

Article

Soar into STEMed: Examining the Impact of a Service-Learning Internship on a Pre-Service Teacher's Conceptions of Culturally Responsive Teaching

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Abstract: Teachers' self-efficacy and beliefs about culturally responsive teaching are intricately intertwined with their practice and influence the ways they interact with children and families in and outside the classroom. To understand how participation in a service-learning internship (i.e., *Soar into STEMed*) focused on promoting science and mathematics content knowledge, self-efficacy, and conceptions about culturally responsive pedagogies, we examined pre- and post-survey responses to the Culturally Responsive Teaching Self-Efficacy (CRTSE) and Culturally Responsive Teaching Expectancy (CRTOE) scales and written reflections for one pre-service teacher, Alexis. The findings indicated that Alexis' self-efficacy and outcome expectancy beliefs declined across the internship, yet remained relatively high. Alexis' reflections further indicated an ability to identify and implement responsive teaching practices, though many fell short of being considered culturally responsive. The findings also demonstrated that the CRTSE and CRTOE scales were unable to capture all of the teaching activities that occurred in informal settings. Consequently, this study illustrates that Alexis' participation alone in the internship was insufficient in growing her conceptions of culturally responsive teaching, and more targeted and directed activities are necessary. Moreover, instruments that can more accurately assess pre-service teachers' self-efficacy and outcome expectancy beliefs regarding culturally responsive teaching across contexts is needed.

Keywords: service-learning; internship; science; mathematics; teacher preparation



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1. Introduction

Teaching practice is intricately intertwined with self-efficacy and beliefs. Teachers' self-efficacy impacts student motivation, teaching performance, and student achievement [1,2], whereas teachers' beliefs inform pedagogy, including which practices are implemented, what instructional goals are set and competencies fostered, and which tasks are used with which students [3–5]. In content areas that have historically been viewed as acultural or universal, such as science and mathematics, teachers' self-efficacy and beliefs are critical to implementing instruction that aligns with culturally responsive [6] reform-oriented instruction (i.e., instruction promoted by the Next Generation Science Standards (NGSS) and Common Core State Standards for Mathematics (CCSS-M)). Consequently, teacher educators must consider ways to bolster pre-service teachers' self-efficacy in and productive beliefs about culturally responsive science and mathematics teaching during their teacher preparation. One way to do this is through service-learning experiences.

Service-learning is different from community-based activities (e.g., practicums within teacher licensure programs). Service-learning engages students in course-related, organized service activities that meet the identified needs of community-based organizations

while also reinforcing the academic knowledge and skills learned in the classroom [7]. Service-learning emphasizes mutual benefit for the university and community, expanding opportunities to engage with diverse populations in informal environments, and promotes “an enhanced sense of personal values and civic responsibility” ([7], p. 112). Service-learning places equal focus on the service activity and the learning, involves reciprocity, benefits the public good, and engages students in structured reflection [8,9]. Structured, critical reflection is an important component of service-learning and requires students to analyze their experiences in the context of broader societal issues, the academic discipline, and course content [10]. In teacher education, service-learning experiences can increase pre-service teachers’ self-efficacy, generally and in relation to specific content areas (e.g., science, mathematics) [11–15], and productively inform beliefs about teaching and learning [12,16]. Many universities have developed internships based on the principles of service-learning in order to harness the benefits of both types of experiential learning [17,18]. Educators who prepare pre-service teachers can utilize service-learning to provide additional experiences outside of required licensure coursework to foster pre-service teachers’ self-efficacy in teaching science and mathematics using culturally responsive pedagogies.

Given the potential benefits of utilizing service-learning internships to cultivate culturally responsive teachers, this study sought to understand the impact of a service-learning internship conducted in an informal learning space (i.e., a local zoo). More specifically, this study sought to examine a pre-service elementary teacher’s (PSET’s) conceptions of culturally responsive teaching after participating in a science- and mathematics-focused service-learning internship that included varied capacity-building activities (e.g., facilitated educational interactions as docents with diverse intergenerational zoo visitors, curriculum development) intended to promote content knowledge, self-efficacy, and beliefs in and about science and mathematics as well as the use of culturally responsive pedagogies.

2. Literature Review

2.1. Leveraging Informal Learning Spaces for Teacher Preparation

In their teacher preparation program, PSETs often confront time, access, and resource challenges that can lead to feelings of underpreparedness and a lack of interest in teaching science and mathematics upon graduation [19]. In effort to overcome these challenges and increase opportunities within teacher preparation programs, scholars (e.g., [20–22]) have leveraged informal learning spaces as places to prepare future science and mathematics teachers. Findings from this body of research indicate that pre-service teachers benefit from experiences in informal spaces, such as increased content and pedagogical knowledge, productive beliefs and attitudes towards teaching, self-confidence and self-efficacy, and aspects of teacher identity [20–28].

Informal learning spaces can include museums, parks, and aquariums. However, zoos represent one of the most popular informal learning spaces due to their high attendance rates [29,30]. In the U.S. alone, approximately 183 million people visit zoos each year, with 57% of visitors being children 11 and younger [21]. Consequently, zoos represent an informal learning space that is advantageous for utilizing in teacher preparation programs given the preponderance of young children and families in conjunction with the benefits to future teacher development.

2.2. Preparing Culturally Responsive Teachers within Service-Learning

Culturally responsive teachers who work with racially, ethnically, culturally, and linguistically diverse students use various instructional techniques to meet the specific learning preferences and needs of their diverse students [31]. Characteristics and best practices of culturally responsive teaching include: maintaining high expectations for academic success; building on students’ strengths and interests; providing a culturally relevant curriculum; valuing family, community, and collaborative learning; and serving as a facilitator of learning more than teacher [32–34]. Though the techniques employed in culturally responsive teaching adhere closely to the best practices for teaching, Ladson-

Billings [33] emphasizes that culturally responsive teaching is more about a teacher's perspective than individual teaching strategies; culturally responsive teachers place value on lived experiences, family influence, and collaborative effort.

