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“The reason why I didn't like [math] before is because I never felt creative”: Affective Outcomes from Teaching Actions to Foster Mathematical Creativity in Calculus 1

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In this paper, we describe the student-reported affective outcomes from teaching actions of professors involved in a professional development experience to explicitly value creativity in their Calculus 1 courses. Using the four main teaching themes that emerged (Task-Related, Inquiry Teaching, Teacher-Centered, and Holistic Teaching), we further explored the data for affective outcomes resulting from teaching actions that foster student creativity. We observed five distinct affective outcomes: Enjoyment, Confidence, Comfort, Negative then Positive Feelings, and Negative Feelings. Enjoyment and Confidence were the most reported affective outcomes from the creativity-fostering teaching actions. Particularly, Enjoyment was reported the most from Holistic Teaching and Task-Related teaching actions; Confidence was reported the most from Holistic Teaching actions among all the types. Finally, we offer concrete creativity-based teaching actions that have the capacity to build students' mathematical enjoyment and confidence.

Keywords: mathematical creativity, affect, confidence, enjoyment, teaching actions

Learners bring their prior experiences into the classroom that influence how they learn mathematics, who should learn it, and how they feel about learning it; this impacts students' persistence in mathematics and other STEM fields (Ellis et al., 2016). For example, Laursen et al. (2014) found that teaching pedagogies impacted students' affective gains in confidence, intent to pursue more mathematics classes and attitude about mathematics. Furthermore, despite having similar grades, students in Laursen et al.'s study reported different learning gains by gender and pedagogy. That is, these students had a weaker sense of mastery that is not reflective of actual content knowledge. Indeed, affective outcomes such as confidence impact persistence through Calculus II and STEM in general (Ellis & Cooper, 2016). There are numerous aspects of a course that could impact students' affect. In this paper, we concentrate on the teaching actions aspect of a creativity-based undergraduate Calculus I course, because creativity is often overlooked in this course (Ryals & Keene, 2017). We conclude with teaching actions that have the greatest potential to positively impact students' enjoyment of and confidence in doing mathematics.

Background Literature & Theoretical Perspective

We utilize a relativistic perspective of mathematical creativity (Liljedahl & Sriraman, 2006). Through the four “C” model of creativity, we situate our definition of mathematical creativity as “mini-c,” defined as “subjective self-discoveries—the novel and personally meaningful insights and interpretations inherent in the learning process” (Kaufman & Beghetto, 2013, p. 230). This notion of self-discovery necessitates a phenomenological perspective (Abakpa et al., 2017; van Manen, 1990) – we asked participants to define creativity in their own words, report if they felt creative according to their definitions, and list aspects of the course that impacted their levels of creativity. We focus on students' perspectives because actions to foster mathematical creativity have mainly been posited as theory or conjecture (e.g., Sriraman, 2005); actions based on empirical work have rarely been analyzed at the tertiary level (e.g., Levenson, 2011 for 5th and 6th grades).

Affect encompasses a wide range of constructs that involve feeling (McLeod, 1988), including attitudes, emotions, engagement, and so forth (Middleton et al., 2017). Researchers have long tried to develop constructs that distinguish various forms of affect. McLeod (1988) discussed the importance of beliefs, attitudes, and emotions as a trio; he differentiated among them using the dimensions of magnitude, direction, duration, level of awareness, and level. More recently, Middleton et al., (2017) distinguished between trait-like versus state-like affect: the former refers to affect that is longer in duration, relatively stable, and thus not amenable to change easily (e.g., beliefs), while the latter is shorter in duration, oftentimes in reaction to an event, and can be volatile in intensity. This “in-the-moment” nature suggests state-like affect may be more open to influence by the environment and teacher.

We approach affect broadly as many questions remain over the robustness of definitions and various forms of affect (Grootenboer & Marshman, 2016). Following the recommendations in the literature (Hannula, 2002; Schindler & Bakker, 2020), we define an *affective outcome* as any emotions, beliefs, attitudes—whether they are state-like or trait-like— that the students referenced when speaking about the teaching actions they felt fostered their mathematical creativity. In this paper, we address the research question: what affective outcomes do students report from teaching actions of instructors involved in professional development to explicitly value creativity in Calculus I?

