

Background

This study used a mixed-methods model to evaluate the effectiveness of the Charlotte Teachers Institute (CTI) Summer Research Experience for Teachers (SRET) for Charlotte-Mecklenburg School (CMS) teachers. The SRET program operated over a four-week, sixty-hour period in which CMS classroom teachers were matched in pairs with a university research team at one of three participating universities: University of North Carolina at Charlotte, Johnson C. Smith University, and Queens University. SRET focused on providing mastery and vicarious experiences to teachers with the goal of increasing self-efficacy in the sciences and humanities.

Research Questions

To what extent does hands-on collaborative research promote changes in self-efficacy beliefs among teachers, professors, and students?

How do factors such as mastery and vicarious experiences relate to changes in efficacy beliefs?

Research shows that mastery and vicarious experiences can boost an individual's beliefs in one's capabilities to achieve a goal or outcome.¹ Successes are often interpreted as mastery experiences that can boost self-efficacy, whereas perceived failure typically lowers it. Vicarious experiences provide individuals with an opportunity to witness the successes and failures of others and may thereby alter self-efficacy.² This study uses a T-STEM survey as a quantitative measure for self-efficacy among CMS teachers. A qualitative measure is taken from reflective surveys and a participant observer's reflections which together focus on extracting mastery and vicarious experiences.

Methods

Seventeen CMS teachers participated in this mixed-methods study, and eight undergraduate and graduate students acted as research mentors for the teachers throughout the program. All participants were selected to CTI's 2018 SRET program.

Participants completed:

- Pre and post T-STEM surveys which focused on five constructs³:
 - (1) Science Teaching Efficacy and Beliefs
 - (2) Science Teaching Outcome Expectancy
 - (3) 21st Century Learning Attitudes
 - (4) Teacher Leadership Attitudes
 - (5) and STEM Career Awareness.
- CMS teachers also completed weekly reflections that focused on their mastery and vicarious experiences.

Participant-Observer Reflections:

- Undergraduate student mentor logged daily reflections every thirty minutes while interacting with three CMS teachers in a physics lab at UNC-Charlotte.

Results

A paired samples t-test analysis of the quantitative T-STEM/Humanities surveys showed a statistically significant difference between pre-test ($M=3.4$, $SD=0.46$) and post-test ($M=3.8$, $SD=0.34$) on the Teaching Efficacy and Beliefs construct; $t(14) = -3.02$, $p=0.009$. These results suggest that teachers who engage in hands-on research are more likely to develop self-efficacy and confidence in teaching STEM and humanities subjects. Furthermore, these self-efficacy beliefs represent items such as confidence to teach science and humanities effectively, confidence to answer students' science and humanities questions, and knowledge to increase student interest in science and humanities. Four participant-observation themes: (1) Asking Questions, (2) Praising Success, (3) Personal Responsibility, and (4) Classroom Connections.

Theme	Journal Reflection	Reflection Analysis
Asking Questions	July 10, 2018 Time: 11:30 a.m. "Two teachers ask for clarification of birefringence and fluorescence: 'Can you explain again what birefringence is? Is it the same as fluorescence? I am a little unclear about birefringence but I know it has something to do with the optical properties...' says one of the teachers."	<ul style="list-style-type: none"> Teachers would express feeling more confident about how to complete the task after their questions were answered. Asking questions allows a person to establish fundamental knowledge by clarifying information which directly contributes to an increase in confidence and success rates. Example of a mastery experience.
Praising Success	June 11, 2018 Time: 10:00 a.m. "After several days of trying to get the camera system aligned, the group has produced a beautiful image of the mouse tail and everyone simultaneously cheered while congratulating each other on getting to this point. Now everyone is smiling and one of the teachers says 'I can't wait to see the birefringence of this picture, its going to look so good!'"	<ul style="list-style-type: none"> By praising each other on the success of the system there was a contagious energy in the room that fueled the group into wanting to take more pictures and interpret the results. Genuine praise encourages a person or group to continue forward which increases the belief in oneself that the task can be completed and the goal will be reached. Example of both mastery and vicarious experiences.
Personal Responsibility	June 22, 2018 Time: 11:30 a.m. "Teachers suggest we go back and redo one of the images for the damaged porcine skin because they do not think the fiber optic cable was aligned properly. They all state they would love to repeat the process if it means getting accurate graphs."	<ul style="list-style-type: none"> Taking pride in the results created a sense of personal responsibility to deliver precise results. The teachers had a genuine interest in the project which instilled them with a sense of personal responsibility for the result. When a team takes personal responsibility for the results of their work, it increases confidence in group morale to try their best. Example of both mastery and vicarious experiences.
Classroom Interactions	June 22, 2018 Time: 8:40 a.m. "Teachers discuss how excited they are to tell their students how they spent their summer using lasers and imaging porcine skin to try and detect cancer. One teacher says this will help motivate her class to accept challenges and learn something new along the way."	<ul style="list-style-type: none"> The teachers really wanted to find a way to fit in what they learned in the lab into their classroom curriculum. Taking the time to apply or discuss the skills one learns in or outside their level of expertise to an aspect of their lives, speaks to the confidence gained in having learned those skills. Example of a mastery experience.

