Innovative Communities

Embedding Special Education Faculty in Science Methods Courses

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Abstract

Teachers in general education classrooms must be prepared to meet the needs of all students. This study explored the impact of embedding special education faculty members in general education teacher preparation to coteach a science, technology, engineering, and mathematics (STEM)-based elementary methods block. The Attitudes Toward Inclusion Survey was modified to include STEM education and to develop and implement STEM-based curriculum to meet the needs of all students. Statistical analysis was conducted to determine change over

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time for the STEM-based cohort in relation to a non-STEM-based cohort in five domains reflected in the survey. Significant increases were apparent for those teacher candidates participating in the cotaught cohort in the domains that reflect perceptions of students with disabilities (SWDs), understanding the role of a general education teacher in working with SWDs, and the knowledge and pedagogical skills needed to integrate STEM instruction. Implications for preservice teachers and teacher preparation programs are discussed.

Introduction

The emphasis on science, technology, engineering, and mathematics (STEM) education dates back to Sputnik and the sense of urgency this Russian satellite gave the United States to win the space race. The concern that the United States was falling behind Russia placed a spotlight on our education system, and a much-needed revolution began. The perception that the United States continues to underperform compared to other countries is still relevant today. Jobs in new fields like nanotechnology, bioinformatics, and evolutionary genomics continue to remain vacant because we are not preparing students with the mathematical and scientific knowledge and skills required for such jobs. According to the Trends in International Mathematics and Science Study (TIMSS; Provasnik et al., 2016), the United States has shown no change in advanced math or science since 1995. If the United States wants to continue to compete in the global economy, we need to ensure that our students are well educated in the STEM areas.

Our country's economic well-being is dependent on how well teachers prepare students for occupations pertaining to STEM. The National Science Board (2015) details three insights resulting from its analysis of its 2014 science and engineering indicators report: (a) the "STEM workforce" is extensive and critical to innovation and competitiveness; (b) STEM knowledge and skills enable multiple, dynamic pathways to STEM and non-STEM occupations alike; and (c) assessing, enabling, and strengthening workforce pathways is essential to the mutually reinforcing goals of individual and national prosperity and competitiveness. The view that a STEM workforce is essential to economic development, innovation, and global competitiveness is driving much of the agenda in higher education as we strive to prepare large numbers of individuals to work in these fields. Furthermore, the knowledge and skills developed through STEM-focused education provide individuals with a variety of skills (e.g., complex problem solving, analytical thinking, mathematical reasoning, inquiry stance) transferable to other occupations. These skills are crucial to ensure students are prepared to compete in the global economy. Thus there is a need for *all* students, including students with disabilities (SWDs), to develop a strong foundational understanding in STEM. The shift from textbook-based instruction to inquiry-based STEM instruction promotes students' problem solving, analytical thinking, meaningful engagement, and deeper thinking (Buchanan, Harlan, Bruce, & Edwards, 2016; Watt, Therrien, Kaldenberg, & Taylor, 2013).

STEM education may provide a platform for students to move beyond lower level thinking (e.g., recall) and gain critical content knowledge to engage in higher order thinking (e.g., evaluate; Basham & Marino, 2013). These skills are crucial to ensure all students, including SWDs, are prepared to compete in the global economy and meet the demands of the 21st century.

Entire populations of students are being denied high-quality education in STEM. The National Research Council (2012) reports underrepresentation of culturally and linguistically diverse groups and patterns of low academic performance among diverse learners and SWDs in STEM areas. Complicating matters, the data have shown an increased reluctance to participate in STEM education by youth throughout the world (Boe, Henrikson, Lyons, & Schreiner, 2011). To increase student achievement in these areas and prepare for global competitiveness, President Barak Obama made STEM one of his priorities in his education efforts. Holdren, Marrett, and Suresh (2013) of the National Science and Technology Council Committee on STEM Education emphasized the need to invest in preparing and recruiting high-quality K–12 STEM teachers and broadening participation in STEM fields by underrepresented groups. These concerns are exacerbated given the new administration's views on education and proposed budget cuts to education that threaten programs designed to support children and families and develop teachers (Office of Management and Budget, 2017). Per Johnson, Campbell, Spicklemire, and Partelow (2017), the proposed cuts to Title II funding "translates to a loss of 40,000 teachers' salaries" and disproportionally impact regions experiencing critical teacher shortages. Furthermore, proposed cuts to after-school programs and summer programs that provide remedial and enrichment opportunities disproportionally impact our most vulnerable student populations.