Methods

Participants and Setting

Within a larger NSF-funded project investigating fostering mathematical creativity in Calculus I, this study focuses on semi-structured interviews conducted with 34 undergraduate Calculus I students. The larger research project consists of 3 total cohorts of instructor participants from various universities in the U.S. We report only on the two completed cohorts. The research team interviewed 12 students from Cohort 1 (Spring 2019) instructors and 22 from Cohort 2 (Spring 2020). Because different students have different educational experiences or opportunities, we provide students’ self-reported gender and racial categories (Adiredja et al., 2015) along with their instructors’ self-reported gender and racial categories. Twenty-four students self-identified as female (four bi-racial, five Latina, four Black, two AAPI[1], one Persian, eight White), nine as male (one bi-racial, one AAPI, one Latino/Hispanic, six White), and one as non-binary (White). These students’ instructors participated in an online professional learning community in which fostering creativity in Calculus was the emphasis. Nine total instructors have completed participation in the project: three from Cohort 1 and six from Cohort 2. Six self-identified as female (two Latina or Hispanic, three White, one Black) and three as male (one AAPI, two White).

Data Collection, Coding, and Analysis

Participating students were interviewed once by one of the authors for 45-90 minutes towards the end of their Calculus course, prior to taking their final exam. We asked students questions such as “Did you feel creative in this course?”, “Why and when do think you were creative?”,

[1] Asian Americans or Pacific Islanders

"What have you learned about your mathematical creativity from this course?", and "What aspects of this course contributed to your or your classmates' creativity in the course?" First, we used responses to this last question to code the transcribed interview data for students' references to teaching actions when talking about their own or others' creativity. We created nodes using a combination of descriptive and in vivo coding (Saldaña, 2016). From those nodes, we used the process of theming (Saldaña, 2016) to categorize the teaching actions. The themes that encompass the teaching actions are described in Satyam et al. (submitted) as follows:

- *Task-Related*: any action that mentions properties of a mathematical content task (re-) designed, evaluated, or assessed by the instructor.
- *Teacher-Centered*: any action that was mostly focused on the instructor, whether it be verifying correctness or connecting topics.
- *Inquiry Teaching*: any action that can be linked to inquiry-oriented (or -based) instruction.
- *Holistic Teaching*: any teaching actions that do not require a response from students yet psychologically builds an environment for fostering creativity.

Each teaching theme has sub-types and associated concrete teaching actions. For more details on each theme, sub-types and teaching actions, see Satyam et al. (submitted).

We used nVivo™ (a qualitative analysis computer software) to isolate all student references coded with any of the teaching themes and performed a secondary coding for students' self-reported affective outcomes. Therefore, the affective themes that we have categorized came directly from student-reported teaching actions that contributed to their or their peers' creativity. To code the affective outcomes, we took the same coding approach as for the teaching actions: creating nodes using descriptive and in vivo coding followed by theming. To identify themes, we organized the nodes into groups using constant comparison (Glaser & Strauss, 1967).

Results

Five affective themes surfaced and were titled: *Enjoyment, Confidence, Comfort, Negative then Positive Feelings, and Negative Feelings.* At times, students reported several affective outcomes in one utterance. In those cases, all affective themes appropriate were used to code the student's words. Below, we expand on how we coded for each affective theme and provide interview excerpts. The corresponding teaching action is given in quotation marks and teaching theme in parentheses. The underlined portions indicate the context that situate the quote into the affective theme; the underlined and italicized words show the phrases associated with the theme. Conversational fillers such as "um", "like", "so", "I guess", or "you know" were removed.

Enjoyment

The *Enjoyment* theme includes utterances that reflected students' enjoyment, excitement, interest, appreciation, entertainment, or satisfaction due to the professor's creativity-based teaching action. Moments where students were stimulated or inspired by their professor were also coded into this theme. For example, Optimus's (White male student with Hispanic female instructor) response which stemmed from the teaching action "assign open-ended questions" (*Task-Related*) is shared below.