Statistics show a significant incongruity in U.S. public schools between the race/ethnicity of teaching staff and the race/ethnicity of students. In 2017–2018, schools whose student populations were over half students of color had a 63% percent white teaching staff [35]. Despite this demonstrated need for cultural competence, the concept of culturally responsive pedagogy has struggled to become ingrained in teacher preparation programs [36,37]. However, some universities have attempted to answer the call for culturally responsive teachers by integrating service-learning into teacher preparation programs, which provides opportunities for pre-service teachers to work in a range of settings with students from diverse backgrounds [38].

There is limited research on how service-learning impacts pre-service teachers' understanding of culturally responsive teaching. Prior research with pre-service science teachers demonstrates that service-learning experiences can increase their confidence in working with diverse learners, science teaching self-efficacy, attitudes towards and perceived relevance of science, enthusiasm for science teaching, and science identity [39,40]. A study of physical education pre-service teachers working with children in a service-learning setting showed that pre-service teachers reported a better understanding of children living in poverty, improved communication skills, and enhanced future teaching expectations [41]. Yet, other research has produced mixed results. For instance, service-learning experiences over a semester failed to change pre-service teachers' commitment to multicultural education [42] or reduce preconceived assumptions about low-income, urban students of color [43]. Thus, more research is needed to fully understand how service-learning experiences can promote pre-service teachers' orientation to and implementation of culturally responsive pedagogy, particularly in the fields of science and mathematics.

3. Analytical Framework

To assess pre-service teachers' self-efficacy and outcome expectancy beliefs related to culturally relevant teaching, Siwatu [44,45] developed two measures, the Culturally Responsive Teaching Self-Efficacy (CRTSE) scale and the Culturally Responsive Teaching Outcome Expectancy (CRTOE) scale. These two measures assess pre-service teachers' capacity for implementing culturally responsive pedagogy (i.e., self-efficacy) and their beliefs that such pedagogy will have positive outcomes for classrooms and students (i.e., outcome expectancy), respectively. Both measures were developed based on prior research that identified specific competencies related to culturally responsive pedagogy that varied in their attention to students' culture (e.g., adapting instructions based on students' learning preferences, minimizing the cultural mismatch between home and schooling practices, promoting students' cultural identity, interpreting standardized test results cautiously knowing they may be biased; see Siwatu [44] for more detailed information).

Siwatu's [44,45] measures for assessing self-efficacy and outcome expectancy beliefs were constructed around four domains: curriculum and instruction, classroom management, student assessment, and cultural enrichment. Table 1 identifies specific teacher actions for each domain that corresponds to items on each measure (e.g., CRTSE classroom management, "Determine whether my students like to work alone or in a group"; CRTOE curriculum and instruction, "Incorporating a variety of teaching methods will help my students to be successful"). It is important to note that during construct validation, Siwatu [45] determined that all items on each measure were only loaded to one factor. Consequently, the two measures do not appear to differentiate between the domains of curriculum and instruction, classroom management, student assessment, and cultural enrichment. However, these domains and corresponding teacher actions are a useful analytical framework and were used in the current study to consider different aspects of culturally responsive teaching.

Table 1. Domains of culturally responsive teaching and specific teacher actions as identified by Siwatu [44,45].

Domain	Teacher Actions
Curriculum and Instruction	<ol style="list-style-type: none"> (1) Connect classroom activities to students' cultural and home experiences (2) Modify instruction to maximize student learning (3) Design culturally relevant curricula and instructional activities (4) Design instruction that is developmentally appropriate and meets students' affective, cognitive, and educational needs.
Classroom Management	<ol style="list-style-type: none"> (1) Create a culturally compatible learning environment that is warm and supportive (2) Minimize the effects of the cultural mismatch (3) Effectively communicate with students (4) Develop a community of learners (5) Attempt to foster meaningful relationships with parents and families
Student Assessment	<ol style="list-style-type: none"> (1) Use a range of assessments (formative and summative) (2) Allow students to demonstrate understanding in a variety of ways (3) Understand standardized assessments may be biased and interpret results with caution
Cultural Enrichment	<ol style="list-style-type: none"> (1) Support students to develop appreciation for their culture (2) Support students' academic success while maintaining/sustaining cultural identity

4. Study Context: Description of the Research-Practice Partnership

The internship in this study, called the *Soar into STEMed Internship*, is a part of a larger research-practice partnership designed to democratize access to science and mathematics education throughout the Southern Gulf region. The research-practice partnership leadership team is composed of a science educator (Wallace), mathematics educator (Smith), and a zoo educator. The research-practice partnership has five primary objectives to: (1) leverage the zoo as a site to prepare culturally responsive and community-informed anti-racist science and mathematics PSETs; (2) utilize complex multifaceted views of science and mathematics teaching and learning to support zoo education and PSET preparation efforts; (3) establish sustainable systems of educational support for the zoo; (4) enhance the zoo education curriculum; and (5) expand zoo educational experiences beyond the zoo walls. The activities of the research-practice partnership include providing personnel support (e.g., undergraduate service-learning PSET students, *Soar into STEMed* interns) to facilitate educational activities (e.g., docent experiences, school field trips, children's story time), lending educational expertise to refine the zoo education curriculum, and increasing educational outreach activities (e.g., nature swap).

The *Soar into STEMed Internship* was developed based on early successes experienced by service-learning students in an undergraduate science teaching methods course for PSETs [46] and challenges faced with traditional school practicum sites (e.g., COVID-19 restrictions, limited access to high-quality mentor teachers). The internship provides PSETs with additional opportunities (outside practicum experiences) to learn with(in) and from the community in an informal learning space as they become culturally responsive community-informed science and mathematics educators. The initial internship cohort began in August 2022 and was composed of four PSETs. Interns are responsible for facilitating visitor education, supporting K-12 field trip lessons, refining the zoo educational curriculum for broad use (e.g., teachers, families, and informal educators), and mentoring undergraduate service-learning students who work as educational docents at the zoo (see Table 2). To date, the interns have interacted with over 1000 zoo visitors, ranging in age from birth to elderly, during zoo hours. In addition to supporting the zoo's educational activities, interns also participate in weekly cohort meetings facilitated by Smith and Wallace.

Table 2. Soar Into STEMed internship activities for Fall 2022.

