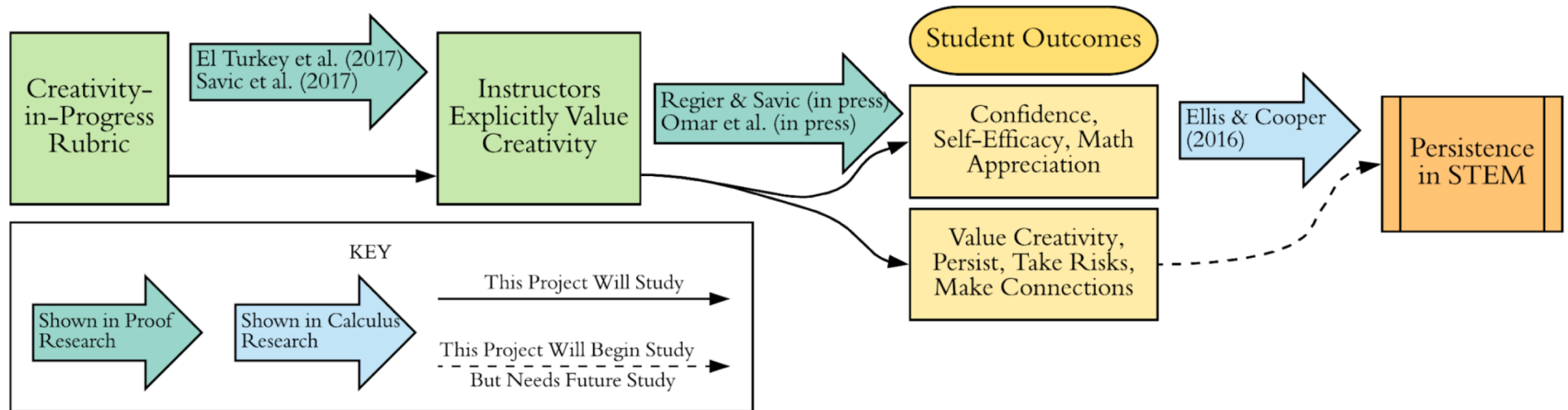


A University Instructor's Pedagogical Shifts as a Result of Focusing on Mathematical Creativity

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AMNS 2019, Pohkora

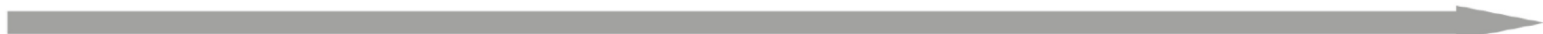



CRG

Creativity in Calculus



National Science Foundation (#1836369, 1836371)

TAKING RISKS

	Beginning	Developing	Advancing
Tools and Tricks ²	Uses a tool or trick that is usual for the course or the student	Uses a tool or trick that is partly unusual ³ for the course or the student	Creates a tool or trick that is unusual for the course or the student
NA <input type="checkbox"/>			
Flexibility ⁴	Introduces one solution path	Introduces more than one solution path	Uses more than one solution path
NA <input type="checkbox"/>			
Posing Questions	Recognizes there should be a question asked, but does not pose a question ⁵	Poses questions clarifying a step within a solution	Poses questions about reasoning within a solution
NA <input type="checkbox"/>			
Evaluation of Solution Attempt	Checks surface-level ⁶ features of a solution attempt	Checks an entire solution attempt for reasoning	Revises or validates an entire solution attempt for reasoning
NA <input type="checkbox"/>			

**Creativity-in-Progress Rubric
on Problem Solving
(Proving - Savic et al., 2017)**

Mathematical Creativity

Why Mathematical Creativity?

Required to do mathematics (Borwein, Liljedahl, & Zhai, 2014)

Skill demanded in many STEM fields (Wilson, Lennox, Hughes, & Brown, 2017)

More equitable classroom (Luria, Sriraman, & Kaufman, 2017)

Why Instructors?

