in the four-stage creative process (Wallas, 1926; Hadamard, 1945)
 - Preparation, incubation, insight, verification
- Aesthetic
 - Teacher valuing solutions that utilize unusual proving techniques, come from diverse topics of mathematics, or make efficient or elegant solutions

FIVE PRINCIPLES (CONT.)

- Free Market
 - Creating a classroom environment that allows students to freely take risks, input ideas, thoughts, and solutions
- Scholarly
 - creating a classroom environment “in which students are encouraged to debate and question the validity of... approaches to problems..., be encouraged to generalize the problem and/or the solution, as well as pose a class of analogous problems” (p. 28)
- Uncertainty
 - “Students [are] exposed to the uncertainty and the difficulty of creating mathematics” (p. 28)

INQUIRY INSTRUCTION

- Academy of Inquiry-Based Learning: students
 - (a) are deeply engaged in rich mathematical tasks;
 - (b) have ample opportunities to collaborate with peers
- Kuster et al. (2017) describe four components of IOI:
 - (1) Generating student ways of reasoning;
 - (2) building on student contributions;
 - (3) developing a shared understanding; and
 - (4) connecting to standard mathematical language and notation.

RESEARCH QUESTIONS

- What teacher actions or practices in the proof-based undergraduate classroom might foster students' perceptions of mathematical creativity?
- What are some commonalities and differences between Teaching for Creativity and Inquiry Instruction?

DATA COLLECTION

- Teacher's impressions (diaries, goals, interviews)
- Teacher's instruction (Livescribe™ data, notes)
- Students' impressions (online survey, interviews, homework, reflections)

GAIL TANG'S CLASS - SETTING

- 14 Students, Transition to proof course, Spring 2016
- IBL with her own written notes
- Mid-semester introduced a Creativity-in-progress Rubric on Proving (El Turkey et al., 2017; Savic et al., 2017)
- Reflections throughout the course asking about mathematical creativity

CLASSROOM DISCUSSION

- Xiomara finished demonstrating her proof of the following theorem:
"The sum of the squares of two odd integers cannot be the square of an integer."
- **(A)** Gail: Okay everyone look at what you did and compare to what Xiomara did... Questions? Comments?
- Peyton: Is the "two times an odd number, therefore it cannot be a perfect square", is that... is that like a rule that we can use?
- **(B)** Gail: Is it? [followed by an explanation by Xiomara]
- Peyton: Oh no, I just... I got to that point too but I just didn't know to do with it so... [chuckles]
- **(C)** Gail: So do you believe her argument?
- Peyton: Yeah? Yeah, I think so.

CODING GAIL'S ACTIONS

- **(A)** Gail: Okay everyone look at what you did and compare to what Xiomara did... Questions?
Comments?
 - Creativity: Scholarly and Free Market
 - Inquiry: Building on student contribution (2) and Developing a shared understanding (3)

STUDENT RESPONSES

- **Carrie: “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.”**
- Uncertainty
- (1) Generating student ways of reasoning; (3) developing a shared understanding;

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- Scholarly
- (2) building on student contributions; (3) developing a shared understanding;

DIFFERENCES?

- Does teaching for creativity and inquiry instruction have any differences?
 - Does IBL/IOI lead to what the teacher desires?
 - How much “freedom of time and movement” does a person have (Gestalt) or uncertainty in an IBL/IOI classroom?
- **“And I worked on this proof like I said all semester. It appeared on our first exam and then it appeared later on in the course ... And so I went through and did it probably a hundred times. Finally I ended up proving it and when [Gail] had reviewed it, she told me that there were nine different ways to prove it and this is not one of them, but it’s true and it works, and it’s phenomenal. And it was very exciting. It was a creative moment. It took me months to get there but I got there and it was very exciting.” - Carrie**

INQUIRIES?

- Where does the aesthetic principle fit into inquiry?
- Could fostering creativity happen in a non-inquiry classroom?
 - 5 portfolio problems with a major component of the grade on meta-cognition and creativity (Omar et al., submitted revisions)

DISCUSSION

- There are signs that using the five principles may shed light on the commonalities between Teaching for Creativity and Inquiry Instruction
 - Scholarly and components 2 and 3
 - Free market and components 1 and 3
 - Uncertainty and component 1
 - Gestalt and aesthetic? Component 4?
- We intend to compare/contrast Teaching for Creativity and Inquiry Instruction in terms of teachers' and students' actions.

“SO I THINK THAT LIKE EVERYONE’S CAPABLE OF MATHEMATICAL CREATIVITY. I THINK THAT MATHEMATICAL CREATIVITY IS NOT REALLY KIND OF TAUGHT OR NOT MADE ACCESSIBLE TO PEOPLE, SO I THINK PEOPLE A LOT OF TIMES DON’T REALIZE THAT THEY’RE CAPABLE OF BEING CREATIVE.”

THANK YOU!

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CODING GAIL'S ACTIONS

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- **(B)** Gail: Is it? [followed by an explanation by Xiomara]
 - Uncertainty and Free Market
 - Generating student ways of reasoning (1) and building on student contributions (2)

CODING GAIL'S ACTIONS

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 - Scholarly
 - Developing a shared understanding (3)