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Developing Preservice Elementary Teachers' Professional Identity as Science Teachers Through Community-Based Service-Learning

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As preservice elementary teachers (PSETs) engage with the community, they start to develop their professional identity as educators. This longitudinal, mixed methods study examined how participation in a science-focused, community-based service-learning (CBSL) experience, a Family Energy Fair, influenced the professional identity development of 39 PSETs. Pre- and post- surveys were utilized, incorporating quantitative and qualitative components, including students' reflections on their experience. Pre- and post-CBSL findings indicate that there was growth in both individual and social aspects of PSETs' developing identity. Individually, PSETs identified themselves as more knowledgeable about science content, standards, and the need for personal flexibility in teaching. However, they were only slightly more confident about their abilities as science teachers and less likely to see teachers as content experts. Socially, PSETs were more likely to view themselves as facilitators or helpers as a result of the CBSL experience, assisting students in understanding difficult concepts and seeing connections. Pre- and post-CBSL reflections demonstrate that while 80% initially did not understand what CBSL was, by the end of their multidimensional service-learning experience, they greatly expanded their ideas about the identity of teachers as collaborators with the community.

Keywords: *preservice elementary teachers, energy, identity development, science methods, service-learning*

Desarrollo de la identidad profesional de los maestros en formación como profesores de ciencias a través del aprendizaje-servicio basado en la comunidad

A medida que los futuros maestros de primaria (en inglés 'PSET') se involucran con la comunidad, comienzan a desarrollar su identidad profesional como educadores. Este estudio longitudinal a corto plazo de métodos mixtos examinó cómo la participación en una experiencia de aprendizaje-servicio comunitario (ASC) centrada en la ciencia, una Feria de Energía Familiar, influyó en el desarrollo de la identidad profesional de treinta y nueve futuros maestros de primaria. Se utilizaron encuestas previas y posteriores, en las que se incorporaron componentes cuantitativos y cualitativos, incluidas las reflexiones de los estudiantes sobre su experiencia. Los hallazgos previos y posteriores a la experiencia de ASC indican que hubo un crecimiento en la identidad de los maestros, tanto en aspectos individuales como en los sociales. Individualmente, los maestros se identificaron a sí mismos como más conocedores del contenido y los estándares científicos, así como de la importancia de la flexibilidad personal en la enseñanza. Adquirieron algo más de confianza en sus habilidades como profesores de ciencias, pero pocos identificaron a los profesores como expertos en contenido. Socialmente, como resultado de la experiencia ASC, los maestros fueron más propensos a verse a sí mismos como facilitadores o asistentes que ayudan a los estudiantes a comprender conceptos difíciles y a hacer conexiones. Las reflexiones previas y posteriores demuestran que si bien el 80% inicialmente no entendía qué era ASC, al final de su experiencia de aprendizaje-servicio multidimensional, los maestros participantes expandieron enormemente sus ideas sobre la identidad de los docentes como colaboradores de la comunidad.

Palabras clave: *futuros maestros de primaria, energía, desarrollo de la identidad, métodos científicos, aprendizaje-servicio*

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Community-based service-learning (CBSL) experiences for preservice elementary teachers (PSETs) are valuable for many reasons. Universities develop partnerships with community schools to promote PSETs' academic development, self-efficacy, professional dispositions, and social understanding of educational contexts (Root & Furco, 2001; Verducci & Pope, 2001). In science, service-learning experiences may be crucial in helping preservice teachers overcome anxiety about learning and teaching content which they perceive as challenging (Enochs & Riggs, 1990; Harlow, 2012; Palmer, 2001).

CBSL experiences are experiences separate and distinct from students' traditional practica and student teaching experiences. They are cooperative, experiential learning in community contexts that integrates coursework, reflection, and social action through activities that meet community needs (Cress, 2005; Eby, 2001; Eyler & Giles, 1999). Rich community-based service-learning experiences for students move beyond volunteering, with activities and experiences designed to encourage real-world problem-solving, develop interpersonal and civic skills, and enhance understanding and application of academic content (Eyler & Giles, 1999). They also differ from practica and student teaching experiences by being more informal, guided by community needs and learners' interests. This is in contrast to the uniform goals and objectives that often accompany traditional educational field experiences.

Engaging students in CBSL experiences is important, given that 33% of practicing teachers in the United States perceive their length of engagement in the classroom through practica and student teaching experiences prior to graduation as too short (Feistritzer, 2011). Research shows that teachers are more likely to implement new content and methods when they are given multiple opportunities to practice what they have learned during their teacher education program (Darling-Hammond et al., 2009), including through course-based service-learning experiences. These opportunities may help to further clarify PSETs' goals and aspirations around teaching, ensuring the teachers we train today are in the field tomorrow. U.S. data suggest that up to 50% of new teachers leave the field by their fifth year (U.S. Department of Education, 2014).