Research focused on students (Sriraman, 2004)

Pre-Service Teachers (Leikin, 2014; Moore-Russo & Demler, 2018)

Beliefs

“Psychologically held understandings, premises, or propositions about the world that are felt to be true”

Richardson (1996, p. 103)

Mathematical Teaching Beliefs

Jeanne: “The role of the teacher is to present the content in a clear, logical and precise manner.” (p. 111)

Kay: “using a variety of approaches to stimulate the students’ interest and to suit the different topics” (p. 114)

Thompson (1984)

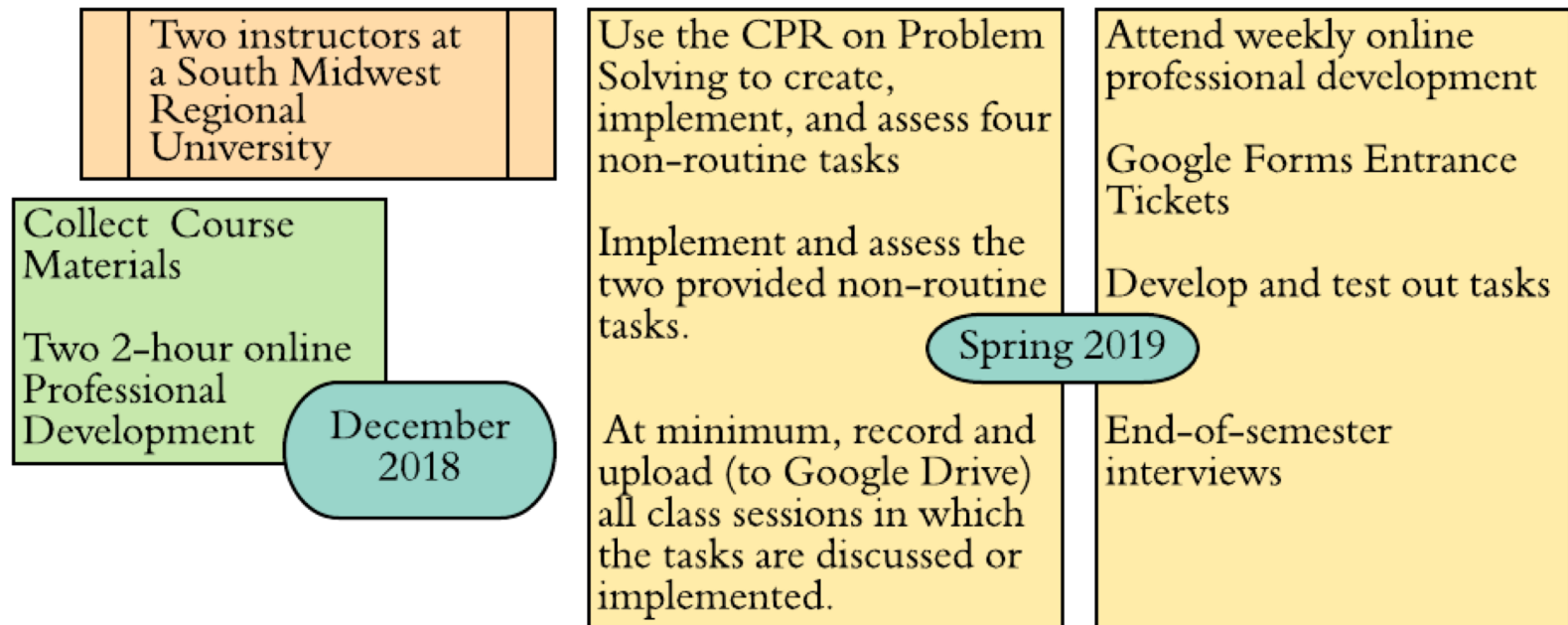
“ Because central beliefs have been developed through experience, new activities giving rise to positive experiences and reflection upon these experiences is critical to belief change.”

Pajares (1992); cited by Grootenboer and Marshman (2016, p.265)

What pedagogical shifts
occur while teaching to
foster mathematical
creativity?

**Research
Question**

Setting



Coding Methods

Holistic Coding (Saldaña, 2013)

- Watched interviews for perceived belief shifts
- Met to discuss shifts

Semi-Narrative Coding (Saldaña, 2013)

- Coded entrance tickets
- Coded end-of-semester interviews
- Coded Tasks

“ I think failure can foster creativity. **[FAILURE]** You attempt a problem using ‘standard’ procedures and it doesn't lead to anything fruitful. So, you think about other ways to approach the problem. **[MULTIPLE APPROACHES]** What additional information do you have? Is that information useful? etc. **[EVALUATION]** I think making the students the teachers can also foster creativity. **[STUDENTS TEACHING EACH OTHER]**”

Jo Parker, 12/11/18
Entrance Ticket

“ I think it would be difficult, but not impossible, to get students to ‘teach’ during class. (It is a matter of creating a safe environment.) I think well thought out assignments can work, but creating the assignments can be tricky.”

