

The Impact of Service-Learning on Teacher Candidates' Self-Efficacy in

Teaching STEM Content to Diverse Learners

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### Abstract

The purpose of this study was to investigate the impact that service-learning has on teacher candidates' self-efficacy in teaching science to diverse learners. Participants included teacher candidates enrolled a STEM (science, technology, engineering, and math) content/pedagogy service-learning course during two semesters. Teacher candidates worked with two community partner on projects, with each semester featuring work with one of the community partners. Data collected included quantitative data gathered from the Science Teaching Efficacy Beliefs Instrument Form B (STEBI-B) as well as students' responses to reflective assignments. Results suggest that course teaching strategies, especially the inclusion of service-learning, may be responsible for teacher candidates' reports of increased confidence in engaging diverse learners as well as greater self-efficacy for teaching science.

## The Impact of Service-Learning on Teacher Candidates' Self-Efficacy in Teaching STEM Content to Diverse Learners

Through active involvement in service-learning, teacher candidates are immersed in community-based settings where they have the opportunity to meet and interact with children, families, and community members in real-world contexts. A requirement of service-learning is that the community-based experiences must relate directly to the subject matter of the course in which the teacher candidates are enrolled, such that teacher candidates learn the course content as they engage in service-learning experiences. Additionally, service-learning depends upon the commitment of both the university and community and/or school partner. As a collaborative process, service-learning within teacher preparation coursework has potential to provide teacher candidates with opportunities to develop academic, civic, professional knowledge or dispositions for teaching as well as to promote mutual respect and provide benefits for everyone involved (Jacoby, 2003).

Service-learning involves reciprocal impact (Baldwin, Buchanan, & Rudisill, 2007), meaning that it is beneficial to both the community and/or school partners as well as the teacher candidates and the college. With this sense of reciprocity in mind, we worked with the Office of Community-Based-Learning at our college to find partners specifically interested in collaborating to work with teacher candidates enrolled in a STEM (science, technology, engineering, and math) content/pedagogy service-learning course. Relying upon both quantitative and qualitative data, the current study explored how service-learning in diverse educational contexts provides undergraduate teacher candidates enrolled in a STEM content/

pedagogy service-learning course with opportunities 1) for increased self-efficacy in teaching science and 2) to cultivate deeper understandings of working with diverse learners.

### **Background and Rationale of the Study**

#### **Changing School Demographics**

One thing is certain; the face of our nation is changing. Nowhere is this more evident than in public school classrooms. According to statistical data, the percent of enrollment in PK-12 schools by race/ethnicity has shifted dramatically since 1970 when the majority of the Baby Boomers were enrolled in elementary school and high school. In 1970, the student population was 79% non-Hispanic White, 14% Black, 6% Hispanic, and 1% Asian and Pacific Islander and other races. In 2008, 59% of the school age population was non-Hispanic White, 18% Hispanic, 15% Black, and 5% Asian (U.S. Census Bureau, 2011). Increasingly, our current students are born in other nations<sup>1</sup>, speak languages other than English at home, and carry different cultural traditions with them to school. Due to changing patterns in demographics, the United States will soon experience a population diversity never before experienced by any nation, a population in which all races and ethnicities are part of minority groups that make up a complex whole.

#### **Service-Learning as a Response to Increased Classroom Diversity**

Due to shifts in school demographics towards greater ethnic and linguistic diversity, the task of preparing a teaching workforce has become increasingly more complex; teachers need the skills necessary to teach to high standards while also being effective with all learners. One reason for this complexity is the fact that most teacher education programs continue to be populated with students who are primarily White, female, monolingual, and middle class, which is a

candidate pool with limited intercultural experiences and the potential to assume that their own educational and life experiences are similar to or identical to those of their students.

In order to address the homogeneity found in the candidate pool, teacher preparation programs are “challenged with building bridges across a critical gap in the understanding of diverse socioeconomic, linguistic, and cultural backgrounds and the inequalities existing for people different from the mainstream culture” (Baldwin, Buchanan, & Rudisill, 2007, p. 316). Coffey (2010) brings the argument one step further by suggesting that there “is a need to formally prepare teachers to educate all students, taking their multiple backgrounds into account in order to cultivate trusted relationships, build on students’ funds of knowledge, and ensure their academic success” (p. 335). Yerrick (2005) further suggests that teacher candidates must be exposed to diverse educational contexts where assumptions “that their own experiences and histories are sufficient to draw upon for expert pedagogical choices” (p. 204) are challenged. In this way, teacher candidates are challenged to view the world through the lens of communities other than their own, and to examine critically the culture of power (Delpit, 1995/2006) and to consider their assumptions about White as normative (Macintosh, 1998).

A critical component for preparing teachers for today’s classrooms, therefore, must be to situate them in diverse settings, including informal science contexts where they have multiple opportunities to interact with its diverse members as well as reflect upon and make meaning of those experiences. Service-learning affords teacher candidates the opportunity to interact with members of diverse communities, and Wade (2000) provides guidance, noting the importance of 1) ensuring collaboration to minimize the asymmetry between the server and the served, 2) offering varied community experiences to provide multiple perspectives on societal issues, and

3) planning for critical reflective papers and discussion so that teacher candidates are able to confront their preconceived biases and/or beliefs.

Collaborative community service-learning can provide teacher candidates with experiences outside their comfort zones, and “has the potential for empowering prospective teachers to confront injustices and to begin deconstructing life-long attitudes and constructing socially just practices” (Baldwin, Buchanan, & Rudisill, 2007, p. 315). Studies show that service-learning has strong civic outcomes when activities are intentionally connected to civic knowledge, skills, and dispositions. This can be accomplished through dialogue and assignments that specifically help students to see the linkage and understand the meaning of their service (Boyle-Baise & Sleeter, 1998; Buchanan, Baldwin, & Rudisill, 2002; Sleeter, 2000).