Internship Activity	Description	Frequency and Duration			Participants
		Times per Week	Hours	Semester	
Cohort Meetings	Interns engaged in discussions related to their zoo and educational experiences and activities over the past week. Interns also received instructions, training, or reminders on internship activities.	1	1–1.5	1	Interns; Science Educator Faculty; Mathematics Educator Faculty; Graduate Assistants; Zoo Education leadership attend based on topic/need
Written/Video Reflections	Interns wrote/recorded a reflection based on their zoo and educational experiences and activities over the past week.	1	1	1	Interns
Docent Interactions	Interns facilitated educational activities with zoo visitors, including children and their families, based on a central topic (e.g., palm oil, habitats and adaptations).	1–2	2–6	1	Interns; zoo visitors (average of 42 visitors/day)
Zoo Curriculum Refinement	Interns refined zoo education curriculum materials to align with NGSS and CCSS-M and created additional educational activities for zoo visitors.	1–3	1–4	0.5	Interns
Field Trip Liaison	Interns facilitated educational interactions with K-12 students who were at the zoo on a field trip with their class/school.	As needed	0.5	1	Interns; K-12 students on a field trip (average of 45–50 students/day)
Mentor Science Education PSETs	Interns mentored and provided support to service-learning Science Education PSETs while at the zoo.	1	2	1	Interns; Science Education PSETs; zoo visitors (average of 42 visitors/day)

5. Methodology

This study is part of a larger project examining the effectiveness of a research-practice partnership between a science educator (Wallace), mathematics educator (Smith), and a zoo educator. This study focused specifically on the *Soar into STEMed Internship* (described above) and used mixed methods to answer the following question: *In what ways can an informal community-based partnership contribute to the preparation of a culturally responsive teacher?*

The present study examined one intern, Alexis [Author], who represented a deviant case (i.e., atypical) [47] in multiple ways. Most notably, Alexis was the only intern who had declining scores on both CRTSE and CRTOE across the internship program (see Tables 3 and 4 in Findings). Despite this decrease, Alexis demonstrated productive insights about culturally responsive teaching across cohort meetings, reflections, curriculum development, and interviews. Alexis was also one of only two interns who had previously worked at the zoo as a service-learning student, which provided a strong foundation to further build upon.

Table 3. Alexis' pre and post-survey results on CRTOE.

CRTOE Item	Domain	Pre-Survey	Post-Survey	Change
A positive teacher-student relationship can be established by building a sense of trust in my students.	CM	90	87	−3
Developing a community of learners when my class consists of students from diverse cultural backgrounds will promote positive interactions between students.	CM	93	85	−8
Acknowledging the ways that the school culture is different from my students' home culture will minimize the likelihood of discipline problems.	CM	100	85	−15
Understanding the communication preferences of my students will decrease the likelihood of student-teacher communication problems.	CM	94	87	−7
Conveying the message that parents are an important part of the classroom will increase parent participation.	CM	93	89	−4
The likelihood of student-teacher misunderstandings decreases when students' cultural background is understood.	CM	95	84	−11

Table 3. Cont.

CRTOE Item	Domain	Pre-Survey	Post-Survey	Change
Changing the structure of the classroom so that it is compatible with my students' home culture will increase their motivation to come to class.	CM	96	84	−12
Establishing positive home-school relations will increase parental involvement.	CM	94	86	−8
Student attendance will increase when a personal relationship between the teacher and the students has been developed.	CM	92	85	−7
CM Total Score		847	772	−75
CM Strength Index		94.11	85.78	−8.33
Revising instructional material to include a better representation of the students' cultural group will foster positive self-images.	CE	98	87	−11
Students will develop an appreciation for their culture when they are taught about the contributions their culture has made over time.	CE	89	85	−4
Encouraging students to use their native language will help to maintain students' cultural identity.	CE	99	83	−16
Students' self-esteem can be enhanced when their cultural backgrounds is valued by the teacher.	CE	92	85	−7
Helping students from diverse cultural backgrounds succeed in school will increase their confidence in their academic ability.	CE	99	86	−13
When students see themselves in the pictures that are displayed in the classroom, they develop a positive self-identity.	CE	94	85	−9
CE Total Score		571	511	−60
CE Strength Index		95.17	85.17	−10
Incorporating a variety of teaching methods will help my students to be successful.	CI	93	87	−6
Students will be successful when instruction is adapted to meet their needs.	CI	93	86	−7
Connecting my students' prior knowledge with new incoming information will lead to deeper learning.	CI	97	84	−13
Matching instruction to the students' learning preferences will enhance their learning.	CI	90	86	−4
Providing English Language Learners with visual aids will enhance their understanding of learning assignments.	CI	97	85	−12
Using my students' interests when designing instruction will increase their motivation to learn.	CI	92	85	−7
Simplifying the language used during the presentation will enhance English Language Learners' comprehension of the lesson.	CI	97	86	−11
Students' academic achievement will increase when they are provide with unbiased access to necessary learning resources.	CI	90	85	−5
Using culturally familiar examples will make learning new concepts easier.	CI	100	87	−13
CI Total Score		849	771	−78
CI Strength Index		94.33	85.67	−8.66
Assessing student learning using a variety of assessment procedures will provide a better picture of what they have learned.	SA	96	84	−12
The frequency that students' abilities are misdiagnosed will decrease when their standardized test scores are interpreted with caution.	SA	91	84	−7
SA Total Score		187	168	−19
SA Strength Index		93.5	84	−9.5

Note. Entirely uncertain (0) to entirely certain (100).

Table 4. Alexis' pre- and post-survey results on CRTSE.

CRTSE Item	Domain	Pre-Survey	Post-Survey	Change
Obtain information about my students' academic strengths	CM	92	80	−12
Determine whether my students like to work alone or in a group	CM	94	86	−8
Determining if my students feel comfortable competing with other students	CM	92	81	−11

Table 4. Cont.