> I think the most creative I felt was when I did that C++ program to do my homework. <u>*It felt nice* to just do a different way and approach from a completely different angle.</u> I think it gives you a <u>different level of *satisfaction*</u> because it's not like the same mundane objective. And getting those results, you just don't get that satisfaction. <u>*It was cool* for me</u>

> to figure something out finally on my own. It's one thing that really turns me off about math; it's like, "damn, I'm learning about like just something some smart dude said" and you know, I don't understand how we got to this point…I'm just spitting out whatever he said. I don't know why. I don't know what it really means…Nobody told me to make the C++ program, nobody told me how to put it together, *it was very satisfying* when I did get the result I wanted.

Confidence

Students' references that mentioned confidence, success in the class, feeling good about themselves, self-efficacy (making use of ideas for next time or feeling they can figure out a problem in the future), or persistence were coded under this theme. Aon (African American/ Black/Nigerian female with Hispanic female instructor) expressed the sentiment below from the teaching actions "allow for freedom in time" (*Holistic Teaching)* and "teach how topics are connected" (*Teacher-Centered).*

> I remember the first the very first day of class, she already gave us the problem and I was like "oh, my gosh like, I don't know this." But then as the class went on, it was like, "wow, I see why she taught us this, because it connects to this…[S]he thought that teaching us something else before something else would really help us connect when we learn that next topic. And it really did. Just being very abstract with it really helped me be creative when it came to math. Because *I feel like today, if you give me a problem, I'll be able to think of different ways [it can be, went about]*.

Comfort

Students reported they felt no pressure in being right or wrong, comfortable, encouraged, and their mistakes were valued. They also reported that they were not made to feel dumb and that they did not feel rushed. They felt the classes they were in grew closer as a group and felt like different backgrounds, including nationalities, state residencies, and educational systems were appreciated. All these types of references were coded into this theme. Amelia's (White female with White female instructor) quote fits into this theme because she discusses the comfort in not having to perform quickly with respect to the teaching action of "prompt and encourage different approaches or divergent thinking" (*Holistic Teaching*).

> I think that's kind of the reason why I didn't like it before is because I never felt creative. I just felt like I had to do these steps and give these answers. And now understanding that it's all right to take different steps. Before it was always you have to take the quickest steps to get to the answer the quickest, and you have to do everything quickly. And now *I like how it's not rushed.*

Negative then Positive Feelings

There were instances of students reporting initial negative feelings and then a shift to a positive feeling. Experiences below like Sal's (biracial Filipina American female with Latinx female instructor) were coded into this theme. Her quote was coded with the teaching actions "assign writing" (*Task-Related)*; "allow to present in class" and "allow for discussion in class" (*Inquiry Teaching*); "divide class into groups for collaboration" (*Inquiry Teaching*); and "respect differences in the classroom" (*Holistic Teaching*).

> [The instructor assigned] very reflective, open-ended questions that necessarily aren't calculus related. I think she just wants this to show…there is a possibility to approach [calculus] differently than what she's teaching or than what may be one of your peers is

doing… I think she also just wanted to address the fact that everyone’s minds work differently…whether it be more creative or more like critical thinking or more analytical…So people might be moving at different speeds or might be just thinking and approaching of, approaching certain calculations differently…*In the beginning, I’ll be honest, I didn’t really exactly see a point to it*. Just because, it was like very early on in the semester, and I was just like, like, "I wonder *why we aren’t doing math*." But I’m like, "OK, that’s fine. I understand these reflective questions much more than I do calculus. So that’s all right." *[I]n the beginning, I definitely was a little lost in the intent* that she had. But then *looking back* on it, *I definitely see it has helped*. And honestly, *it’s helped us grow closer as a class, I feel, because it was a very good… bonding moment for everyone* because it kind of *forced us to talk,* in a way, and *get to know each other and kind of share our ideas and perspectives*. So that *definitely helped.*

Negative Feelings

Feelings of annoyance, struggle, frustration, or being overwhelmed were coded into the *Negative Feelings* theme. Additionally, comments regarding a negative change in belief in their mathematical skill level were captured in this theme. Bryan (White female with White male instructor) mentioned the negative feelings towards the end of the semester when the instructor made “use of Karakok et al.’s (2020) Creativity-in-Progress Reflection (CPR) on Problem Solving tool” (*Holistic Teaching*).