### **Role of Reflective Practices**

Embedded within courses in teacher preparation programs, service-learning possesses the potential for engaging teacher candidates in critical discussions and reflective practices where they are able to examine in-depth the personal biases they hold, with the ultimate goal of better understanding the meaning and relevance of diversity. Experiences such as these have the power to provoke teacher candidates to begin to understand children who initially appear to be living in seemingly different worlds and to challenge teacher candidates’ assumptions about minority students’ abilities, their communities, and their schools. Through reflection, teacher candidates may begin to move from accepting the status quo to questioning it. “Ultimately such questioning can lead to altered understandings and perhaps even subsequent actions. Thus, service-learning has the potential for being the catalyst for transformative thinking” (Baldwin, Buchanan, & Rudisill, 2007, p. 317). It is our hope that these initial experiences in their teacher preparation

program will help teacher candidates move beyond thought to action, to consider a teaching career where they are actively “working to make a difference in the civic life of our communities and developing the combination of knowledge, skills, values, and motivation to make the difference” (Ehrlich, 2000, p, vi). Thus, a goal of this study is to investigate the role that service-learning plays in teacher candidates’ development of deeper understandings of diverse learners as well as increased self-efficacy in teaching science.

### **Why STEM (Science, Technology, Engineering and Math)?**

There is no question that the future success of students and our nation will depend on the skills and knowledge developed in science, technology, engineering, and mathematics, or the STEM fields. STEM knowledge and skills are crucial to virtually every endeavor of individual and community life. “All young Americans should be educated to be ‘STEM-capable,’ no matter where they live, what educational path they pursue, or in which field they choose to work” (Carnegie Foundation, 2007, p. 1). However, as articulated in a preliminary draft of the Next Generation Science Standards (2011-2012), “the U.S. system of science and mathematics education is performing far below par and, if left unattended, will leave millions of young Americans unprepared to succeed in a global economy” (p. x).

Yet research indicates that despite the number of science courses taken, teacher candidates continue to enter their practicum (student teaching) as well as their professional careers lacking self-efficacy or the belief that they can successfully teach science in diverse classrooms (Banks, 2006; Tosun, 2000). One potential reason for this could be that less time is spent teaching science than any other subject in elementary schools (Stefanich and Kelsey, 1989). Additionally, when science is taught, teaching comprises textbook readings, memorizing,

repeating and confirming scientific facts, and listening to lectures (Yager & Lutz, 1994). Service-learning experiences embedded within key teacher preparation coursework appear to be a promising venue for increasing teacher candidates' science teaching self-efficacy and potentially the drive to teach more science. Therefore, as indicated, a second goal of this study is to investigate the role that service-learning plays in cultivating teacher candidates' self-efficacy in teaching science.

### **Self-Efficacy in Teaching Science**

Self-efficacy is “the belief in one’s capabilities to organize and execute the courses of action required to manage prospective situations” (Bandura, 1995, p. 2). Essentially, self-efficacy is a person’s belief in his or her ability to succeed, or the level of competence they expect to display in any given situation. These beliefs are determinants, or part of the foundation, for how people think, behave, and feel. Efficacy beliefs have the power to influence how much effort people are willing to put forth when pursuing goals, how long they will persist in the face of adversity, their resilience in rebounding from temporary setbacks, and how much stress or depression they experience in coping with demanding situations (Bandura 1986, 1993, 1995).

Self-efficacy can be divided into two cognitive constructs: (1) personal self-efficacy and (2) outcome expectancy. Personal self-efficacy is the individual’s conviction that he or she can orchestrate the necessary actions to perform a given task. More specifically, personal self-efficacy was defined by Bandura as “judgments about how well one can organize and execute courses of action required to deal with prospective situations that contain ambiguous, unpredictable, and often stressful elements” (1977, p. 201). Outcomes expectancy is “a person’s estimate that a given behavior will lead to certain outcomes” (p. 201) or the individual’s estimate



of the likely consequences of performing that task at the expected level of competence (Bandura, 1986).

Riggs & Enochs (1990) developed an instrument to measure the efficacy of teaching science, the Science Teaching Efficacy Belief Instrument (STEBI). Consistent with Bandura's theoretical framework, Riggs and Enochs (1990) identified two uncorrelated factors: personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE). PSTE is the teachers' belief in their ability to teach science, whereas STOE is the teacher's belief in students' ability to learn. When applied to the study of teachers, Enochs and Riggs (1990) predicted that science teachers who believed student learning could be influenced by effective teaching would persist longer, provide more academic focus in the classroom, and exhibit a larger repertoire of ideas and strategies.

Science Teaching Efficacy Belief Instrument (STEBI) has been used in research to understand efficacy beliefs in teaching science. As measured using the STEBI, teachers with a higher sense of personal science teaching efficacy (PSTE) reported spending more time teaching science and were more likely to spend the amount of time needed to adequately develop the science concept being considered (Riggs & Jesunathadas, 1993). Low self-efficacy beliefs were reflected in the limited amount of time spent teaching science (Gilbert & Yerrick, 2001; Weiss, 1997). Consistent with these findings, the research of Lumpe, Haney, & Czerniak (2000) found that teachers with high self-efficacy implemented more inquiry-based activities whereas teachers with low self-efficacy transmitted knowledge through a fact-based curriculum. PSTE was related to the rating a teacher gave to the personal relevance of science and the teachers' enjoyment of science activities (Watters & Ginns, 1995). Higher PSTE scores among pre-service teachers have

been related to their preference to teach science (Lucas, Ginns, Tulip, & Watters, 1993) and to a more humanistic orientation toward control in the classroom (Enochs, Scharmann, & Riggs, 1995).

Scores on the second factor of the STEBI, the teacher's belief in students' ability to learn (STOE) have been related to the quality of teaching in science. Teachers with low scores on the STOE were found to rely more heavily upon text-based approaches rather than hands-on, activity-based approaches, and teachers with low scores used cooperative learning less (Riggs, 1995). Research also has documented that teachers with low scores on the STOE were rated as less effective in science teaching, rated themselves as average, and were rated as poor in attitude by site observers (Enochs, Scharmann, & Riggs, 1995).

### **Developing Teacher Candidates' Science Teaching Efficacy Beliefs**

Teacher candidates who have high levels of science teaching self-efficacy are confident in their ability to teach science and believe that diverse student groups can be successful in science if they receive effective teaching. Given the strong relationship that exists between teacher efficacy, instructional practices, and student achievement, Tschannen-Moran, Woolfolk Hoy, & Hoy (1998) suggest a need to determine which practices embedded within teacher preparation programs facilitate the development of teachers who have high levels of science teaching self-efficacy.