Table 1. Five themes extracted from Participant Observer Reflections (first column), example of journal reflection that establishes the corresponding theme (second column), and analysis of reflection that supports respective theme (third column).

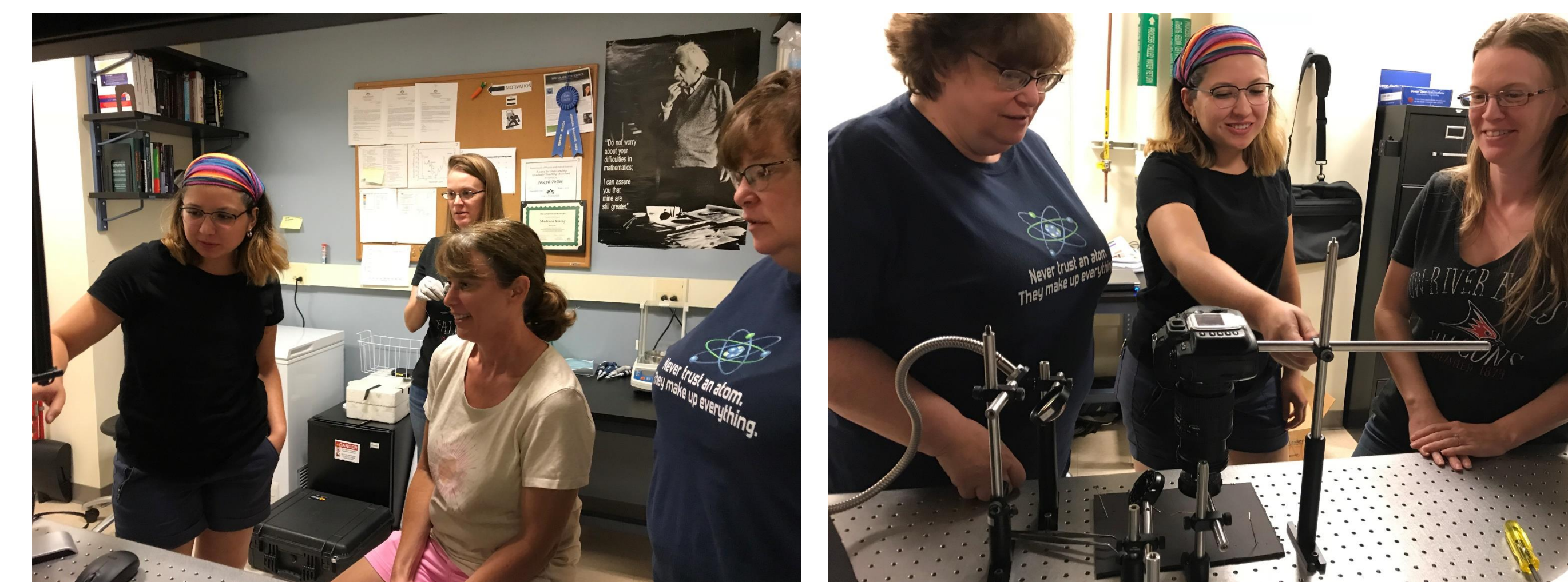
Conclusion

Results demonstrate teachers improved self-efficacy beliefs and confidence after engaging in hands-on research in a university setting. These results suggest that engaging teachers in collaboration and hands-on research can positively change self-efficacy beliefs and confidence. In particular, this construct explores teachers' attitudes toward student success. Teacher confidence and knowledge are associated with positive student academic outcomes. Implications from these findings suggest those who are interested in positively influencing teacher self-efficacy beliefs should invest in hands-on, collaborative research in a university setting. Themes from the participant-observation underscore the importance of asking questions and praising successes in research settings.

Recommendations

Further research should explore analysis at the group level (professors, teachers, and students) to determine group differences as they are integral to the establishment of an environment that promotes such teacher interactions and behaviors as highlighted in the four main themes from participant observations. Reflections expose four recurring themes among mentors that directly impact the establishment of a productive environment. This study recommends that future research examine: (1) Building Fundamental Knowledge, (2) Collaborative Learning, (3) Encouragement, and (4) Establishing Routine as it relates to the group dynamics of a successful experience in increasing self-efficacy beliefs.

SRET's mission is to strengthen STEM and humanities teaching through intensive research collaborations among P-12 teachers, university scientists and Ph.D. and undergraduate students.



2018 SRET participants Nancy Ceja (student), Susan Trammell (professor), Liz Ratliff and Jackie Smith (teachers) (Photo by Scott Gartlan)

References

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- [2] Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, 84, 191–215
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