At this point, I feel like [using the CPR was] …*one more thing I have to do* and *it doesn’t mean as much to me* because I have seen a little bit improvement on what I rate myself, but sometimes I feel like either *I don’t understand how to use it* or I just feel like *it doesn’t necessarily apply*. Um, and so then *I find it a little bit annoying* to be doing it and also sometimes I just forget *because I forget to do it*. In the beginning it was very helpful and I did think it was good to do that.

Teaching Actions and Affective Outcomes Overlaps

We used nVivo™ to run overlaps of students’ data between the creativity-fostering *Teaching Actions* and *Affect* because we were interested in uncovering the teaching actions that had the greatest number of reported affective outcomes. Table 1 below shows the counts of the quotes that were coded with both the *Affect* listed in column 1 and the *Teaching Action* in row 1. Note that these are not the counts for number of students. That is, one student could have several quotes referring to *Enjoyment* & *Inquiry Teaching.* Table 1 is organized by frequency of the codes for both the *Teaching Actions* (most to least from left to right in row 1) and *Affect* (most to least from top to bottom in column 1). For example, *Enjoyment* is the most reported *Affect*, and *Holistic Teaching* is the most reported *Teaching Action.*

For the purposes of this paper, we will look at the three largest counts in Table 1: *Enjoyment* & *Holistic Teaching* (18), *Enjoyment* & *Task-Related Teaching Actions* (18), and *Confidence* & *Holistic Teaching* (17). Within these overlaps, we look at the most reported creativity-based teaching action to uncover which could be most encouraged to foster these affective outcomes.

In examining the *Holistic Teaching* actions that made students feel creative while also feeling *Enjoyment* or excitement, the action that had the greatest number of references was “prompt and encourage different approaches or divergent thinking.” In the *Enjoyment* and *Task-Related* intersection, students reported enjoyment came mostly from tasks that were “open-ended (i.e., that can be solved in multiple ways).” The top two *Holistic Teaching* actions that students reported affected their *Confidence* positively were “de-emphasize correctness in class” and “use of CPR”.

Table 1. Number of Affect Utterances by Teaching Action Theme

		Teaching Action				
		Holistic Teaching	Task-Related	Inquiry Teaching	Teacher-Centered	TOTAL
Affect	Enjoyment	18	18	14	2	52
	Confidence	17	14	8	8	47
	Comfort	14	7	6	4	31
	Neg then Pos	5	8	3	1	17
	Negative	3	3	1	0	7
	TOTAL	57	50	32	15	

Conclusion

These student experiences point to the promise of incorporating creativity tasks in Calculus I to increase students’ enjoyment, confidence, comfort, and transitional feelings of this gatekeeper class. There were also negative affective outcomes reported, but as Table 1 shows, they were comparatively fewer than the other affect themes. Table 1 also shows that *Enjoyment* and *Confidence* were the most reported affective outcomes from the instructors’ teaching actions. Considering students’ references to *Enjoyment* and *Confidence* together, the creativity-based teacher actions that most promote both affective outcomes are:

- prompt and encourage different approaches or divergent thinking
- de-emphasize correctness in class
- show excitement after student contributions, and
- explicitly encourage students in their creativity.

It appears these four teaching actions have the most potential for practitioners not only for fostering student’s creativity, but also encouraging students’ enjoyment of and confidence in the course. Ellis et al. (2016) found that all mathematically-capable students in their sample of 1,524 lost confidence over the course of their Calculus I course. Thus, encouraging students’ confidence is particularly important for STEM students since those with less confidence are less likely to continue on in STEM (Nugent et al., 2015). As teaching is shown to be a major influence on students’ persistence in school subjects (Rasmussen & Ellis, 2013; Regan et al., 2015), these four creativity-based teaching actions have major implications on persistence in Calculus I. We offer some examples of how to incorporate these teaching actions in the course.

The instructors in our study “prompt and encourage different approaches or divergent thinking,” by soliciting different ways from individual or groups of students. Eb (Asian-American female with Black female instructor) reported on the comfort of choice in different methods or approaches to open-ended questions:

> …definitely the questions that were a little bit more open-ended and not just solve it and find a particular answer. Especially the ones where depending on how you solve it or which identities you’re using, you might come up with something that looks different at the end but it means the same thing, or as long as you solved it correctly using correct rules, you’ll come up with an answer that should be correct and there might be multiple

answers to that. In that case, I really like that because I could pick and choose which one I'd want to use or which ones which ones I'm most comfortable with.