CRTSE Item	Domain	Pre-Survey	Post-Survey	Change
Identify ways that the school culture (e.g., values, norms, and practices) is different from my students' home culture	CM	91	85	−6
Implement strategies to minimize the effects of the mismatch between my students' home culture and the school culture	CM	96	78	−18
Obtain information about my students' home life	CM	94	85	−9
Build a sense of trust in my students	CM	95	90	−5
Establish positive home-school relations	CM	96	85	−11
Develop a community of learners when my class consists of students from diverse backgrounds	CM	96	81	−15
Identify ways how students communicate at home may differ from the school norms	CM	95	81	−14
Obtain information about my students' cultural background	CM	96	80	−16
Greet English Language Learners with a phrase from their native language	CM	95	91	−4
Design a classroom environment using displays that reflects a variety of cultures	CM	95	82	−13
Develop a personal relationship with my students	CM	95	82	−13
Praise English Language Learners for their accomplishments using a phrase in their native language	CM	96	88	−8
Communicate with parents regarding their child's educational progress	CM	95	85	−10
Structure parent-teacher conferences so that the meeting is not intimidating for parents	CM	95	86	−9
Help students to develop positive relationships with their classmates	CM	94	83	−11
Communicate with the parents of English Language Learners regarding their child's achievement	CM	91	84	−7
Help students feel like important members of the classroom	CM	90	86	−4
Use a learning preference inventory to gather data about how my students like to learn	CM	85	86	1
Obtain information regarding my students' academic interests	CM	90	91	1
CM Total Score		2058	1856	−202
CM Strength Index		93.55	84.36	−9.19
Teach students about their cultures' contributions to science	CE	95	80	−15
Design a lesson that shows how other cultural groups have made use of mathematics	CE	96	87	−9
CE Total Score		191	167	−24
CE Strength Index		95.5	83.5	−12
Adapt instruction to meet the needs of my students	CI	90	80	−10
Use a variety of teaching methods	CI	95	81	−14
Use my students' cultural background to help make learning meaningful	CI	94	80	−14
Use my students' prior knowledge to help them make sense of new information	CI	97	74	−23
Obtain information about my students' academic weaknesses	CI	95	85	−10
Revise instructional material to include a better representation of cultural groups	CI	95	84	−11
Critically examine the curriculum to determine whether it reinforces negative cultural stereotypes	CI	95	86	−9
Model classroom tasks to enhance English Language Learners' understanding	CI	99	84	−15
Use examples that are familiar to students from diverse cultural backgrounds	CI	85	87	2
Explain new concepts using examples that are taken from my students' everyday lives	CI	93	91	−2
Use the interests of my students to make learning meaningful for them	CI	100	87	−13
Implement cooperative learning activities for those students who like to work in groups	CI	95	87	−8
Design instruction that matches my students' developmental needs	CI	98	88	−10
CI Total Score		1231	1094	−137
CI Strength Index		94.69	84.15	−10.54
Assess student learning using various types of assessments	93	85	93	8

Table 4. Cont.

CRTSE Item	Domain	Pre-Survey	Post-Survey	Change
Identify ways that standardized tests may be biased towards linguistically diverse students	96	83	96	13
Identify ways that standardized tests may be biased towards culturally diverse students	90	85	90	5
SA Total Score		279	253	−26
SA Strength Index		93	84.33	−8.67

Note. Not confident at all (0) to completely confident (100).

5.1. Alexis

Alexis is a white, female undergraduate junior who was concurrently enrolled in an elementary teacher education program while employed as an intern. As part of her licensure program, Alexis was completing courses to become endorsed in reading, social studies, and mathematics. In the semester prior to the internship (spring 2022), Alexis worked at the zoo as a service-learning student while enrolled in Author's science methods course. Alexis wanted to continue her engagement at the zoo because it was "fun to experience learning outside of the classroom". Alexis saw the benefit of her zoo experiences on her teaching practice, stating in her application that she wanted to "further my knowledge of how to appropriately teach and engage students" since it was a "hands-on experience" and "learning opportunity" for her and zoo visitors.

5.2. Data

Data for this study were composed of a subset of data collected as part of the larger study. The data reported were from Alexis' CRTSE and CRTOE pre- and post-survey responses and her weekly written reflections. We chose to use both sets of data to gain a greater understanding of the nuances of Alexis' conceptions of culturally responsive teaching via triangulation.

5.2.1. Quantitative Data

The quantitative data in this study consisted of pre- and post-surveys of the CRTSE and CRTOE [45]. The CRTSE measure included 40 Likert-type items that evaluated the degree to which pre-service teachers felt confident performing a specific culturally responsive teaching action, such as "Assess[ing] student learning using various types of assessments" and "Critically examin[ing] the curriculum to determine whether it reinforces negative cultural stereotypes". Participants determined their level of confidence using a scale from 0 to 100, where 0 indicated not confident at all and 100 indicated completely confident. The CRTOE measure included 26 Likert-type items that evaluated the certainty pre-service teachers felt performing a specific culturally responsive teaching action would lead to positive outcomes. Questions included items such as "Acknowledging the ways that the school culture is different from my students' home culture will minimize the likelihood of discipline problems" and "Assessing student learning using a variety of assessment procedures will provide a better picture of what they have learned". Participants determined their level of certainty for each item using a scale from 0 to 100, where 0 was entirely uncertain and 100 was entirely certain. As previously discussed, all items on each measure were initially developed based on four domains of practice related to culturally responsive teaching: curriculum and instruction, classroom management, student assessment, and cultural enrichment. In some cases, items were directly related to students' culture (e.g., CRTOE curriculum and instruction, "Using culturally familiar examples will make learning new concepts easier"; CRTSE curriculum and instruction, "Revise instructional material to include a better representation of cultural groups"), and in other cases they were more general practices (e.g., CRTOE curriculum and instruction, "Connecting my

students' prior knowledge with new incoming information will lead to deeper learning"; CRTSE curriculum and instruction, "Design instruction that matches my students' developmental needs").

Using descriptions from Siwatu [44,45] of culturally responsive teaching practices and specific teacher actions (see Table 1), we mapped individual items on the CRTOE and CRTSE to the identified domains of curriculum and instruction, classroom management, student assessment, and cultural enrichment. Though Siwatu's [45] analysis determined that items on the CRTOE and CRTSE did not load to more than one factor and were therefore unable to accurately measure individual domains, we were interested in examining how our intern's confidence and certainty regarding these practices correlated with statements in written reflections.

Like Siwatu [48], we calculated total scores for the participant's self-efficacy and outcome expectancy by summing the values for each item. Total possible scores ranged from 0 to 4000 for CRTSE and 0 to 2600 for CRTOE. Next, we calculated a strength index by calculating the average score for each survey. Strength indexes could range from 0 (low self-efficacy or outcome expectancy) to 100 (high self-efficacy or outcome expectancy). We calculated similar strength indexes for each domain for each measure (which also ranged from 0 to 100).