Even in high-quality, state-certified, and nationally accredited teacher education programs such as ours, students benefit when practica and student teaching experiences are supplemented by CBSL opportunities. In our initial practica, PSETs often have limited roles within the classroom, with the focus on observing teachers and assisting students as needed. Hence, CBSL experiences can help students gain valuable experience working with schools and their community prior to advanced practicum courses and student teaching—experiences that require them to take on greater responsibility and leadership roles.

CBSL experiences may be especially important in science education. Students in the United States currently rank 17th in a 2018 Program for International Student Assessment (PISA) study of the world (Organization for Economic Cooperation and Development, 2018) and 48 states report shortages of science teachers (Cross, 2017). These data raise concerns that U.S. students will not have the skills and access to experiences needed in the emerging global economy. CBSL experiences, outside students' typical practica or student teaching experiences, may provide opportunities that benefit both schools of teacher education and those in the local community, enriching content knowledge in disciplines such as science, where information is changing and evolving. This is particularly important, given that even when students get into the field via practicum experiences, their opportunity to engage in science teaching is more limited as classroom experiences often focus on literacy and mathematics instruction (Milner et al., 2012; Rivera Maulucci, 2010).

Professional Identity Development in PSETs

As PSETs begin to engage with the community, elementary schools, and students through CBSL experiences, they gain not only valuable content knowledge but also start to develop their identity as professional educators, both as individuals and in their social role within the classroom and community. As generalists, preservice teachers focusing on the elementary school years often develop dual identities as general and science educators (Chen & Mensah, 2018; Mensah, 2008). The development of a strong professional identity may be vitally important to their self-efficacy and retention in the teaching profession, as they merge their past, present, and future ideas about themselves as teachers (Bernstein, 1996). These

identities are constructed using insights gained from interactions within their microsystem and are influenced by culture and context (Bronfenbrenner, 1979). While required practica start the process of identity development, the addition of CBSL experiences to other offerings within teacher education programs can help to further crystalize students' views and ideals regarding themselves and their future profession (Carrier et al., 2017; Luehmann, 2007; Wilson et al., 2015).

Theoretical and conceptual work attempts to define professional identity, its components, and developmental trajectory. Gee (2000) saw professional identity fundamentally as being “recognized as a certain ‘kind of person’ in a given context” (p. 99). He discussed the components of identity development as aspects of an individual’s nature such as their upbringing or innate tendencies; interchanges with institutions such as schools, and the discourse they have with others; and the affinity they develop with groups, or identification as a member of a community. In Gee’s framework, individuals play an active or passive role in adopting, challenging, and negotiating how they identify themselves. Carrier et al. (2017) discussed the process of identity development, highlighting how individuals “begin to develop an identity within that community that changes over time as they move from novice toward expert and as they incorporate the mannerisms, language, and customs of that community into their identity” (p. 1735).

Luehmann (2007) suggested that some teaching opportunities, such as those offered by CBSL experiences, “afford more identity resources” by providing “collaborative teaching in out of school contexts” (p. 829). She asserted that experiences teaching in community-based settings provide PSETs with more freedom and lower-stakes settings that encourage risk-taking, serving as a safer environment in which to explore both how they view themselves as individuals; as effective, knowledgeable content learners; and, socially, as members of the school community. More recent work by Hanna et al. (2020) lays out a conceptual framework for teacher professional identity, highlighting four components, including their motivation for becoming a teacher; their self-image or view of themselves as a member of the profession; self-efficacy or their individual skills; and task perception or what they see as the goals of teaching. Again, these aspects look at both the individual’s personal skills and attributes (self-efficacy and motives) and social role (professional interchanges and tasks).

Several studies have examined the process of identity development in PSETs, highlighting both changes in PSETs’ conceptions of their individual self-efficacy and in their social or interactive sense of self. Longitudinal case studies have found changes in identity from preservice to post-graduation, with PSETs expanding their notion of themselves as teachers. In particular, they come to see the complexity of their role and the need for not only individual skills such as content knowledge but also social aspects such as science inquiry skills developed in interaction with students (Carrier et al., 2017; Chen & Mensah, 2018). Chen and Mensah (2018) highlighted the role that outside placements and experiences have for future science teachers. They discussed how these experiences help teacher candidates see themselves individually as scientists as well as social agents, interchanging with students and other professionals as they engage in the teaching of science, trying on different teacher identities in the process. They theorized that these experiences, even over the course of one semester, influence preservice teachers’ ways of seeing themselves and how they participate in classrooms.