According to Bandura (1977, 1986), there are four major sources of self-efficacy: enactive mastery experiences, vicarious experiences provided by social models, social persuasion, and psychological state. Of these four sources, "The most effective way of developing a strong sense of efficacy is through mastery experiences," (Bandura, 1994). Mastery

experiences within the context of teacher preparation programs are those instances where teacher candidates are provided with opportunities to teach. Tschannen-Moran et al. (1998) explain:

Only in a situation of actual teaching can an individual assess the capabilities she or he brings to the task and experience the consequence of those capabilities. Through situations of actual teaching, teacher candidates gain information about how their strengths and weaknesses play out in managing, instructing, and evaluating a group of students. (p. 229)

Research findings on the outcomes of mastery experiences confirm their promise in enhancing teaching self-efficacy (Enochs & Riggs, 1990; Wade, 1995; Watters & Ginns, 1995). As it relates specifically to science teaching efficacy, Cone (2009) reported that after participating in service-learning, teacher candidates “were confident that with effective science teaching, diverse student groups could be academically successful in science” (Cone, 2009, p. 31).

### **Current Study**

While there are many goals in elementary science teacher education, one must be to instill confidence in teacher candidates the ability to teach science successfully. This is relevant particularly because “once efficacy beliefs are established, they appear to be somewhat resistant to change” (Tschannen-Moran, et al., 1998, p. 23). Therefore, the current study explored how service-learning in diverse settings provides undergraduate teacher candidates enrolled in a STEM content/pedagogy service-learning course with opportunities for increased self-efficacy in science teaching as well as opportunities to cultivate deeper understandings of diverse learners. More specifically, the following research questions guided this study:

1. What role does service-learning embedded within a STEM content/pedagogy course have on teacher candidates' understandings of and comfort with diverse learners?
2. What role does service-learning embedded within a STEM content/pedagogy course have on teacher candidates' self-efficacy in science teaching?

Many prior studies investigating this second question have relied solely on quantitative measures (Tschannen-Moran, et al, 1998), typically in the form of Likert-scales. Our approach is somewhat different. We chose to include also a qualitative component, or interpretive study to capture in-depth understandings embedded within the rich data set available from student responses to reflective papers and discussions. This approach would yield types of understandings that crystallized when teacher candidates had the opportunity to interact in informal science contexts with children.

The use of reflective papers and discussions is not new. These reflective activities lie at the heart and soul of service-learning. Service-learning should include the vital component of reflection, which engages teacher candidates in knowledge construction and reconstruction as they analyze their own previous understandings of teaching and learning, including preconceived notions of people from diverse cultural and linguistic backgrounds (Boyle-Baise & Sleeter, 1998; Buchanan, Baldwin, & Rudisill, 2002; Sleeter, 2000). This research acknowledges the importance of reflection through its qualitative data, or students' responses to reflective exercises of journals they maintained. Quantitative data was gathered throughout the semester from the Science Teaching Efficacy Belief Instrument (STEBI).

## **Method**

### **Participants**

Participants included 25 undergraduate teacher candidates enrolled in two sections of a STEM content/pedagogy course at a small, undergraduate liberal arts college in the Northeast. There were 23 female and 2 male teacher candidates. Twenty of the teacher candidates were first-year students, one was a sophomore, one was a junior, and two were seniors. All participants gave informed consent. Because teachers do not live necessarily in neighborhoods similar to those of their students, they often have little to no knowledge of what to expect from students who come from different sociocultural backgrounds than themselves (Ladson-Billings, 1994). With this in mind, we worked with the Office of Community-Based Learning at our college to collaborate with two distinct, yet similar community partners.

### **STEM Content/Pedagogy Service-Learning Course**

As part of their licensure program in elementary education, teacher candidates are required to take a three-credit STEM content/pedagogy service-learning course designed to prepare them in the basics of science using a constructivist, inquiry-based model. The first eight weeks of the fourteen-week semester are spent in the college classroom where the curriculum includes an equal emphasis on science content and pedagogical content knowledge (e.g., science talk, constructivist principles, the role of inquiry, and service-learning). Whenever possible, content instruction is delivered via a series of hands-on, inquiry-based activities, with emphasis placed on the cross-cutting concept of energy and matter. Teacher candidates participate in class activities, and complete written assignments, both individually as well as in small groups to have the support of collaboration with class members. Discussions and interactions with individuals

and groups draw attention to important concepts embedded within the inquiry. Short lectures demonstrate key concepts or provide explanations not directly accessible through hands-on inquiry. Teacher candidates are given ample class time to explore materials prior to class discussion or explanations.

Teacher candidates spend the remainder of the six weeks of the semester working with their community partners. During this time, students work in teams of three or four to design and teach lessons to small groups of students, using both the content and the pedagogy learned in class. In the present study, teacher candidates spent 14 – 16 hours working with students from the community partnership.

### **Community Partners and Settings**

**Project 1 - Year 1.** A low-income housing complex in a community neighboring the college was the community partner for the spring of 2011. During the initial contact with the director of the afterschool program, two goals for the collaboration were identified: 1) to provide academic enrichment for students participating in an ad hoc after-school program (attendance was not required, students were free to come and go at will) and 2) to construct a playground. Thus, these two goals became the focus of our first semester of work. The Director arranged for 12 students ranging from grades 3 - 11 to work with teacher candidates for the semester.

**Project 2 - Year 2.** The community partner for the spring of 2012 was a non-profit organization which provides 1) English language classes, 2) assistance in accessing health care and finding jobs, 3) counseling services, and 4) programs for youth and elderly. The director of the association came to the initial planning meeting with a focused goal of providing academic

enrichment during their after-school program. The director arranged for 21 students ranging from grades 1 - 7 to work with teacher candidates for the semester.

**Demographics of the community.** According to United States census data, the city where our teacher candidates completed their service-learning reported a total population of 94,316 in 2011. Nearly a quarter (24.3%) of the population is foreign born, with over a third of the city's population (35.2%) reporting speaking a language other than English at home. The median household income between 2007 and 2011 was reported as \$49,848. The state median is \$65,981. Census data indicates that 15.6% of the population lives below the poverty line.