5.2.2. Qualitative Data

Alexis' written reflections were used as qualitative data. Each reflection was structured around three different prompts. The first prompt asked Alexis to identify three things she learned (based on zoo interactions) related to families, teacher identity, and cultural knowledge. The second prompt asked Alexis for two connections between zoo experiences and (1) coursework and (2) practicum. The last prompt asked Alexis to identify one thing that was surprising/unexpected/left her wondering related to science and mathematics. Initially, we planned for all interns to complete weekly reflections based on weekly activities at the zoo, but due to scheduling conflicts this was not possible, resulting in fewer reflections than weeks of the internship. Overall, we received and analyzed seven reflections from Alexis.

Deductive coding was used to analyze reflections for the presence of Siwatu's [44,45] culturally responsive teaching practices and specific teacher actions (see Table 1). To do this, two of the authors individually coded all reflection responses using the unit of analysis as a response to a single prompt. For instance, Alexis' response to the prompt identifying a connection between zoo interactions and her coursework was analyzed in its entirety and could be given up to four codes to represent each domain. All codes between the two authors were compared and any discrepancies were discussed and resolved. Next, each response was organized by domain and analyzed using the constant comparative method [49] to identify themes. Although Siwatu [44,45] identified specific teacher actions related to each sub-domain as evidenced in the survey items, we chose not to use these actions as a second level coding scheme, since interns worked across contexts (i.e., zoo, elementary school, and university) and many of the actions did not apply. In this way, we hoped to capture a more robust picture of actions that may be indicative of each domain across spaces. Since we were also interested in identifying Alexis' conceptions of culture more broadly, we conducted a separate round of inductive coding [50] using open coding and axial coding [51] on the reflection question that elicited one thing learned about cultural knowledge.

To ensure the reliability of the findings, we used investigator triangulation and had colleagues examine the data, analyses, and findings [52]. We also used member-checking and provided Alexis with a draft of our findings to review and provide feedback. We specifically asked her to comment on the accuracy of information presented, how she was being represented, and our interpretations of her conceptions related to culturally responsive teaching. Alexis completed a reflection as a part of this process, which we

include excerpts of where relevant in our findings to provide additional context. Alexis also chose to have her identity remain known and be a co-author.

6. Findings

In this study, we examined in what ways Alexis' participation in the *Soar into STEMed Internship* contributed to her conceptions of culturally responsive teaching. In this section, we begin by presenting Alexis' results from the CRTSE and CRTOE pre- and post-survey. Then, to situate our discussion of Alexis' conceptions of culturally responsive teaching across each domain, we first share her conceptions of culture more broadly based on her reflections. Next, we delve into each domain and identify Alexis' conceptions as they relate to culturally responsive teaching and general teaching practice based on her written reflections.

6.1. Alexis' Survey Results

Tables 3 and 4 show how each item on the CRTSE and CRTOE was mapped to one of Siwatu's domains of curriculum and instruction (CI), classroom management (CM), student assessment (SA), and cultural enrichment (CE). The tables indicate Alexis' scores on each individual item from pre- to post-survey. We used Siwatu's [45] process for calculating strength index scores (i.e., total score divided by total items) to calculate a strength index for each domain. However, we used this only for the purpose of comparing Alexis' responses on both scales and to highlight changes in her confidence or certainty levels from pre- to post-survey.

Alexis' pre-survey total score for the CRTSE was 3759 with a strength index of 93.98, while her post-survey score was 3370 with a strength index of 84.25. Alexis' pre-survey CRTOE total score was 2454 with a strength index of 94.38, while her post-survey total score was 2222 with a strength index of 85.46. This represents a -232 change in total score and a -8.92 change in strength index for the CRTOE and a -389 change in total score and a -9.73 change in strength index for the CRSTE.

Alexis also decreased in strength indexes from pre- to post-survey when examined by domain. Table 5 shows the change in Alexis' strength index and total scores from pre- to post-survey in specific domains. Although one other intern also showed decreasing scores, Alexis was the only intern who decreased in *every* domain on both assessments. When reflecting on this decline, Alexis expressed this was "somewhat of a shock" and was unsure why this may have occurred, stating "I wish I had my own personal answer to why my scores may have declined but I can't think of anything".

Table 5. Change in Alexis' total score (TS) and strength index (SI) from pre-survey to post-survey per domain.

CRT Domains	Pre TS	Post TS	Change	Pre SI	Post SI	Change
CRTOE						
Classroom Management	847	772	-75	94.11	85.78	-8.33
Curriculum and Instruction	849	771	-78	94.33	85.67	-8.66
Assessment	187	168	-19	93.5	84	-9.5
Cultural Enrichment	571	511	-60	95.17	85.17	-10
CRTSE						
Classroom Management	2058	1856	-202	93.55	84.36	-9.19
Curriculum and Instruction	1231	1094	-137	94.69	84.15	-10.54
Assessment	279	253	-26	93	84.33	-8.67
Cultural Enrichment	191	167	-24	95.5	83.5	-12

6.2. Alexis' Broad Conceptions of Culture

Alexis' reflections shed light on her broad conceptions of culture. In her reflections, Alexis identified culture as including: an animal's culture (e.g., "Learn each animal's history

within its own culture and how they're protected"), culture as home practices (e.g., "Don't be shocked when students have lots of animal knowledge or none at all. Some families promote learning about the environment/animals while others may not. Just never be shocked by either choice."), culture as age (e.g., "I'm beginning to realize which boxes are better for specific ages and who engages in them more."), culture as competence (e.g., "I can tell at times the students understand the game or lesson pretty quickly and I would like to challenge them more"), and culture as learning preferences (e.g., "I'm a visual learner"). Alexis' expansive notions of culture align with some aspects of common definitions of culture (e.g., culture as home practices); however, some do not (e.g., animal's culture). We believe that Alexis' conceptions of what counted as culture and cultural activities described in her reflections were influenced by zoo experiences given the nature of the internship and reflection prompts. Consequently, Alexis may have other ideas about culture that did not arise in these reflections because they were not explicitly linked to zoo interactions.