Jo Parker, 12/11/18
Entrance Ticket

“ I was actually surprised with the first task, the limit task. It appears that most found the limit one way and didn't bother to find it another way. It was like the question just read 'Evaluate (blah).’ ”

1. Consider the limit $\lim_{x \rightarrow 1} \frac{\sqrt{x} - 1}{x - 1}$. Evaluate this limit in as many ways as you can.

Jo Parker, 2/5/19
Entrance Ticket

“ I think a lot of it has to do with the problems we do in class. We usually only approach them one way and we call it good. Sometimes I approach a problem multiple ways, but I rarely show my work. (I talk through the alternative method(s).)”

Jo Parker, 2/5/19
Entrance Ticket

“ I love the fact that you can approach it in many different ways. And I think the traditional way that students think of it is multiply by the conjugate. But they can factor it. It's just a little trick. And they don't think to factor linear terms. And so I like that. I think it's cute. It's a little bit outside the box but it's still within their realm of knowledge. And I like that you can approach that problem in multiple ways.

**Jo Parker, 5/14/19
Exit Interview**

“ It’d be nice if just another student popped up and say ‘hey I approached it by factoring or I used the T chart’ which I know is not the best method but it gives me intuition as to what’s going on. So I think in my mind that’s what ‘going well’ [means].”

Jo Parker, 5/14/19
Exit Interview

“I do think the tasks are showing them [mathematical creativity]... So Kayleen on the last day came up and she did an integral problem where she had to come up with a function that such that when you integrated it from some specific values you got a specific number and it was not how I thought about it. **And it's not how her peers necessarily thought about it. So seeing it in action is beneficial. 'Hey she got something different than me. But it works out the same.'** So that peer influence I think is really beneficial.”

Jo Parker, 5/14/19
Exit Interview

Other Belief Shifts

Jo Parker and
Coverage of Content

“That at the beginning of the semester, I was very nervous about time. Very packed but, who cares—in some sense—I can spend 15 minutes once a week just saying "hey do this problem in class" or I can give it to them outside of class and then say "hey let's come to the board and you all put up your solutions and we can talk about them." I'm much more aware of that.

Other Belief Shifts

Jo Parker and
Posing Questions

“I think next time I teach I need to hone in on the posing questions part because that's also something I struggle with when I'm on the spot. They're doing something that I need to think about, how can I pose a question to them rather than just ‘look here’?”

“Admittedly on Monday, my students--I'm now **behind--but they were asking phenomenal questions.** We were talking about increasing and decreasing and then all of a sudden one of the students goes "well doesn't that show you that you have an absolute min at this point ?" "Heck yes, it does ." ... **So they're saying and thinking great things that I don't normally get out of my students ... So they're thinking about things a different way.”**

Jo Parker, 3/16/19
Week 10 PD

“ Significant change in teachers’ beliefs and attitudes is likely to take place only after changes in student learning outcomes are evidenced.”

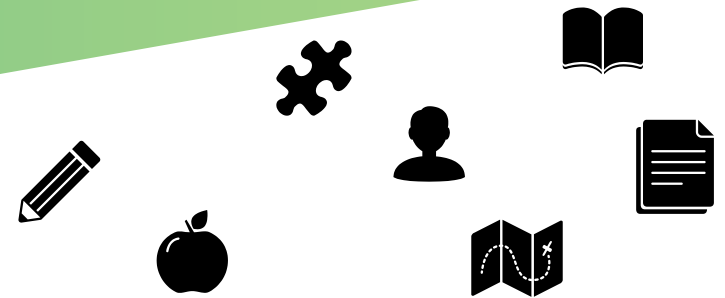
Guskey (1986, p. 7)

Discussion

- These shifts occurred because of**
- Explicitly valuing creativity through intentional task development**
 - Instructor's willingness to change and evaluate teaching practices**

Future Research

- Analyze data collected on students
- More analysis on tasks created by instructors
- Analyze teaching actions when fostering creativity
- Follow up after one year



Thank you!

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