Despite the recent emphasis on preparing students for these fields (National Research Council, 2012; Holdren et al., 2013; U.S. Department of Education, 2016), more must be done to ensure that all students have equitable access to STEM career pathways. Research has shown that individuals with disabilities are significantly underrepresented in STEM programs and careers when compared to typically developing peers (Bargerhuff, 2013). This concern is coupled with the pattern of low academic performance in STEM among SWDs and a growing reluctance to participate in STEM education (Boe et al., 2011). Furthermore, SWDs often lack access to higher level mathematics and science courses (i.e., algebra), which can be gateways to increased educational and career opportunities (Shifrer, Callahan, & Muller, 2013). A critical step to providing access involves preparing general and special education teachers to be cognizant of evidence-based practices and technology (i.e., universal design for learning; UDL) that address the varied learning needs of SWDs. Thus there is a strong need to cultivate a cadre of teachers who possess the requisite content knowledge, pedagogical skills, and commitment to engaging SWDs in the general education curriculum, including the sciences. To meet this need, some teacher preparation programs have opted to blend or merge general education and special education (SPED) programs via dual certification (Blanton & Pugach, 2007). However, the manner in which content is infused may differ significantly across programs, and there are concerns over the possible watering down of SPED content given the time limits for program completion mandated by many states.

Another way in which teacher candidates may be prepared to work with SWDs is through completion of a stand-alone course on instructing SWDs. The challenge with this method is that the presentation of the learner is isolated from methods and content. Developing general educators to work with SWDs requires teacher preparation programs to provide instruction that is simultaneously responsive to all three: learner, method, and content (García & Tyler, 2010). Based on this reality, we embedded SPED faculty in methods courses (specifically literacy and science) at the elementary level throughout one semester. The purpose of the project was to determine if such a collaborative would enhance candidates' attitudes regarding SWD and their sense of efficacy in differentiating STEM instruction for this population. In addition, we were interested in seeing if this partnership could also serve as a vehicle for creating a viable, sustainable community of practice between SPED faculty and faculty from varied disciplines. The research questions for this study were as follows:

1. How do the perceptions of SWDs in inclusive settings of preservice teachers who participated in the collaborative initiative cohort (EESTEM) differ from those of preservice teachers who were in the comparative cohort?

2. How do the perceptions of inclusion of preservice teachers who participated in the EESTEM cohort differ from those of preservice teachers who were in the comparative cohort?

3. How do the perceptions of of their own ability to teach SWDs of preservice teachers who participated in the EESTEM differ from those of preservice teachers who were in the comparative cohort?

4. How do the perceptions of their own ability to embed STEM instruction of preservice teachers who participated in the EESTEM cohort differ from those of preservice teachers who were in the comparative cohort?

5. How do the understandings of their role in enhancing their ability to meet the needs of SWDs of preservice teachers who participated in the EESTEM cohort differ from those of preservice teachers who were in the comparative cohort?

We begin by providing a brief literature review on teachers' attitudes toward inclusion and the importance of teacher preparation programs providing meaningful models of collaboration for preservice teachers, particularly in the area of STEM. We then examine the beliefs and perceptions of general education preservice teachers through the administration of a survey and conclude with addressing implications for teacher preparation programs.