6.3. CRT Domain: Classroom Management

The domain of classroom management captures the ways teachers develop a rich and robust understanding of their students' cultural backgrounds, experiences, and home practices. Teacher actions in this domain include gathering information about students' cultural backgrounds, experiences, learning preferences and communication styles, interests, and family practices; establishing and sustaining a productive learning environment composed of meaningful relationships; communicating effectively with linguistically diverse students and families; understanding that behavior is a cultural phenomenon; and collaborating with guardians in educational activities. Alexis' scores declined in this domain for both surveys, yet her confidence ratings remained relatively high on individual items, with ranges between 84 and 100 (CRTOE) and 78 and 96 (CRTSE). Looking over Alexis' reflections, the classroom management domain represented the second most frequent area of comments. Her comments coalesced around two actions: understanding families' practices and involving families in educational practices. Although these actions are considered culturally responsive practices, the ways Alexis described them appeared to be generally reflective of responsive teaching.

Alexis demonstrated growing attention toward uncovering and understanding families' home practices. In her reflections, it seems Alexis considered home practices to be representative of family values and priorities and day-to-day activities. This is most evident in her reflection from 16 September 2022, where she stated, "Don't be shocked when students have lots of animal knowledge or none at all. Some families promote learning about the environment/animals while others may not. Just never be shocked by either choice". In this statement, Alexis is explicit that families have different values related to educating their children and, in turn, children will have a range of prior knowledge based on these values (e.g., knowing a lot about emus because the family raised them, reflection 1 October 2022). Yet, her advice to "never be shocked" about families' values is a productive approach when engaging with diverse families and in line with culturally responsive teaching. However, as evidenced in her survey responses to related teacher actions (e.g., CRTSE, "Obtain information about my students' cultural background"), Alexis' confidence and beliefs about the importance of understanding students' family practices in her teaching declined over the internship.

Alexis valued involving families in educational activities while at the zoo. She specifically sought to promote "engagement across everyone" including "parents when they participate" (16 September 2022). Alexis was clear in her view that zoo education was a family affair, stating "The zoo is a bonding experience for all and our focus isn't only about the younger children. Each person is open to learning regardless of age" (15 November 2022). Alexis' approach to engaging families may be tied to her skills at "connecting with a variety of ages" (20 September 2022) that she honed while previously working as an educational docent. Alexis' later reflections emphasized an interest in engaging families who spoke languages other than English. In her reflection from 5 October 2022, she relayed

an experience she had with a family whose child acted as a language broker, “I had an experience with a boy who was the translator for his family. I didn’t talk slowly, but I was mindful because I do tend to talk at a faster pace. Even though the family didn’t understand me, I still engaged with them while he translated”. Alexis appeared to be engaging in culturally responsive teaching practices, as evidenced by her self-awareness about her speech patterns and her ability to self-monitor when communicating with linguistically diverse families. Moreover, Alexis’ focus on the family—not just the child—indicates an intentional move to include the family in the activities, regardless of their language status. Consequently, Alexis’ actions as relayed in her reflections indicate a productive orientation towards engaging with families that is illustrative of culturally responsive practices. Yet, it is unclear if these practices were crossing over to school contexts, since explicit references to school interactions were absent. It is worth noting that Alexis was only at a school site one day per week during the internship as a part of her teacher preparation coursework and often left immediately at the end of the school day, thereby providing few opportunities to engage with families at school. Although Alexis clearly valued the importance of involving families in their children’s learning, her declining scores on related survey items seem to indicate otherwise. It is possible that after the internship, Alexis’ self-efficacy and outcome expectancy beliefs were more accurately reflected in the surveys. For example, her experience interacting with the family whose caregivers spoke a language other than English may have impacted her overall confidence and beliefs regarding communicating with parents of multilingual learners.

6.4. CRT Domain: Curriculum and Instruction

The domain of curriculum and instruction captures the ways in which teachers connect and design academic experiences to enhance understanding of and sustain students’ culture as well as modify instruction to facilitate access, relevancy, and appropriateness for each student. Teacher actions in this domain include utilizing a range of pedagogical approaches, crafting learning opportunities about cultures within content areas, and adapting instruction in response to students’ needs. As with the other domains, Alexis’ CRTSE and CRTOE scores in this domain declined between the pre- and post-survey, but remained relatively high (strength indexes between 84–86 on post-surveys). Looking across Alexis’ reflections, this domain most frequently arose with statements predominantly focused on modifying or adapting instructions for a range of learners based on their academic needs and interests. This action is considered culturally responsive; however, the way Alexis described this approach was generally reflective of good teaching practice.

Alexis made only one explicit reference to diverse students when writing about curriculum and instruction practices. This occurred on 20 September 2022, when she wrote, “Don’t dumb things down for ELLs [English language learners]. Talk normally, not slowly”. In this statement, Alexis posits that curriculum modifications should not be based on a student’s language status. Instead, the rigor of the content should be maintained. This perspective towards adapting content for emergent multilingual learners is productive and challenges conflation of linguistic competencies with intellect. Alexis also articulates that teachers should attend to the pacing of their speech and should “talk normally”. However, this idea fails to recognize that speech pacing does matter for some students. A culturally responsive teacher would attend to their speech pacing and make modifications if the data indicate it is needed.

Attending to and modifying language was a practice that emerged early in Alexis’ reflections. Most often this arose when she introduced or defined key vocabulary and concepts to children. Alexis identified a range of strategies she used to facilitate children’s understanding, which included “using words they’ll understand to explain concepts, like pesticides can be explained differently” (9 September 2022). She further emphasized that when explaining complex ideas or terms, it was essential to “use simple definitions” (9 September 2022) to “make sure the definition is easily understandable so the students can fully grasp the meaning of the word” (16 September 2022) and repeating “the same

words to emphasize vocabulary and their [children's] own knowledge of it" (16 September 2022). Alexis further commented that based on her experiences at the zoo, she knew "what terms to use based on the child's age for them to understand the [content]" (20 September 2022). Alexis' attentiveness to her audience across interactions is reflective of a responsive practitioner. Such practices may have been at the forefront of Alexis' mind given her concurrent coursework related to literacy methods for K-5 students.