For specific open-ended tasks that can be designed to "prompt and encourage different approaches or divergent thinking" see El Turkey et al. (submitted).

With regard to the "de-emphasize correctness in class" teaching action, students reported the emphasis on the freedom to mess up during the learning process due to a lack of grading for correctness. For example, Ensigo (Mexican female with White male instructor) shared:

> My creative abilities in this class have been a lot better than they had been in calculus one in high school just because…here…it doesn't matter if we have the right or wrong answer. [W]hat I learned about my personal creative abilities is that I have more of a freedom to you know mess up. And it being OK because they're not looking for the right answer.

One way instructors can promote the freedom to mess up is to grade certain assignments for completion and save grading for correctness for more summative assessments.

Students from this study reported that instructors' excitement moved them, as it showed the instructors' investment in their learning. Jennifer (White Female with White Male instructor) said, "[H]e would always get excited whenever we would answer the questions and…whenever we would be understanding. It was just nice to see that he was like rooting for us, (laughing) all the time." We can see that these seemingly small actions can have big impacts on students.

Lastly, instructors can encourage creativity by explicitly acknowledging that creativity is a mathematical skill. Clare (White female with White male instructor) reported:

> [C]reativity...I learned it's a thing. I learned that in math there are ways to be creative. And I think I've started understanding that and using it. But I also understand now why creativity and math is so important because the creative solutions or the creative people are the ones that are the most helpful and are making those innovative discoveries…[T]he exam questions are so open ended and…when we would go through [the answers], no one would necessarily have the same way of going about it. I think that's what helped me understand that there is a creativity level.

This also helps to address the myth that creativity and mathematics have an empty intersection.

Though this study shows existence of positive affective outcomes from explicitly teaching for creativity, we need to collect more data to generalize to the greater undergraduate Calculus I student population in the U.S. Furthermore, in the future, we want to take a more in-depth analysis of affective outcomes by social identity categories such as gender, race/ethnicity, or their intersections. It is important to tease out the experiences of students and women of color because they often report negative affective outcomes that impact their ability to succeed or persist in STEM (Leyva et al., 2021; McGee & Martin, 2011, Trytten et al., 2012). We also want to highlight teaching actions that may promote positive affective outcomes by social identities. Preliminary analysis shows that learning in a course that explicitly fosters mathematical creativity is not a zero-sum game that benefits one group; as seen above, students from many different social identities have reported positive affective outcomes.

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References

Abakpa, B., Agbo-Egwu, A. O., & Abah, J. (2017). Emphasizing Phenomenology As A Research Paradigm For Interpreting Growth And Development In Mathematics Education. *Mathematics Education Series, 42*(1), 391-405.

Adiredja, A. P., & Andrews-Larson, C. (2017). Taking the Sociopolitical Turn in Postsecondary Mathematics Education Research. *International Journal of Research in Undergraduate Mathematics Education*, 444-465.

Ellis, J., Fosdick, B. K., & Rasmussen, C. (2016). Women 1.5 times more likely to leave STEM pipeline after calculus compared to men: Lack of mathematical confidence a potential culprit. *PloS One*, *11*(7), e0157447.

Ellis and Cooper (2016). Gender, switching, and student perceptions of Calculus I. In T. Fukawa-Connelly, N. Engelke Infante, M. Wawro, S. Brown (Eds.) *Proceedings of the 19th annual conference on Research in Undergraduate Mathematics Education* (pp. 125-135). Pittsburgh, PA.

El Turkey et al. (submitted).

Grootenboer, P., & Marshman, M. (2016). The affective domain, mathematics, and mathematics education. In *Mathematics, affect and learning* (pp. 13–33). Springer.

Hannula, M. S. (2002). Attitude towards mathematics: Emotions, expectations and values. *Educational Studies in Mathematics, 49*(1), 25–46.