CBSL and Professional Identity Development

Individual and Social Identities

Multiple studies have suggested that high-quality CBSL experiences strengthen PSETs’ individual identity, including sense of self-efficacy. For example, Cone’s (2009, 2012) quasi-experimental study compared PSETs in her science methods courses who received “service-learning enhanced” versus “standard” experiences. Service-learning-enhanced experiences included spending one hour per week implementing the science lessons learned during class with children at a local community center. Utilizing interviews and pre- and post- questionnaires, she examined changes in PSETs’ self-efficacy beliefs. Cone’s work found changes in PSETs’ self-efficacy in the service group, rooted in the opportunities provided within the CBSL experience for mastery experiences. This included engaging in authentic teaching experiences, which

allowed PSETs to engage directly with diverse students. Vicarious learning, which includes watching another model teaching techniques—a strategy frequently used in practicum experiences—was not shown to be as effective in developing a sense of self as competent to meet a range of challenges that may be experienced in teaching. The CBSL component also expanded PSETs' ideas about their professional identity, leading the service-learning-enhanced group to view individual qualities such as inquiry, flexibility, and the use of diverse approaches to teaching content as more important in teaching science than those in the traditional sections of the course, who focused on individual preparation and social engagement as the keys to effective teaching (Cone, 2012).

Work by Moseley et al. (2004) examined a CBSL experience where PSETs served as science buddies to elementary school students and offered a Family Science Night for parents, at which children could present their projects. Utilizing a variety of qualitative data sources (i.e., field notes, individual written reflections, and large group oral discussions), they found that PSETs grasped several important ideas about teaching through their service-learning experience, including the need for teachers to plan but be flexible, highlighting individual aspects of the self that are important to teaching success. However, their work also emphasized the development of a teachers' social identity, acknowledging the importance of teachers being facilitators who learn from their experiences with students outside and in the classroom. As a result of their experience, they also were more likely to value students as individuals and science teaching as a student-centered endeavor.

Other studies have found that CBSL experiences enrich PSETs' sense of the professional skills important to their role and identity as science teachers. Cartwright (2012) utilized field notes from observations, reflections, and interviews with college students to understand the impact of a service experience in an afterschool program. She found that PSETs' ideas about "science talk" expanded and developed during the semester; PSETs learned that inquiry-based science instruction is not about helping students find the "right answer," and it requires teachers to give up some control to their students, highlighting the social aspect of teachers' evolving identity.

Cox-Petersen et al. (2005) also integrated work in an afterschool program with coursework in science and literacy. Through an examination of PSETs' student portfolios and qualitative reflections, they found changes in PSETs' confidence in teaching science and pride in their accomplishments in working with elementary school students. However, they also became more conscious of the social aspects of a teachers' role and identity, including how teachers need to plan collaboratively and to implement interactive, inquiry-based science activities in which they directly engage with students.

Wilson et al. (2015) had PSETs combine an environmentally focused science curriculum course with a variety of service-learning experiences in the community (working in outdoor learning spaces, creating a community garden, and facilitating a Family Science Night). Qualitative data, including written reflections and interviews at the end of the semester, were used to look at themes identified by PSETs. PSETs highlighted individual areas of growth, including helping them to actively and physically experience science content and to develop their own philosophy of teaching science, emphasizing the individual changes they experienced as learners. They also felt that they made an impact on other individuals and/or the community, highlighting how the experience promoted social aspects of their identity.

The Present CBSL Experience with PSETs and Questions About Identity Development

Developing a sense of identity is a process; it develops both over time and in the context of experiences such as those offered by CBSL. Studies of a variety of CBSL efforts examined in this literature highlight many potential ways in which CBSL experiences may shape the identity of PSETs. Some studies show the role these experiences play in developing individual skills such as content knowledge, confidence, flexibility, and a view of themselves as not only teachers but learners (Cone, 2012; Cox-Petersen et al., 2005; Moseley et al., 2004; Wilson et al., 2015). Others have suggested that these experiences may be more important to the development of social aspects of their identity as teachers, including their role as facilitators in the inquiry process and as experts on not just content but also on their students and their needs (Carrier et al., 2017; Cartwright, 2012; Chen & Mensah, 2018). Hence, the present study examined how a CBSL

science experience, a Family Energy Fair offered as part of a science methods course, influenced the development of PSETs' identity, both individually and socially.

Research suggests that well-crafted CBSL experiences, which encourage real-world problem-solving, develop interpersonal and civic skills, enhance understanding and application of academic content, and address community needs and learners' interests (Eyler & Giles, 1999), have the potential to develop both individual and social aspects of identity. The Family Energy Fair was a thoughtfully constructed CBSL experience that enabled PSETs to have multiple types of engagement with elementary school students and teachers and was not affiliated with a required practicum experience. This multidimensional CBSL project had several components. At the beginning of the semester, the first author was invited to the science methods class to talk to the PSETs about the concept of CBSL and the project.