Alexis also made reference to Universal Design for Learning (UDL) [53] in one reflection, noting, "It's interesting to see how our class discussion of UDL matches with these boxes and how it's something we can easily incorporate into our teachings" (5 October 2022). Even though Alexis is not specific about what aspects of UDL align with educational interactions at the zoo, the connection between UDL and her practice as a docent at the zoo is notable, since UDL's goal is to increase access and retain educational rigor for each student. Moreover, such practices have the potential to increase Alexis' ability to be a culturally responsive elementary teacher.

A final practice that emerged in this domain was the need to use a range of instructional strategies and activities to maintain students' interest and engagement. Alexis was particularly attuned to the need to keep zoo visitors engaged in the activities, yet expressed instances of uncertainty in how to do this effectively via her wonderings such as the question, "How can I make sure I don't sound like a record player for each guest?" (16 September 2022). Alexis appeared to offer herself some ideas in response to this wondering in the next week's reflection, stating "If it seems interesting, students are eager to learn. Hook them in at any point then reel them in" (20 September 2022). This strategy of hooking students into the task or activity aligns with culturally responsive teaching. On 11 October 2022, Alexis later offered additional ideas to keep students engaged in activities or lessons based on her concurrent coursework,

In my CIE 305 [K-8 social studies methods] class we've been discussing various types of learning and what teachers can do to be more active within the class and this makes me think back to the docent boxes. These are simple lessons that can be taught normally but incorporating games or artifacts makes the students learning more exciting and inviting.

Although Alexis identified a range of ways to adapt activities or lessons to ensure students were interested and engaged, she still appeared to grapple with maintaining engagement for each student, as evidenced by her question on 11 October 2022, "How do I draw back in a student that seems bored?" This continued dilemma may shed some light on why Alexis' scores decreased between her pre- and post-survey responses on items related to using a variety of teaching methods and utilizing students' interests to make learning meaningful amidst their relative high rating.

6.5. CRT Domain: Student Assessment

The domain of student assessment captures the ways in which teachers take into consideration students' diverse ways of knowing and communicating as well as understanding inherent biases of standardized assessments. Teacher actions in this domain include providing a range of ways for students to demonstrate understanding on formative and summative assessments (e.g., portfolios, self-assessments, multimodality) and interpreting standardized assessment scores cautiously. Like the other domains, Alexis' total scores in this domain declined on both surveys between the pre- and post-test; however, the range of her individual ratings remained relatively high before and after the internship (i.e., range from 83 to 96).

Alexis was the only intern who referenced assessment in her reflections and, in both cases, involved two questions she raised. The first question was, "What should we do to ensure the students are understanding the [docent] box?" (9 September 2022). The second question, "What informal assessments can I do at my carts to see if the visitors are retaining the knowledge of the docent cart?", was from her last reflection on 15 November 2022. Neither of her questions specifically reference culture or culturally responsive prac-

tices. Thus, it is unclear what connection she saw between these questions and culture or cultural knowledge.

Alexis' two questions do shed light on her thinking about assessment more generally. First, her questions appear to be general wonderings about what kinds of assessments could be used to measure visitor learning. Her use of "assessments" could indicate a consideration for the multiple ways visitors could demonstrate their learning in line with survey prompts (i.e., CRTSE, "Assess student learning using various types of assessments"; CRTOE, "Assessing student learning using a variety of assessment procedures will provide a better picture of what they have learned"), yet the lack of specificity makes this claim uncertain. Additionally, Alexis uses more precise language when describing what aspects of assessment she wondered about in her latter reflection question, which may indicate a growing understanding of assessment practices from her teacher preparation coursework. Alexis' interest in assessment in her last reflection may also have been tied to the zoo's need to evaluate the impact of docent interactions on visitors' knowledge and understanding—a topic that had been discussed with our zoo partner and interns.

6.6. CRT Domain: Cultural Enrichment

The domain of cultural enrichment identifies teacher actions that (1) support students to develop an appreciation for their culture and (2) prepare students to be academically successful while sustaining their cultural identity. For example, a teacher who supports students' appreciation for their own culture would infuse content related to the students' culture into their science lesson (e.g., exploring Native Americans' relationships with turtles or tortoises). Alexis' responses across items in this domain on both measures declined by an average of 10 (CRTSE) or 12 (CRTOE) points. However, her overall post-survey scores remained relatively high (CRTSE average of 84 and CRTOE average of 85), which indicated she remained relatively confident in her self-efficacy and outcome expectancy beliefs.

Alexis' reflections offer little insight into why her scores may have declined. Across the reflections, she made no reference to the specific actions in this domain of the survey (e.g., "Teach students about their cultures' contributions to science"). We hypothesize that the fleeting interactions with zoo visitors may not immediately lend themselves to the use of the specific teacher actions identified in this domain. Consequently, the teacher actions in this domain do not seem to fully capture what cultural enrichment activities may look like amidst brief interactions with culturally diverse audiences across contexts, such as informal learning spaces.

7. Discussion

In this study, we sought to understand in what ways participation in a service-learning internship at a local zoo contributed to a PSET's conceptions about culturally responsive teaching. Using a single case study, we examined changes in Alexis' self-efficacy and outcome expectancy beliefs related to culturally responsive teaching before and after the *Soar into STEMed Internship* using the CRTSE and CRTOE measures [44,45]. To provide a robust understanding of Alexis' conceptions, we triangulated our quantitative findings with written reflections and member-checking. The findings from the study indicated that Alexis' self-efficacy and outcome expectancy beliefs about culturally responsive teaching within the context of science and mathematics declined, yet remained relatively high across the internship. Alexis' written reflections further indicated an ability to identify and implement (via self-report) responsive teaching practices; however, many of these practices fell short of being considered culturally responsive according to the teaching actions identified by Sitwatu [44,45]. Overall, the study findings indicate three areas that science and mathematics teacher educators should consider when planning for and implementing service-learning in teacher preparation programs: (1) leveraging the increased opportunities to refine pedagogy across spaces, (2) intentionally planning activities to promote culturally responsive teaching, and (3) utilizing appropriate methodological tools.