### **Data Sources and Collection**

**Written assignments.** All data sources used to address our research questions were assignments completed by teacher candidates as part of their final grade for the course. Written assignments included the following: three in-class response papers, reflective journal entries completed after each site visit (where teacher candidates were asked to relate their service-learning experiences to course content), an assessment report, and a grant proposal to fund a structure for a future 'science playground'. Prompts for the in-class response papers were given verbally. In the first, teacher candidates were encouraged to reflect upon their own experiences as learners of mathematics and science. In the second, teacher candidates were encouraged to reflect upon their prior experience working with diverse learners. Upon the completion of the service-learning component of the course, teacher candidates wrote a third in-class response paper by writing about their overall experience during the semester where they designed and taught their own science lessons and activities.

**Instrument.** The Science Teaching Efficacy Belief Instrument Form B (STEBI-B) developed by Enochs & Riggs (1990) was used for pre- and posttests. The STEBI-B is a modification of the Riggs (1988) Science Teaching Efficacy Belief Instrument (STEBI) Form A and consists of 23 items that assess the self-efficacy beliefs of teacher candidates. The STEBI-B measures two sub-scales: 1) 13 items on the Personal Science Teaching Efficacy (PSTE) scale and 2) 23 items on the Science Teaching Outcome Expectancy (STOE) scale. Each item was linked to a five-point Likert-scale response ranging from “strongly agree” (5) to “strongly disagree” (1). Possible scores on the PSTE range from 13 to 65, and STOE scores may range from 10 to 50. Examples of the items from Enochs and Riggs (1990) include “I know the steps necessary to teach science concepts effectively” (item #5, PSTE Subscale) and “The teacher is generally responsible for the achievement of students in science” (item #14, STOE Subscale).

### **Data Analysis**

**Qualitative data.** All written sources of data were reviewed and deconstructed into meaningful units for coding ranging from one phrase to several sentences. The initial codes were organized into three categories: 1) responses related to working with diverse populations 2) responses related to self-efficacy in teaching science (as it relates to personal self-efficacy), and 3) responses related to self-efficacy in teaching science (as it relates to outcomes expectancy). These three data sets were then carefully examined and initial codes that fell into a particular pattern were grouped together into broader themes that represented interpretations of meaning for the teacher candidates. Once this process was completed by two of the study’s authors, coders met and discussed developing categories. Differences in opinion were resolved, and consensus reached through negotiation. Frequencies of interpretive codes were noted. Inter rater reliability



was about 93% between two researchers. For confidentiality, pseudonyms were used when reporting out data.

**Quantitative data.** To estimate internal reliability, Cronbach's alphas for the overall scale as well as each of the sub-scales were calculated for both pre- and posttests. To check the effectiveness of the service-learning on teacher candidates' science teaching efficacy beliefs, means and standard deviations were calculated on pretests and posttest scores. Repeated measure ANOVA was employed to determine whether the difference between the pretest and posttest scores were statistically significant.

## **Results**

### **Research Question 1**

The first research question is as follows: What role does service-learning embedded within a STEM content/pedagogy course have on teacher candidates' understandings of, and comfort with, diverse learners? Results of the current study revealed that service-learning can impact teacher candidates' dispositions towards teaching in diverse settings. As shown in Table 1, qualitative results relating to teacher candidates' understanding of, and comfort with, diverse students can be best explained through three distinct categories: awareness of stereotypes, efficacy in engaging diverse learners, and moving towards civic engagement.

Table 1  
*Themes Related to Teacher candidates Understanding of, and Comfort with, Diverse Learners*

Category	Theme with Sample Exemplars	Percent Articulating Exemplar
Awareness of Stereotypes	Re-examining preconceptions	
	Recognized lack of experience working with diverse students	52
	Expressed initial concern about working with diverse students	36
	Reported change in perceptions about the students and the community	52
	Recognizing underlying causes for academic/behavioral challenges	
	Recognized their own misconceptions about the community	40
	Looked beyond difference to find common ground	72
	Suggested superior position for themselves (e.g., role model)	24

Efficacy in	Growing relationship with individual learners	
Engaging Diverse Learners	Concerned behavioral symptoms would interfere with instruction	60
	Developed understanding of underlying causes for behaviors deemed inappropriate	72
	Expressed increased efficacy in engaging individual learners	64
	Learning to engage students with individually/culturally responsive teaching	
	Expressed initial concern about ability to engage students	68
	Articulated awareness of the importance of flexibility in meeting individual needs	72
	Expressed belief in mastery learning for all students	40
Moving Toward Civic Engagement	Expanding their role as a 'teacher'	
	Recognized connections between the environment outside classrooms/schools and student development	44
	Planning for civic action	
	Expressed desire to advocate for students, families, and community	20

**Category one: Awareness of stereotypes.** To work effectively with diverse learners teacher candidates must not only understand the students whom they are working with, but also understand the communities the students call home. Due to a lack of exposure to diverse students

as well as diverse communities, many teacher candidates possibly entered service-learning unknowingly holding blanketed stereotypes. Prior to their participation in the service-learning accompanying this class, 52% reported having little to no experience working with students from diverse backgrounds, and 36% expressed concerns about working with students from linguistic, cultural, and/or socio economic backgrounds different than their own. Concerns ranged from anxieties about the potential for “a significant language barrier” to “not knowing how to deal with certain situations due to difference in background.”

*Re-examining preconceptions.* Despite the fact that few teacher candidates openly discussed stereotypes that they held for the students and community before entering this service-learning experience, 52% reported a change in their beliefs across the semester. As Emma stated:

I was introduced to students from backgrounds I was unfamiliar with and learned that many stereotypes people have about students from towns like B\* are simply not true. I myself believed that many of these students would be unmotivated, and I quickly realized that I was wrong. These students are just as motivated as students from other backgrounds.

For 40% of the teacher candidates, service-learning also afforded them the opportunity to look beyond difference and to find common ground with the students they were working with.

Sophia articulated her feelings regarding diversity:

While the experience was meant to show us how to handle diversity, I really learned that there were more similarities than differences. As a group we looked at the students as kids who were very much like ourselves when we were their age. They were curious and intelligent and did not look at us different from them.

Although 40% of teacher candidates eventually recognized their own misconceptions, 24% expressed that they were, or they could be, “a role model” for students, possibly suggesting a superior position for themselves. One teacher candidate, Regina, reflected:

I wanted to be the best role model I could be and completely commit myself to them when I was there . . . I desperately want to be part of these kids’ lives for as long as they want me to be.