The second author focused mainly on introducing the science concepts regarding energy, the content area of focus, to the PSETs in their science methods course. She assisted them in researching and developing activities for an Energy Fair for students and teachers at a local elementary school, which was held at the university. As part of the Energy Fair, two classes of PSETs developed eight activities each, which they offered for two different groups of 4th-grade classes. PSETs had the opportunity to run their activities and teach their lessons to multiple groups of students during the Family Energy Fair. Activities focused on understanding different types of energy, measuring energy usage, preventing energy loss through finding drafts, and calculating energy saving at home by making simple changes. The second author also helped them plan and pilot two lessons on the same topic that were team-taught at the elementary school.

The elementary students and teachers not only came to the university and participated in the Energy Fair but also visited the Biomass Heating Plant and the Resource Recycling Center at the University. PSETs helped to coordinate and lead these experiences. Hence, learning about energy was not confined to content knowledge, but the elementary students, teachers, and PSETs also had opportunities to see how renewable energy was being used to heat the buildings at the university and the daily applications of reduce, reuse, and recycle principles practiced in the community. The experience allowed for multiple levels of interchange with the school, teachers, and students. It also met a community need as energy usage and savings are important considerations in the poor rural area where both the school and university are located.

As part of the project, pre- and post- assessments of PSETs were utilized to explore the following questions:

1. How can a multidimensional CBSL project influence PSETs' developing sense of professional identity?
2. In what ways does this experience, based in both the classroom and the community, contribute to changes in individual versus social aspects of PSETs' developing identity as elementary school science teachers?

Methods

Setting and Participants

Setting. Family Energy Day was held on the campus of the university and facilitated by PSETs who were enrolled in a science methods course. Attendees were 4th-grade students from a nearby elementary school, accompanied by parents and teachers. The university and the elementary school are located in the northeast part of the United States. Information from the National Center for Education Statistics(2018) described the elementary school as rural with a student population of 321, composed primarily of students who identify as being Caucasian (94%); 53% receive free or reduced lunch. The 4th-grade students walked to campus. They participated in an Energy Fair facilitated by PSETs and also visited the campus Biomass Heating Plant and the Recycle-Reuse-It Center run by the university. During the Science Fair, eight stations of energy-related, hands-on activities were set up by the PSETs. The 4th graders were divided into groups and were given 10 minutes to work on each activity with the guidance of the PSETs who were in charge of

the stations. PSETs also visited the same elementary school to implement two additional energy-related lessons, working in teams.

Participants. The participants were PSETs who were enrolled in a four-year college program, seeking a Bachelor of Science degree in elementary education (K–8). The data were collected while the group was taking a science methods course with the second author. Although all participants took the science methods course in the same semester, they were from two different course sections. The total number of PSETs in the course was 39, with 20 PSETs in the morning section and 19 in the afternoon section. However, only data from 35 participants (1 sophomore, 29 juniors, and 5 seniors; 6 males and 29 females) were complete; four PSETs did not submit the post- questionnaire. Students enrolled in the course had completed an introductory practicum prior to taking the science methods course. In this practicum they focused on observing teachers and working with students only when needed. One-third of the students had taken an advanced practicum that involved greater responsibility and interchange within K–8 classrooms. Only three out of the 39 students in the study were enrolled in a practicum course while taking the science methods course and the two courses were not connected in any way.

Data Collection

This mixed methods, longitudinal study used a survey with a combination of closed- and open-ended questions administered to PSETs pre- and post- the CBSL experience.

Close-ended, quantitative survey questions. Quantitative questions were adapted from the Science Teaching Efficacy Belief Instrument-B (STEBI-B) designed for preservice teachers (Bleicher, 2004; Enochs & Riggs, 1990) and the 2000 National Survey of Science and Mathematics Education (Weisset al., 2001). Five items from the STEBI-B Personal Science Efficacy Scale were chosen; these questions had factor loadings ranging from .47 to .74 with the full subscale; the alpha of the full subscale was .90 (see Enochs & Riggs, 1990). These five questions were chosen as they focused on aspects of science instruction that might reasonably be experienced in the context of a CBSL experience such as having the skills to teach science, willingness to explore different strategies for teaching science, comfort with student questions, and explaining concepts to students. Five questions were taken from the 2000 National Survey of Science and Mathematics Education. The questions focused on important skills for effective science instruction such as familiarity with the national science standards, experience teaching science, involving students, helping students see connections, and communicating with parents and other teachers.

Respondents rated the 10 statements using a Likert scale, with responses ranging from *strongly disagree* to *strongly agree*. Five of the statements examined PSETs' developing identity as individuals, including knowledge, confidence, and experience, and five examined their social identity, including their views on engaging with students and fellow teachers.

Open-ended questions and prompts. Pre- and post- open-ended questions centered on goals and outcomes related to learning science content about energy, teaching methods, and their community-based service-learning experience. Prompts included the following:

1. What do you hope to learn/did you learn about the topic of energy?
2. What do you hope to learn/have you learned about teaching science to elementary school students?
3. What do you know about community-based service-learning?