7.1. Leveraging Opportunities to Refine Pedagogical Practices

The service-learning internship provided Alexis (and other interns) with repeated opportunities to implement responsive teaching practices (e.g., modifying language and questions based on a visitor's age, increasing visitor's interest and content relevance, implementing a range of activities) outside of practicum placements. For instance, as a docent educator, Alexis interacted with an average of 39 zoo visitors per day—individuals who were nearly all previously unknown. This was in contrast to her practicum experiences, where she engaged with the same group of students (25–30) over a semester. Consequently, the sheer magnitude of zoo interactions provided a multitude of varied opportunities for interns to test out and refine a range of pedagogical practices and strategies (e.g., different ways to differentiate the same question) at different scales (e.g., across a single day, week, or month). As evidenced in Alexis' reflections, these experiences productively impacted her pedagogical competencies in science and mathematics teaching (e.g., increased ability to differentiate questions on the fly and adapt language to more effectively communicate with young children). Yet, we believe the impacts of Alexis' ability to transfer competencies across spaces were not fully captured given the ambiguity in some of the written reflections, which occurred amidst explicit questions asking about connections between zoo interactions, coursework, and practicum experiences. Based on our data, it appears that more direct conversations and targeted reflection activities are needed to fully capture the source and extent of the transfer of pedagogy across educational spaces (e.g., early childhood classrooms, informal spaces, elementary classrooms). For example, explicitly asking PSETs to reflect on how zoo interactions prepared them for work in the classroom as related to culturally responsive teaching would have been more likely to elicit the connections the *Soar into STEMed* internship was designed to promote.

The context of the internship also provided Alexis with multiple opportunities to engage families in educational activities—experiences that may help to address PSETs' feelings of unpreparedness for working with families [54]. Alexis' approach towards involving families, including parents/guardians, within zoo educational interactions was productive and reflective of a responsive practitioner. Such findings indicate the potential for other PSETs to develop similar productive orientations towards engaging in educational activities with families—a necessity for culturally responsive teaching [45]. Activities such as zoo interactions could complement teacher preparation coursework (e.g., courses focused on parents and families, multicultural education, or culturally responsive teaching) by providing additional instances for PSETs to refine their competencies in effectively communicating and engaging with diverse parents/guardians.

7.2. Intentionally Designing Activities to Promote Culturally Responsive Practitioners

Villegas and Lucas [55] express the need for teacher education programs to centralize issues of diversity, a commitment to diversity, and integrations about cultural knowledge throughout. Our findings support this notion. In the absence of curricular lessons and classroom discussions on culturally responsive teaching, Alexis' interactions with racially and linguistically diverse intergenerational zoo visitors across the internship failed to substantially contribute to her development as a culturally responsive teacher, as evidenced by declines in CRTSE and CRTOE scores and in written reflections. One reason for this may be the ephemeral interactions with zoo visitors that limited interns' ability to learn about visitors' cultural backgrounds, experiences, interests, and practices—knowledge that is needed to implement culturally responsive teaching [33,56]. Yet, Alexis is certain that the internship did not negatively impact her thinking about culturally responsive teaching, stating “I do know one thing for certain is that my beliefs nor ideas haven't wavered during this internship”. Consequently, future research is needed to investigate different ways to leverage interactions within service-learning contexts to promote culturally responsive orientations to teaching science and mathematics in the absence of a robust programmatic focus on educational equity and sustained involvement with children and families.

The findings from this study also indicate a need for more specific and targeted activities related to culturally responsive teaching. Although the internship required Alexis to compose reflections with an explicit prompt asking for connections to cultural knowledge, she was not given or directed to specific definitions of what counts as culture. Consequently, when describing connections to cultural knowledge, Alexis identified aspects that fell outside of what Siwatu [44,45] identified as culture (e.g., animal culture). That said, we did not find evidence of bias in Alexis' reflections, even amidst a limited understanding of the influence and benefit of culture within science and mathematics teaching. Thus, our findings indicate that deeper and more explicit discussions and critical reflections about culturally responsive teaching and its connection to zoo experiences are necessary to produce a greater appreciation of culture's influence on student learning in science and mathematics. Furthermore, if researchers in service-learning are striving to cultivate specific features of culturally responsive teachers, these considerations should be *explicitly* integrated into the initial design of the formal coursework or internship structure from the onset. Placement, or participation, alone in a service-learning internship may be used to *amplify explicit instruction* as opposed to acting as a substitute for fostering conceptions of culturally responsive teaching.

7.3. Tools to Measure PSETs' Self-Efficacy and Outcome Expectancy Beliefs about Culturally Responsive Teaching

As our findings indicated, the CRTSE and CRTOE instruments were not the best tool for capturing conceptions of culturally responsive teaching across spaces. Specifically, the instruments did not distinguish between teaching activities that occur in a school setting and those that occur at the zoo. Additionally, the instruments focused almost entirely on teaching activities that occur in a school setting and were not necessarily translatable to teaching activities at the zoo. Consequently, utilizing multiple modes of data collection are essential for researchers of service-learning or community-based experiences until another instrument is developed that better captures PSETs' self-efficacy and outcome expectancy beliefs towards culturally responsive teaching across contexts. Such an instrument should be structured in a way that could be adapted to a specific content area, such as science or mathematics, that would allow scholars to gain a more robust understanding of how conceptions of culturally responsive teaching are impacted in various ways across spaces and disciplines.

8. Conclusions

The findings from this study contribute to the nascent research literature that examines the impact of service-learning experiences on PSETs in general and specifically related to culturally responsive teaching in science and mathematics. Our findings do not fully confirm or refute existing research demonstrating the benefits of service-learning to PSETs. Based on the survey findings, the internship appeared to negatively impact Alexis' conceptions of culturally responsive teaching. However, her written reflections and commentary indicate the opposite, along with her increased pedagogical skill. Thus, to sufficiently capture the nuance of PSETs' conceptions of culturally responsive teaching and the overall impact of service-learning experiences on pedagogy across spaces, previously constructed tools developed for classroom settings are insufficient. However, until a new tool is developed, researchers should complement existing instruments with additional data sources to capture a robust picture.

Lastly, the study findings indicate several areas that science and mathematics teacher educators should consider when planning for and implementing service-learning in teacher preparation programs: (1) ensuring that PSETs connect experiences in the service-learning environment to practice in the traditional classroom; (2) explicitly providing instruction on culturally responsive teaching practices; and (3) identifying appropriate methodologies to assess self-efficacy and outcome expectancy beliefs regarding culturally responsive teaching across contexts.

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