***Recognizing underlying causes for academic and behavioral challenges.*** As evidenced by written reflections and class discussions, service-learning stimulated nearly three-quarters (72%) of teacher candidates to look beyond preconceived notions and to question the subtle, yet significant causes behind behaviors that they believed would interfere with instruction. Emma discussed her student’s behavior in one reflection: “I learned that teachers cannot immediately label a student as a ‘bad student because they misbehave; in most cases, there is an underlying reason for their misbehavior.”

Through their experiences with service-learning, teacher candidates also began to understand that the underlying causes for these behaviors are not as clear-cut as they once thought, that these behaviors can come from various sources and be expressed in different ways. Addison examined her student’s disinterest in the program:

When I first met C\* he was very closed off and didn’t want anything to do with our group or me. On our initial visit, he basically told us he didn’t want us there . . . and was not confident in his intelligence.

This sub-theme of assuming a connection between not understanding the content and behavior they deemed inappropriate was common. When reflecting on her experience, Emma commented:

I do not know if this was due to the fact that he was not paying attention or maybe he genuinely did not understand the lesson. Perhaps his interruptions and goofy behavior were ways to hide the fact that he did not understand what was being taught.

Other teacher candidates began to think more globally, questioning the role of students' lives outside of school on their academic behavior. One teacher candidate wrote "What teachers need to remember . . . is that children have a life outside of school. This life can be full of hardships and other struggles which the children may sometimes carry over into their school time."

Re-examining preconceptions and questioning underlying causes for student behavior not only allowed teacher candidates to reserve instant judgment but also appeared to lay the foundation for positive, individual relationships with their students.

**Category two: Efficacy in engaging diverse learners.** Teacher candidates initially had reservations concerning both students' ability to learn STEM content, as well as their own ability to effectively engage this group in instruction. Findings suggest that service-learning provided them with opportunities to build individual relationships with their students, relationships which eventually became the foundation for the planning and delivery of effective STEM based lessons.

***Growing relationship with individual learners.*** At the start of the service-learning experience, 60% of teacher candidates were concerned that the students showed behaviors that

had the potential to interfere with instruction. However, throughout their service-learning experiences teacher candidates acknowledged strong bonds forming between themselves and their students. As relationships strengthened, some teacher candidates found that students' behaviors improved. John explains, "After much interaction with the pupils, I feel as though they trust us more and so they pay better attention now. Recently, the pupils haven't acted out or even interrupted as they used to."

After weeks of ongoing individual interactions, nearly two-thirds (64%) of teacher candidates spoke about feelings of increased efficacy for engaging their students. Addison articulated the relationship with her student:

C\* counted on me being there every week and now that the experience is over I could tell he was sad. C\* definitely had a hard time letting me get to know him and help him, but once he did, his intelligence and personality really shined through. This experience was extremely eye opening.

Teacher candidates also spoke about the idea that it was important to devote time to building relationships with students. Even though it could take time for the relationships to develop, once the relationships were in place, teacher candidates could see how this made an impact. Emma noted the "importance of one-on-one interactions with all students." Emma continued, "Even though it may just be a few minutes, it makes such a big difference, and it allowed me to see a different side of A\* - a side that wants to learn."

***Learning to engage students with culturally responsive teaching.*** At the beginning of the semester, two-thirds of teacher candidates (68%) expressed concerns about their abilities to appropriately engage students in the learning process. Many reasons were expressed for these

difficulties, with 40% indicating that their lack of experience in teaching was a factor (e.g., “keeping students from different academic levels on the same page”). The nature of teaching in an informal setting of an after-school program was cited as a factor by 72% (e.g., “We came into the building during a time which they usually were playing and doing what they desired.”)

Service-learning also allowed many of teacher candidates (64%) to realize early on that rigidly following planned lessons might not always be the most successful way to engage students. While acknowledging the importance of well-prepared lessons, their experiences with service-learning allowed almost three-quarters (72%) of teacher candidates to come to an understanding of the importance of flexibility with the goal of meeting individual student needs. As evidenced by teacher candidates’ reflections, this was easier said than done. When speaking about one specific student, Holly commented,

[He] was very reserved with us. He seemed to put on a facade that was supposed to make them look cool and tough, making sure that we knew that they did not care . . . Attributes such as this caused us to alter our lesson plans accordingly, and prepared us for our lessons to come.

For many teacher candidates it was not until they realized the importance of tailoring pedagogical decision-making to individual students that they finally reported experiencing success. As Regina explained, “To teach effectively, you cannot just take the subject and topic and make a lesson, you must build a lesson around the personalities of your class.”

Regardless of the effort needed, our teacher candidates agreed that struggling to engage all students was challenging but well worth the effort. Angela summarized it well:



After all my visits, I have experienced many struggles . . . but in the end I found it was all worth it because I got to meet five amazing second graders who have taught me about diversity and I have learned a lot through their eyes.

Many teacher candidates came to the conclusion that mastery learning was possible, and in turn, the teacher candidates' efficacy for engaging all learners was strengthened. Findings showed that 40% of teacher candidates became strong believers of mastery learning for all students. Heather said it concisely: "These children allowed me to see that deep down, every student has the motivation and capability to succeed in school".

**Category three: Moving toward civic engagement.** Forty-four percent of teacher candidates reported that service-learning provided them with opportunities to make sense of the myriad connections between the environment outside classrooms/schools and student development. Once their eyes were open to these connections, 20% of teacher candidates expressed a desire to take the additional step of advocating for these students, their families, and their community.

*Expanding the role of a "teacher"*. Service-learning provoked more than half of teacher candidates (52%) to question their understandings about the role that teachers play in the lives of their students. Heather reflected, "I discovered how significant my role as both a teacher and a human being really will be, in order to help all of the future children that I encounter lead successful lives." Other teacher candidates reflected on the importance of teachers becoming integrated into the community, stating "we believe that reaching out into our surrounding neighborhoods creates a greater sense of community; a community in which we can learn and grow from each other."