Teacher Attitudes Toward Inclusion

The President's Council of Advisors on Science and Technology (2014) report to the president highlighted the need for an increased emphasis on STEM education in ensuring our nation's ability to compete at a global level and address challenges we are facing regarding energy, health, and environmental protection. The council also described the ongoing lack of representation and the achievement gap in this area among students of color, women, and SWDs. Given that SWDs are increasingly served in inclusive settings, there is a need to ensure that general education teachers are able to design and implement instruction that meets individual learning needs. This is especially important in mathematics and the sciences. Failure to provide access to this content means we will continue to experience disparities for SWDs to be able to enter the STEM field.

Feelings of efficacy are important in the use of inclusive practices. Research (Paneque & Barbetta, 2006) has suggested that a teacher's belief in his or her ability to work with SWDs predicts his or her attitude and willingness to work in an inclusive setting; yet, teachers continue to express concerns regarding their ability to teach students with disabilities. The lack of a sense of efficacy in their ability to meet the needs of SWDs negatively impacts their views of inclusion (deBoer, Pijl, & Minnaert, 2011) and may further feelings of inadequacy regarding teaching SWDs.

Teacher beliefs are an essential tool in teacher preparation, and failure to attend to teacher beliefs may hinder the acquisition of professional knowledge necessary for becoming an effective teacher (Hart, 2004; Morton, Williams, & Brindley, 2006). Because teacher beliefs are instrumental in the success of inclusion, we have used this construct as the theoretical frame for this study (Pajares, 1992). Teachers who have a stronger sense of self-efficacy and ability indicate a more positive attitude and outlook on inclusive practices (Brownell & Pajares, 1999; Lifshitz, Glaubman, & Issawi, 2004; Lopes, Monteiro, Sil, Rutherford, & Quinn, 2004). Therefore enhancing teacher ability to differentiate instruction to ensure positive outcomes for SWDs is essential to improving STEM education.

Moreover, research on preservice teachers' perceptions of inclusion of SWDs, like their in-service peers, indicates that preservice teachers do not feel adequately prepared. Brown, Welsh, Hill, and Cipko (2008) noted, "Preservice teachers have expressed concerns regarding a lack of confidence in teaching students who are mainstreamed, which is largely based on inadequate experience developing strategies for teaching students with special needs in teacher education programs" (p. 2088). As a result, many teacher preparation programs have revised their programs to provide additional content pertaining to SWDs, including applied experiences. Some research suggested that meaningful university experiences can positively influence preservice teachers' attitudes toward inclusion (Alvarez McHatton & Parker, 2013; Brown et al. 2008; Jobling & Moni, 2004; McCray & Alvarez McHatton, 2011; Shippen, Crites, Houchins, Ramsey, & Simon, 2005). For example, in a longitudinal study, Alvarez McHatton and Parker (2013) explored elementary and SPED preservice teachers' perceptions of inclusion as they partnered for a classroom management course and a field placement in K–5 classrooms. Analysis (pre, post, and 1-year maintenance) of survey responses revealed statistically significant changes in attitude in multiple domains by the elementary preservice teachers but no change in the SPED preservice teachers. Similar results were found in Brown et al.'s (2008) study of embedding SPED instruction into preservice general education assessment courses. Outcomes indicated that teacher candidates' knowledge of inclusion and confidence levels in meeting the needs of SWDs significantly increased compared to the comparative group. Although this work is promising, the purposeful pairing of educational methods course work and modeling inclusive and coteaching practices within general education teacher preparation programs is still limited.

The research on teacher beliefs coupled with the fact that SWDs have limited access to STEM curriculum is a catalyst as to why teacher preparation needs to improve the way it addresses preservice teachers' knowledge of STEM content and how to effectively teach SWDs. The construct of teacher beliefs was used as the theoretical framework for this study (Pajares, 1992). What teachers believe has a profound and direct influence on how they teach their students. By embedding SPED faculty into methods courses, we were able to provide students with opportunities to see faculty deliberately model inclusive and coteaching practices, which they could then apply in their field experiences. Ultimately, the goal is to identify practices that develop general and SPED teachers' sense of efficacy in teaching STEM content to diverse learners. Given the continued disparity in educational outcomes for SWDs and lack of participation in STEM fields, along with continued reports by teachers regarding their lack of preparation in meeting the needs of these students, determining strategies that enhance teachers' ability in both STEM and with SWDs is essential in ensuring equitable opportunities for this population.