Students responded to these open-ended prompts both before and after their CBSL experience, reflecting only on their CBSL experience that semester. Reflection is a major component of service-learning courses (Sherman & MacDonald, 2009). Phenomenological data analysis, as described by Moustakas (1994), was employed in this study. Phenomenological data analysis is a qualitative approach. In this case, the researcher worked to explore how the PSETs viewed their goals for and interpretation of the CBSL experience in terms of its contributions to their professional identity and evolving sense of self. Phenomenological analysis has the goal of trying to understand how a particular experience shapes an individual's views and feelings. Pre- and post- reflections of PSETs' CBSL experience were reviewed.

Coding occurred in two stages. First, the pre-CBSL transcripts were annotated for insights into the participants' experiences and perspectives on being teachers. Next, emerging theme codes we catalogued; it involved looking for patterns in the codes or themes. Some transcripts showed evidence of multiple themes within them. The themes generated in the pre-CBSL reflections helped to form the basis of the coding for the post-CBSL reflections. As such, elements of both phenomenological and thematic analysis were utilized, with an emphasis on the individual and social knowledge and skills that were part of the CBSL experience.

Results

Data Analysis

The quantitative data were analyzed using SPSS statistical package (Version 19). Paired sample *t*-tests were used to examine pre- and post- differences for the 10 Likert-scale statements. This statistical test was utilized as the objective was to examine the difference between a matched pair where the dependent variable is continuous (i.e., interval or ratio level), where the subjects in each sample were the same, the data were normally distributed, and there were no outliers in the difference between the two related groups. In addition, the effect size for all the statements was determined using Cohen's *d*, which stated that a near 0.2 is a small effect, a *d* near 0.5 is a medium effect, and a *d* near 0.8 is a large effect (Cohen, 1988).

Changes in Individual and Social Identity

Results of the paired sample *t*-tests are shown in Table 1.

Table 1
Paired Sample T-Tests for the 10 Statements (n = 35)

	Questionnaire Statements	Pre-Mean	Post-Mean	Difference Between Means					
				Pre-Post	SD	t	df	Sig. 2-tailed	Cohen's <i>d</i>
Individual Knowledge and Efficacy	1. I am familiar with the national science standards.	2.20	3.80	-1.60	1.01	-9.41	34	.000***	1.58
	2. I have the experience of teaching science.	2.30	3.97	-1.66	1.26	-7.79	34	.000***	1.32
	4. I am willing to explore inquiry teaching in science beyond the information that are provided in syllabi or textbooks.	4.37	4.54	-0.17	.79	-1.29	34	.205	.22
	6. I do not wonder whether I have the necessary skills to teach science.	2.46	3.00	-.54	1.20	-2.68	34	.011*	.45

	Questionnaire Statements	Pre-Mean	Post-Mean	Difference Between Means					
				Pre-Post	SD	t	df	Sig. 2-tailed	Cohen's <i>d</i>
	10. I believe I can be a good science teacher.	3.97	4.03	-.06	1.03	-.33	34	.744	.06
Social Skills Knowledge and Efficacy	3. If I am to teach science, I would welcome student questions.	4.54	4.34	+.20	1.43	.83	34	.414	.14
	5. I can devise activities which involve student participation in learning of science.	4.09	4.37	-0.29	.86	-1.97	34	.058	.34
	7. When a student has difficulty understanding a science concept, I will usually know how to help the student understand it better.	2.94	4.60	-.66	.87	-4.46	34	.000***	.76
	8. I can help students see connections between science and other disciplines.	3.85	4.09	-.23	.60	-2.26	34	.030*	.38
	9. I know how to communicate with parents/teachers.	4.17	4.20	-.03	.86	-.20	34	.845	.03

Note. * = $\rho < .05$, ** = $\rho < .01$; *** = $\rho < .0001$

Qualitative Data

Each set of open-ended responses from PSETs was analyzed using phenomenological and thematic approaches. Multiple themes could be present within a single student's response. Frequency counts were based on how often PSETs noted different themes (see Table 2).

Overall, the CBSL experience was associated with shifts in PSETs' individual and social ideas about teaching and their identity as teachers. Prior to the CBSL, PSETs focused on the need to bolster their individual skills, such as their ability to explain science concepts to students, and to be comfortable or confident when teaching. After their CBSL experience, they focused less on their individual skills in these areas, acknowledging the need to be flexible over practiced or smooth in their approach. While PSETs at both time points acknowledged the need for teachers to be engaging or fun, they were more likely to acknowledge the need for teachers to really be facilitators and to know their students.