*Planning for civic action.* As a culminating project for the course, groups of teacher candidates worked in collaboration with their service-learning partner sites to write grant proposals to fund elements of a future science playground. All teacher candidates groups were able to recognize and articulate the needs of students from historically underserved communities and the importance of collaboration among educators and the community. As stated in one grant proposal,

Our service learning class brought these two institutions together as a result of the beliefs and principles that we share. Both organizations strongly believe in the relevance of a strong education as well as the importance of social activities and community outreach. The combination of the two organizations creates a great sense of community as well as a space in which education, in particular STEM education, can be provided and furthers for those that are willing and able to participate.

Another common theme was the desire to continue to work with the program even after the course was over. As stated by Natalie, “I plan on returning with my group at the beginning of next semester to check back in and to keep volunteering with the \*\*\* because I believe very deeply in what they are doing and their mission.”

## **Research Question 2**

Our second research question was the following: What role does service-learning embedded within a STEM content/pedagogy course have on teacher candidates’ self-efficacy in science teaching? Results of the current study revealed that by providing teacher candidates with authentic mastery learning experiences, the STEM content/pedagogy service-learning course positively contributed to teacher candidates’ science teaching efficacy. Findings were supported

by both quantitative and qualitative results. Qualitative findings will be discussed first. As shown in Table 2, qualitative results relating to teacher candidates self-efficacy in teaching science can be best explained through two categories: personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE).

Table 2  
*Themes Related to Self-Efficacy in Teaching Science*

Category	Theme with sample exemplars	Percent articulating exemplar
Personal science teaching efficacy (PSTE)	STEM content understanding	
	Expressed initial concern about teaching science	56
	Expressed confidence in their ability to learn science	32
	STEM pedagogy understanding	
Science teaching outcomes expectancy (STOE)	Recognized discrepancy between their experiences as science learners and pedagogy explored in class	44
	Attributed success to thorough planning	76
	Witnessing student learning (STEM content)	
	Witnessed students' success in learning science content	52
	Attributed student success to effective teaching	76
	Witnessing student enjoyment (STEM content)	
	Initially believed students would not like science	48
	Witnessed students enjoying, science	76
	Believed their teaching could influence student learning	68

**Qualitative findings: Personal science teaching efficacy.** Personal science teaching efficacy refers to teacher candidates' faith in their ability to orchestrate the actions necessary to effectively teach science. Results of this study suggest that effective science instruction requires teacher candidates to have strong 'STEM content understanding' as well as strong 'STEM pedagogy understanding'. Analysis of teacher candidates' written course work revealed that many initially expressed concerns about their perceived limited understandings of, and level of comfort with, both science content and content-specific pedagogy. Fifty-six percent initially expressed concerns regarding their own weakness as learners of science, while 68% described having had limited experiences with engaging science teaching pedagogy during their own PK-12 educations.

***STEM content understanding.*** In their earliest reflections, 56% of teacher candidates voiced apprehension about teaching science to elementary aged students based upon their limited science content knowledge. Many teacher candidates voiced concerns similar to Jasmine who shared the following:

I remember when I first found out that we were going to be teaching a subject involving science I was petrified. I thought it was going to be very difficult. . . . I was very nervous that I would not be able to explain exactly why things happen, partially because I do not know exactly why they happen myself. My shortage of knowledge in science was a huge factor to my anxieties of educating other in the subject.

Throughout their involvement in service-learning, teacher candidates' attitudes towards teaching and learning appeared to change. For nearly one-third of teacher candidates (32%),

teaching science enabled them to not only learn science content, but also to enjoy it. Erika reflected on her experience with STEM content:

I have never really liked learning about science in school but I have really enjoyed learning it along with the pupils at the school. Teaching it to them makes it so much more exciting and I actually want to learn the information more than I ever have before.

But perhaps, Amber summed it up best. "I have learned a lot from this experience. I am no longer afraid of or intimidated by the idea of teaching science."

***STEM pedagogy understanding.*** The STEM content/pedagogy service-learning course introduced teacher candidates to reform-based science pedagogy emphasizing inquiry, dialog, and meaningful play. For many teacher candidates, these pedagogical approaches were novel, with 44% reporting discrepancies between their own experiences as science learners (PK-12) and the pedagogy explored in class. Addison reflected, "This experience has completely changed my outlook on teaching science. Prior to this class I had always just imagined reading from a book with little to no experiments."

Teacher candidates found that participating in activities in class modeled around these pedagogical approaches was helpful, and three-quarters of teacher candidates (76%) were truly able to experience success was through planning and implementing their own lessons. Holly stated, "Throughout completing these activities it caused me to take a step back and examine how my initial pedagogy differs from my current pedagogy, whose changes are primarily due to my experience at \*\*\*"

Due to the opportunity they were given to design and implement their own science instruction, Aiden believed that "I now have a better understanding of what it takes to develop an

interactive lesson that includes every student participating in an activity that will reinforce a science based concept”.

**Qualitative findings: Science teaching outcome expectancy.** Prior to this course, few teacher candidates reported participating in mastery experiences with teaching in general, and even fewer had experience teaching science. Through the service-learning component of this course, teacher candidates were able to experience successes as well as failures, both of which appeared to contribute to their growth of confidence in science teaching efficacy. Seventy-two percent of teacher candidates reported they were more confident after the service-learning experience. As their own confidence in teaching increased, so did confidence that their teaching could result in higher student achievement. Over three-quarters of teacher candidates (76%) reported that their students learned science better as a result of their improved teaching. As shown in Table 2, qualitative responses related to the category ‘science teaching outcome expectancy’ are explained through two themes: ‘witnessing student learning’ and ‘witnessing student enjoyment’.

***Witnessing student learning.*** Through service-learning, more than half of teacher candidates (52%) were able to see first-hand that students were successfully learning the science content embedded within lessons. Abby reflected, "I was able to see that by the end they were truly interested in learning science and were retaining what we had taught them." Furthermore, more than three-quarters (76%) felt that their teaching could result in higher student achievement. Abby noted

By the end of this final lesson, Nancy had demonstrated that she made remarkable improvement over the five week course. She ended our several sessions with a basic

understanding of the states of matter and the ability to name them all and their basic properties.

For many teacher candidates (76 %) their student success was a source of pride; pride which served as the foundation for their growing confidence in the belief that their teaching could result in positive student achievement. As stated by Kimberly, “It made me feel so good as a teacher when the students finally understood the topics I had taught and I loved when their faces lit up when talking about the science that I had just taught them.”