Karakok, G., Turkey, H., Savić, M, Tang, G., Cilli-Turner, E., & Regier, P. (2020). Creativity-In-Progress Rubric On Problem Solving At The Postsecondary Level. In A.I. Sacristán, J.C. Cortés-Zavala & P.M. Ruiz-Arias, (Eds.). *Mathematics Education Across Cultures: Proceedings of the 42nd Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education, Mexico* (pp. 986-990). Cinvestav/AMIUTEM/PME-NA. https:/doi.org/10.51272/pmena.42.2020

Kaufman, J. C., & Beghetto, R. A. (2013). Do people recognize the four Cs? Examining layperson conceptions of creativity. *Psychology of Aesthetics, Creativity, and the Arts*, *7*(3), 229.

Laursen, S., Hassi, M.-L., Kogan, M., & Weston, T. (2014). Benefits for Women and Men of Inquiry-Based Learning in College Mathematics: A Multi-Institution Study. *Journal for Research in Mathematics Education, 45*(4), 406-418.

Levenson, E. (2011). Exploring collective mathematical creativity in elementary school. *Journal of Creative Behavior*, *45*(3), 215–234.

Leyva, L., Weber, K., & Quea, R. (2021). Detailing Racialized and Gendered Mechanisms of Undergraduate Precalculus and Calculus Classroom Instruction. *Cognition and Instruction*, 1-34.

Liljedahl, P., & Sriraman, B. (2006). Musings on mathematical creativity. *For the learning of mathematics*, *26*(1), 17-19.

McGee, E., & Martin, D. (2011). “You Would Not Believe What I Have to Go Through to Prove My Intellectual Value!” Stereotype Management Among Academically Successful Black Mathematics and Engineering Students. *American Educational Research Journal, 48*(6), 1347-1389.

McLeod, D. B. (1988). Affective issues in mathematical problem solving: Some theoretical considerations. *Journal for Research in Mathematics Education*, 134–141.

Middleton, J., Jansen, A., & Goldin, G. (2017). The complexities of mathematical engagement: Motivation, affect, and social interactions. *Compendium for Research in Mathematics Education*, 667–699.

Nugent, G., Barker, B., Welch, G., Grandgenett, N., Wu, C.R. & Nelson, C. (2015) A Model of Factors Contributing to STEM Learning and Career Orientation, International Journal of Science Education, 37:7, 1067-1088, DOI: 10.1080/09500693.2015.1017863

Rasmussen, C., & Ellis, J. (2013). Who is switching out of calculus and why? In A. M. Lindmeier & A. Heinze (Eds.), *Proceedings of the 37th Conference of the International Group for the Psychology of Mathematics Education* (Vol. 4, pp. 73–80). Kiel, Germany: PME.

Regan, E., & DeWitt, J. (2015). Attitudes, Interest and Factors Influencing STEM Enrolment Behaviour: An Overview of Relevant Literature. In E. K. Henricksen, J. Dillon & J. Ryder (Eds.), *Understanding Student Participation and Choice in Science and Technology Education* (pp.63-88). Springer.

Ryals, M., & Keene, K. (2017). A success factor model for calculus: The relative impact of and connections between factors affecting student success in college calculus. In Proceedings of the 20th annual conference on Research in Undergraduate Mathematics Education (pp. 871-878). San Diego, CA.

Saldaña, J. (2016). *The coding manual for qualitative researchers* (3E [Third edition]). SAGE.

Satyam, R., Savić, M., Tang, G., El Turkey, H., & Karakok, G. (submitted).

Schindler, M. B. & Bakker, A. (2020). Affective field during collaborative problem posing and problem solving: a case study. *Educational Studies in Mathematics, 105*, 303-324.

Sriraman, B. (2005). Are Giftedness and Creativity Synonyms in Mathematics? *Journal of Secondary Gifted Education*, *17*(1), 20–36. https://doi.org/10.4219/jsge-2005-389

Trytten, D., Wong Lowe, A., & Walden, S. (2012). "Asians are Good at Math. What an Awful Stereotype": The Model Minority Stereotype's Impact on Asian American Engineering Students. Journal of Engineering Education (vol 101, no 3).

van Manen, M. (1990). *Researching lived experience: Human science for an action sensitive pedagogy*. London and New York: Routledge.