Table 2*Changes in Individual and Social Aspects of Teacher Identity Pre- and Post-CBSL*

Teachers as ...	Pre-CBSL (<i>n</i> = 39)	Post-CBSL (<i>n</i> = 34)
Individual		
Explains Concepts	17.9%	8.8%
Knowledgeable/Content Expert	20.5%	5.9%
Learner	5.1%	8.8%
Comfortable/Confident	10.3%	0.0%
Evaluator/Assessor of Students	5.1%	0.0%
Human or Fallible	0.0%	5.9%
Flexible or Able to Modify Approach	0.0%	8.8%
Social		
Engaging or Fun	41.0%	41.2%
Facilitating Learning	35.9%	64.7%
Knowing Their Students	12.8%	14.7%
Connecting and Integrating Information	10.3%	11.8%

Note. PSETs could have mentioned more than one theme per response; therefore, totals do not add up to 100%.

Individual changes in knowledge and self-efficacy. PSETs' qualitative responses showed individual changes in their content knowledge and confidence in their skills to teach science. In the pretest analysis, most PSETs considered energy a broad topic which they were not very familiar. They had some general ideas about energy—namely, there are different types of energy, and it can be considered renewable or nonrenewable. Although some PSETs stated that they had learned about energy in middle school, none of the PSETs could state specifically what energy was or name the types of energy. Only five out of 35 PSETs could clearly state what they knew about energy in the pre- assessment.

However, in the posttest assessment, all PSETs were able to state some energy concepts that they had learned, often indicating the connection of the content to their physical experience with it. As one PSET noted,

Energy is the ability to do work! Potential energy is stored energy, kinetic energy is motion! ... Aluminum is a conductor of heat, even though it may be cold to touch. The ice cube will melt incredibly fast on aluminum compared to other materials. Heat conduction absorbs heat from us! Also, just touching something that is cold doesn't mean that it has a lower temperature than us. Energy is everywhere. What a phantom load is and how to save money on energy! (PSET 1.12)

This same student communicated at the pre- assessment that, although they "loved science," they did not know anything about energy that they could recount. The experience working with the students also helped to crystalize their own knowledge, reinforcing the ideas that teachers are also learners within the classroom; viewing flexibility as an important trait; and conceptualizing their role not as authorities who explain and assess, but who develop activities and experiences that help students see connections. While one PSET viewed the goal of their work at the pre- assessment as learning "fun, integrative, hands-on" activities, at the post- assessment they recognized the complexities of teaching science, especially in a setting where they were given a great deal of independence:

I learned that it can be challenging because I don't always know the answers to particular questions, but do have the tools to figure out the answers and that's what's important. ... facilitating within a classroom while watch(ing) students problem solve and work together. (PSET 1.3)

Another student expressed the same sentiment, moving from viewing teachers as content experts to learners who need to be ready for students to "ask unexpected questions sometimes" (PSET 2.8). The student also

noted that it was just as important to have a “well planned out lesson as being able to go with the flow and learn from mistakes made during experiments” (PSET 1.8).

Several PSETs reported that, prior to the CBSL project, they had never taught science in the classroom. After the experience, many seemed to better understand the challenges and complexities in teaching science to elementary school students. As one noted,

I learned that it is not an easy task to teach science to elementary students. You have to vary your teaching so it can meet the needs of all students and you have to make sure to explain the concepts thoroughly so they can understand. (PSET 2.18)

Changes in social knowledge and self-efficacy. The pre-assessment responses of the PSETs demonstrated that they had a general understanding of what teaching in the classroom should look like. All PSETs who took the science methods course had taken their first practicum in their sophomore year, when they went to the schools twice a week and observed the teaching of the mentor teachers. One third of PSETs, who were seniors, had taken an advanced practicum in which they had the opportunity to teach in the classroom by themselves, with the guidance provided by the mentor teachers. However, most of them did not have the opportunity to teach science as part of their experiences. Several PSETs explicitly mentioned that they did not have a chance to teach science in their practicum. One said, “I have never been able to teach a science lesson in any of my practicum, so I hope to learn more about student inquiry and the process of teaching science lessons in the classroom setting” (PSET 2.13).

In considering the social aspects of their identity as teachers, most understood prior to their CBSL experience that teaching science should be like teaching any other content, requiring them to create experiences that are fun and hands-on, and that include visuals to support students. Some PSETs pointed out that the science teaching needed to be related to the standards, modified for diverse needs, and integrated with other disciplines. In the post-assessment, many indicated the need for teachers to be not only engaging in their work but also active facilitators who are not constrained by outside forces such as standards, but who can utilize them to support and develop student learning. As one stated,

I have learned that it’s important to be flexible, and that [if] I don’t know an answer, I need to help the students find out. I have also learned that I need to align my lessons with the State Standards, and that kids learn best with hands-on activities. Lessons that follow 5E (Engage, Explore, Explain, Extend, Evaluate) format usually provide ample ways for students to learn new things. (PSET 1.6)

They also highlighted how teachers and students learned together, through mutual discovery and inquiry. As one commented, “Science is more than just looking through textbooks or researching definitions. There are many fun activities that a teacher can do to engage their students and let them think scientifically” (PSET 1.9).