***Witnessing student enjoyment.*** Before their service-learning experience, 48% of our teacher candidates believed that the students would not like science in general. However, through service-learning, three-quarters (76%) were given the opportunity to witness students not only learning, but enjoying, science. As stated by Aiden, “Through our activities I learned that the students in reality truly enjoy learning science.”

Moreover, two-thirds (68%) of our teacher candidates became hopeful that their effort in teaching science could result in students’ enjoyment of science learning. Natalie describes the progression of her group:

On our first visit, they seemed disinterested when we told them we were going to teach them science. However once we made science fun and interactive through our lessons they seemed to enjoy it more and more each time we visited to the point where they could not wait to come to [our College] and see the science labs.

Through their involvement in service-learning, 76 % of our teacher candidates were given an opportunity to realize for themselves that student enjoyment is not solely due to the content. Student engagement is also a direct result of the way the material is taught. Janice wrote:

I never would have thought to teach science in this way. I remember that when we had our first class and we conversed about the way we were taught science, I thought that the only way to teach science was how my teachers taught me. Science does not have to be merely about formulas and definitions. It can have aspects of play which will help students be more interested as well as using constructivism as a mean towards student's developing their own ideas. This experience has taught me to be a more hands on teacher especially within the STEM subjects.

**Quantitative results: Science teaching efficacy beliefs.** Data collected also included using the Science Teaching Efficacy Beliefs Instrument Form B (STEBI-B). STEBI-B consists of two subscales: a Personal Science Teaching Efficacy (PSTE) scale and the Science Teaching Outcome Expectancy (STOE) scale. To estimate the reliability of the STEBI-B, Cronbach's alphas for the overall scale, as well as each of the sub-scales, were calculated for both the pre- and posttests. Results show acceptable ranges of internal consistencies for all 6 scales: .80 for the overall scale pretest, .80 for the overall scale posttest, .77 for STOE pretest, .72 for STOE posttest, .89 for PSTE pretest, and .79 for PSTE posttest.

As shown in Table 3, mean scores for the overall Science Teaching Efficacy, Personal Science Teaching Efficacy, and Science Teaching Outcome Expectancy show increases in the posttest scores compared to the pretest scores. To determine if the difference between pre- and post-scores were statistically significant, repeated measure ANOVAs were conducted. Results revealed that the mean for the teacher candidates' overall Science Teaching Efficacy scale increased significantly across the semester  $\{F(1, 23) = 70.1, p < .00\}$  as did the Personal Science



Teaching Efficacy mean score  $\{F(1, 24) = 50.9, p < .00\}$ . The increase in Science Teaching Outcome Expectancy mean scores were not statistically significant  $\{F(1, 23) = 1.8, p < .19\}$ .

Table 3

*Pretest and Posttest Scores on Science Teaching Efficacy, Personal Science Teaching Efficacy (PSTE), and Science Teaching Outcome Expectancy (STOE)*

		N	Mean	Std. Deviation
Total Efficacy*	Pretest	23	3.09 (78.74)	.41
	Posttest	23	3.88 (89.33)	.32
PSTE*	Pretest	24	3.31 (44.08)	.64
	Posttest	24	4.04 (52.60)	.47
STOE	Pretest	23	3.56 (35.57)	.47
	Posttest	23	3.66 (36.57)	.37

*Note.* Total efficacy stands for Sum of PSTE and STOE. PSTE stands for Personal Science Teaching Efficacy Belief Scale. STOE stands for Science Teaching Outcome Expectancy Scale. Numbers in parenthesis represent the total mean scores for the scale.

\*  $p < .05$ .

## Discussion

Analysis of our results suggests that two critical elements of service-learning may have laid the foundation for building teacher candidates' efficacy in teaching STEM content to diverse learners. One critical element of the service-learning was the nature of the community partners. In order to influence teacher candidates' perceived efficacy in working with diverse learners, it was paramount to place teacher candidates in community settings where they are not only worked with a diverse population but also had some control over managing the students and the curriculum in ways that made sense to them as future educators. Thus, afterschool programs seeking academic enrichment were selected. A second element of service-learning that potentially paved the way toward building efficacy in teaching STEM content to diverse learners

was the incorporation of frequent, varied, and focused discussions of, and reflections on, the service-learning experience in light of course goals.

Teacher preparation programs have historically employed practicum experiences to engage teacher candidates with students at the grade/age levels associated with their licensure. Although these experiences are a valuable part of the teacher preparation process, it is important to realize that the practicum experiences are very different from service-learning. While both practicums and service-learning are often in diverse settings and linked to specific course goals, they are clearly not the same thing. Practicums serve a very different purpose, that of acculturating teacher candidates to the nature of schools and classrooms. In practicums, teacher candidates are assigned to classrooms where they are encouraged to follow the lead of their cooperating practitioners, enforce existing rules and routines, and teach a curriculum that neither they nor the children had input (Buchanan, Baldwin, & Rudisill, 2002). Given the nature of practicums and the differential power structure they entail, teacher candidates engaged in practicums may be more willing to accept, and willingly take part in, the behaviors and practices they observe rather than to question the existing state of affairs. Thus, in order to provide our teacher candidates with opportunities to question the status quo, this STEM content/pedagogy course was specifically designed to provide teacher candidates with an opportunity to participate in service-learning.

### **Research Question 1**

Results of this study suggest that service-learning embedded within a STEM content/pedagogy course has the power to make an impact on teacher candidates' dispositions towards teaching in diverse settings and their perceived efficacy in engaging diverse learners, as well as

cultivate the notion of teachers as agents of social change. Service-learning provided teacher candidates with access to powerful practical and personal experiences which encouraged them to think deeply about the difference between initial expectations and reality and to question status quo. In particular, results suggest that service-learning opened teacher candidates' eyes to previously held deficit perspectives about diverse learners and communities different from their own. More than half (52%) of our teacher candidates acknowledged that they initially held limited expectations for these students academically and behaviorally—ideas that changed throughout their service-learning experiences. Additionally, nearly three-quarters (72%) reported coming to understand that in order to work effectively with all students it is important to look beyond preconceived notions and expectations about behaviors that interfere with instruction.