Finally, they identified the importance of teachers knowing their students through social interchanges. As one noted, “I learned that you can’t assume that students have previous content knowledge” (PSET 2.11). Through these social interactions, they also learned that “4th graders have a lot of misconceptions and their knowledge of science isn’t as strong [as] I original thought” (PSET 2.12).

Through taking the science methods course, PSETs realized that there was a difference in teaching science as compared with teaching in other disciplines. They found it was not only allowing the students to do the hands-on activities but that teachers also need to allow students to explore the concepts and develop their ideas.

Reflections also revealed some challenges to their social identity that PSETs encountered, especially around classroom management. PSETs often discussed problems they experienced in getting students focused on their work. They reported that they did know how to handle the behavioral problems in the classrooms as they were not familiar with the students and their respective classroom rules. As there were only five classes of 4th graders in the elementary school, the PSETs also had to teach in teams. The challenges of doing this, including the effort and time needed to communicate and collaborate with fellow teachers, were highlighted.

The greatest change in PSETs came in their understanding of their social role in the community. At the pre-assessment, 80% of the PSETs were not familiar with the meaning of CBSL. Some students thought that CBSL was about doing some volunteering that may or may not include a formal learning component; for example, learning about pollution and then cleaning a park, educating a group of people who leave school about how to have a better life, or having community members such as artists come into the classroom to talk to students. After the CBSL project working with the 4th graders, they had a broader sense of what CBSL was, including the social identity of teachers as collaborators. As one PSET noted,

I have learned that it is really important part of school and learning. Collaboration is a helpful and important thing to do because it helps spread the wealth of knowledge even deeper and helps people make meaningful connections between their lifestyles and their learning. It's really a good way to spread our knowledge for the better of an entire community as opposed to just a small group of students. (PSET 1.3)

They also came to understand the bidirectional nature of the relationships between schools and communities. This was exemplified by the statement of one PSET:

The community surrounding our school is an amazing resource. As is with any community that we will soon be teaching in, engaging this community in learning activities grows both the students' involvement in the community, and the community's involvement with the school. (PSET 1.5)

Others discussed the mutual benefits to children's learning when teachers bring all members of the microsystem (parents, schools, neighborhoods, and communities) together (Bronfenbrenner, 1979) so they "are all on the same page" (PSET 2.3) and support student learning across contexts. As one stated, "If we include parents and the community as a support for children, learning will only grow" (PSET 2.17).

Discussion

Reflective teachers are continually working to define themselves as professionals, using insights from experiences in the field to better understand themselves individually and socially. Well-designed CBSL experiences combine high levels of formal learning and community engagement (de Montmollin & Hendrick, 2006). They also incorporate the opportunity to work together in real-world community contexts, engage in social action to meet an identified community need, and to reflect and learn about oneself and the world through the experience (Cress, 2005; Eyler & Giles, 1999). The project discussed here tried to embody multiple ways for PSETs to learn course content while refining their skills through thoughtfully designed experiences in the context of the elementary school, college campus, and community.

CBSL experiences have the potential to enrich PSETs' ideas about the individual skills important to teaching as well as social components of their identity as teachers (Carrier et al., 2017; Cartwright, 2012; Chen & Mensah, 2018). However, this study reinforced and expanded work that looked at how CBSL experiences enrich PSETs' social sense of self, including how PSETs see themselves in social interaction and their role in the larger community.

Individual Aspects of Identity

Many studies have highlighted role of CBSL experiences in PSETs' individual conception of their professional identity. Individual skills and dispositions such as content expertise, flexibility, confidence, the feeling that you are capable of effecting change, and seeing yourself as a learner have been noted in previous work (Cone 2009, 2012; Cox-Petersen et al., 2005; Moseley et al., 2004; Wilson et al., 2005). In the present study, PSETs identified themselves as being more familiar with science standards and experienced in teaching science after their CBSL experience. They noted specific insights about what they had learned about energy in the post-assessment, valuing the direct physical experience with the phenomena provided by the methods course and through the activities developed and used with students. Doing the same activity multiple times with different groups of students was eye opening to PSETs, who learned that in teaching, practice does not always make perfect. Circumstances change, different groups of

students develop new and different questions, and teachers need to be flexible and open versus practiced and polished. This is especially important, given that most PSETs reported that they had little to no prior classroom experience that focused on science teaching.

PSETs highlighted the duality of their role as teachers and learners but not necessarily as scientists, as others have suggested (Carrier et al., 2017; Chen & Mensah, 2018). While slightly more confident in their skills, they also started to view teaching as a complex endeavor. They started to view it as less about explaining, being an authority on content, assessing their students, and being confident. Instead, they started to value and identify being able to shift, observe, and listen as crucial professional dispositions and skills they need to adopt. This CBSL experience provided PSETs with the opportunity to work in teams to develop, lead, and adapt activities and learning experiences to multiple groups of students on a topic with wide-ranging practical applications. It is interesting to note that PSETs felt that they gained valuable experience teaching science; however, they were still not sure they would be strong science teachers. This, in part, may be due to the role of elementary teachers as content generalists (Chen & Mensah, 2018) as opposed to content specialists who are more typically found at the middle- or high-school levels. At this stage in their professional development, they may not also have a clear picture of how much independent engagement will be needed of them as they teach in their own classroom for an extended period. Future work discerning how different types and differences in the intensity of CBSL experiences assist with development of the multiple identities of PSETs is needed.

Social Aspects of Identity

This study extends what we know about how CBSL experiences shape PSETs' social identity. Prior work has demonstrated that CBSL experiences assist PSETs in seeing teaching as student-centered and teachers as facilitators and collaborators who share control in the classroom with students and others (Cartwright, 2012; Cox-Petersen et al., 2005; Cone, 2012; Moseley et al., 2004). Similarly, this study found changes across the CBSL experience for PSETs in their perception of themselves as helpers who can assist help students in understanding difficult concepts and seeing connection.

However, there was no difference in their preparedness to respond to student questions. They reported being quite confident in this area at the pre- assessment but being slightly less comfortable after the CBSL experience. Perhaps the experience of having to think on their feet during their service experiences, especially in a context where they were less familiar with students and their needs, may have left them feeling off guard. Similarly, they felt unprepared to manage behavioral issues when in interaction with students, not having yet defined their identity in this area. This highlights the importance of preparing PSETs for their CBSL experience by providing guidelines and strategies to manage hard questions and behavioral challenges that may occur. The limited timeframe and intensity of the CBSL experience may not have allowed PSETs to use inquiry methods to their fullest extent to discover the answers together with students or to know students well enough to anticipate and head off problems before they occurred. However, they did appreciate and identify with the need for teachers to know their students well.

One of the most promising insights from this study surrounds PSETs' expanded ideas about CBSL. At the start of the study, 80% of PSETs did not understand what CBSL was. By the end of their CBSL experience, PSETs greatly expanded their ideas about a teacher's role and identity as collaborators with parents and the community, including the bidirectional nature of this association. This is in line with Bronfenbrenner's (1979) ecological systems model, which considers the multiple levels of influence on children's development and the reciprocal, bidirectional nature of effects. This CBSL experience enabled PSETs to go out into community schools, host students and teachers on their home campus, and introduce them to community resources located at the university. Having these multiple levels and locations of interchange may have been crucial to helping expand students' ideas about CBSL. Future work examining how their conceptions of service develop and how they incorporate CBSL into their work as they enter the field will greatly enrich our ever-expanding knowledge base. Cross-cultural work is especially important, given that notions of identity, individualism, community, and responsibility differ by culture and context.

Limitations, Future Work, and Conclusions

It is important to acknowledge several limitations of the present study. First, the study was conducted in a rural area in the Northeastern United States. The topic of energy was chosen as the basis for the CBSL intervention as it is closely related to daily life in the region, where energy use and insulation are major issues people are deeply concerned about. Hence, while the project had ecological validity in this setting, the findings may not transfer to other communities with different identified needs. Further, the cultural context in the United States is one that values individuality, and most educational contexts for younger children utilize a constructivist perspective. Cross-cultural work is needed to better understand how CBSL influences professional identity development, especially in contexts that are more collective and communal in orientation and where different models and pedagogy are common.

Second, the survey utilized to examine changes in individual and social aspects of identity development was brief; it examined a limited number of aspects of science teacher identity. Additionally, some questions may have been easier to answer due to the way the questions were worded. For example, it may be far easier to report whether you are familiar with a specific standard or have experience teaching science than whether you believe you will be a good science teacher at some point. Some questions, such as ones about communicating with parents and teachers, were broad. Future work might extend the survey to explicitly examine specific aspects of self-confidence, self-efficacy, and a richer array of questions related to pedagogy. Hanna et al. (2020) recently developed and piloted a multidimensional measure of preservice teacher identity that may show promise as a tool to use in future work.

Third, it is important to remember that the development of professional identity is a long-term process, with this study examining only its development across one 14-week semester. Longitudinal work is needed to more completely understand how other factors, beyond faculty-structured CBSL and field experiences, shape and alter identity. PSETs in this study were instructed to consider only how their CBSL experience influenced their ideas about teaching. However, it is possible that other factors, such as previous volunteer and practicum experiences, may have colored their reflections and views of the experience. Luehmann's (2007) work does suggest that CBSL experiences have a special and unique place in developing teacher identity, given the freedom, safety, and opportunities for reflection they provide. These experiences may be key to the development of teachers' identity as reformer-focused advocates of "student-centered, collaborative inquiry," as opposed to a "teachers tell and students listen" model of education (p. 825).

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