Results suggest that teacher candidates' initial ideas were challenged due to the relationships they were developing with individual learners. Across the semester, 60% of teacher candidates acknowledged strong bonds forming between themselves and their students, bonds which enabled our teacher candidates to think deeply about themselves as future teachers, about their students as individuals and as learners, and the need for instruction to be individually and culturally responsive. At the same time, relationships with individual students enabled more than half of the teacher candidates (52%) to acknowledge the challenges faced by families and their communities and to question their understandings about the role that teachers play in the lives of their students. For some teacher candidates, this recognition led them to 'expand the role of a teacher' to include that of a member of the greater society charged with being a change agent. Most importantly many of our teacher candidates expressed concern about the potential negative

impact of environments in communities and societies on students' academic potentials, with five out of six groups articulating the desire to advocate for these students and the community.

### **Research Question 2**

As previously stated, one critical difference between a practicum and service-learning is the ability of the teacher candidates to take control of, or to manage, both student behavior and the curriculum. Typically, in a practicum teacher candidates are required to follow the lead of their cooperating practitioners as they relate to classroom rules, routines, and the curriculum. Service-learning in the informal setting of an afterschool program provided this group of teacher candidates with a much different experience: the opportunity to design and implement their own science lessons. These opportunities, viewed within the lens of Bandura's (1977) Social Cognitive Theory, can be considered authentic mastery experiences. According to Bandura (1994), mastery experiences such as these are the most effective way to develop a strong sense of efficacy. Our results support this assertion.

Suggested by both quantitative and qualitative results, findings from the current study suggest that providing teacher candidates with authentic mastery learning experiences through service-learning, where teacher candidates are able to design and implement their own instruction contributed positively to science teaching self-efficacy. Results from the STEBI-B revealed that teacher candidates' scores for 1) overall science teaching efficacy, 2) personal science teaching efficacy, and 3) science teaching outcome expectancy all increased across the semester. Additionally, teacher candidates' scores increased substantially for overall science teaching efficacy and personal teaching efficacy. Thus, quantitative results of this study suggest that through intentionally planned projects, linked specifically to course goals, service-learning

has the power to increase teacher candidates' attitudes towards their effectiveness as teachers of science.

Qualitative results illuminate the details underlying these attitudinal changes. For this group of teacher candidates, personal science teaching efficacy requires teacher candidates to have a strong 'STEM content understanding' as well as strong 'STEM pedagogy understanding' (e.g., access to a variety of content-specific pedagogical approaches). Across the semester, written reflections revealed that participation in service-learning enabled many teacher candidates to overcome their initial apprehension in both learning science content as well as choosing appropriate pedagogies. After their participation in service-learning, nearly one-third (32%) of teacher candidates reported a newfound enjoyment in learning science content in preparation for their lessons, while 76% expressed feeling successful in their instruction. Thus, it appears as though service-learning provided these teacher candidates with opportunities not only to "learn" science, but also to "teach" science, two activities which appear to have promoted increased science teaching efficacy.

Increased scores on the STEBI-B related to science teaching outcomes expectancy, or teacher candidates' estimate of the likely consequences of teaching science at the expected level of competence, can be explained through direct experiences working alongside students, witnessing student learning as well as witnessing student enjoyment. Interaction with students during service-learning allowed our teacher candidates to closely observe behavior and learning progress and try out strategies, which, in turn, may have cultivated their confidence in positively affecting students' learning of, and attitude towards, science. Service-learning enabled this group of teacher candidates to see first-hand that when both a strong science knowledge base and

reform-based pedagogies are applied; students not only successfully learned science but also enjoyed the experience.

For many teacher candidates, participating actively in service-learning was a transformative experience. The fact that the results were based on written reflections where teacher candidates attempted to make sense of their feelings, observations, experiences and theoretical understandings gave warrant to the authors' beliefs that teacher candidates were impacted by service-learning. The complementary use of qualitative and quantitative methods adds additional support to the authors' claims regarding the impact of service-learning on teacher candidates' efficacy.

### **Limitations and Recommendations**

It is important to note that findings from this study were drawn from a single institution and an individual instructor. Therefore, generalizing results from this study to other academic institutions is limited. This being said, we believe that the significance of these findings has the potential to extend beyond the preparation of elementary teacher candidates to the preparation of science teachers at all levels of licensure.

While the quantitative results complement the findings from the qualitative analysis, supporting service-learning as vehicle for developing teacher candidates' science teaching efficacy, the authors acknowledge limitations in the design and analysis of the quantitative data embedded within the study. Limitations include a very small sample size with no control group being utilized in the design. Thus, although informative, caution needs to be taken in generalizing these results.

Another limitation relates to the qualitative findings. The prompts for the in-class writing, as well as the reflective journal entries completed after each site visit, were intentionally left as open-ended responses. Therefore, the content of these reflective assignments varied dramatically among teacher candidates. Thus, the percentages we report for the frequency of each category reflects how many brought up the topic without prompting, not how many teacher candidates would agree with each idea. Had we used focused prompts or questions to guide teacher candidates' responses, the percentages reported may have looked quite different.

Suggestions for future studies include use of a quantitative measure of teacher candidates' self-efficacy in working with diverse learners. In order to explore the role of service-learning on teacher candidates' science teaching efficacy, both a quantitative measure (STEBI-B) and qualitative data were used. On the other hand, the findings reported related to teacher candidates' self-efficacy in working with diverse learners was based solely upon teacher candidates' perspectives as revealed by their responses on open-ended, in-class writing as well as reflective journal entries written after each site visit. As discussed above, these written assignments only capture data that teacher candidates chose to disclose. A more objective measure of self-efficacy in working with diverse learners, specifically a pre- and post-quantitative measure has the potential to further clarify and support the qualitative results.

Another suggestion for future research is investigating the impact on our community partners. The current study focused solely on the potential impact that service-learning has on the teacher candidates. The impact of service-learning on our community partners, specifically the partner students with whom our teacher candidates worked, the program director, as well as the center itself were evident. However, the data is anecdotal. Through a robust investigation of the

impact that the service-learning element of this course had on our community partners, it is anticipated that the quality of the service-learning component could be better explored, with the ultimate goal of improving the results for both our teacher candidates and our community partners.



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## Footnotes

<sup>1</sup>According to U.S. census data, in 2010, the nation's foreign-born population reached 40 million, which accounted for 13 percent of the total U.S. population. Another 33 million (11 percent) were native-born with at least one foreign-born parent in 2009, making one in five people either first or second generation U.S. residents.