Purposeful Preparation of General Education Teachers

The achievement of SWDs who partake in general education STEM classes is directly linked to teacher' abilities to understand students' individual learning needs and problem-solving abilities (Basham & Marino, 2013); therefore it is crucial that teacher education programs purposefully prepare general education teachers with the knowledge, ability, and confidence to successfully work with SWDs. While there is an abundance of research supporting the need for in-service general education and SPED teachers to collaborate and increase knowledge of strategies when working with diverse students, there is a lack of research in the area of teacher preparation programs illustrating meaningful models of collaboration for preservice teachers. Per Brown et al. (2008), "teacher education programs have traditionally assigned responsibilities for preparing pre-service teachers to work with students with special needs to SPED programs, creating a divide between general education and special education" (p. 2088). This study examined the implications of embedding SPED content within general education courses.

Methods

The authors designed an exploratory study that took place over a 15-week semester to address each research question. Participants were 34 elementary education majors who were enrolled in four methods courses. Participants were placed in intervention and control groups and given pre- and postsurveys to assess their perceptions of inclusion and STEM education. An independent samples *t*-test was conducted on pre- and posttests to determine whether there were changes in scores from the beginning of the semester to the end and if there were significant differences between groups.

Context

Faculty members from the Department of Elementary and Early Childhood Education and the Department of Inclusive Education at a southeastern university participated in a program intended to improve the preparation of preservice teachers to meet the needs of all students in the classroom, with a focus on STEM preparation. In this state, all general education majors are required to take one three-credit-hour course on SWDs. The objective of the collaboration was to purposefully embed a SPED faculty member within the two methods courses (literacy and science) to address instruction at the intersection of learner, content, and method (García & Tyler, 2010). Specifically, we sought to examine whether this collaboration positively impacted the following: (a) attitudes toward inclusion of SWDs in general education settings, (b) perceptions of self-efficacy, and (c) understanding of STEM curriculum.

Literacy methods course. Instructors met twice during the 10-week period to plan topics and related readings. Understanding characteristics of struggling readers and writers was an initial focus. Candidates were introduced to typical and struggling literacy learner characteristics. The guiding question for course activities was, What strategies can we utilize to remove barriers for struggling readers and writers and allow access to the STEM text?

Self-regulated strategy development (SRSD) instruction was introduced in the literacy methods course. SRSD's primary focus is to teach students strategies (e.g., goal setting, self-monitoring, and self-instruction) needed to carry out a target task (Mason, Harris, & Graham, 2011). Candidates read several articles focused on SRSD mnemonic writing strategies (e.g., POW), watched video models of each step in the framework (e.g., develop background, discuss, model and think aloud, support, release), and engaged in reflective discussion regarding the benefits of SRSD strategies to support learning. Candidates applied this new knowledge during their science (STEM) course (see later).

Collaborative strategic reading (CSR) strategies were also explicitly taught to the candidates over a 5-week period. Candidates were taught that CSR consists of strategies that are implemented before, during, and after reading to enhance comprehension (Klingner & Vaughn, 1998). Specific strategies taught included previewing and predicting, self-questioning, click and clunk, get the gist, asking questions, and summarizing strategies. The SPED instructor explicitly modeled each strategy using a nonfiction science-focused text and CSR-related graphic organizers. Candidates then had the opportunity to practice the strategies in pairs (teacher–student roles) and apply the strategies to new text while they received specific instructor feedback.

Accommodations were also introduced in the literacy course. Candidates completed the IRIS Center Vanderbilt University (n.d.-a, n.d.-b) learning module on accommodations[1] and responded to related prompts. Candidates learned the distinction between accommodations and modifications as well as clear examples of the different accommodation categories. The SPED faculty member led a summarizing class discussion focused on the purpose and benefits of accommodations, and candidates completed case studies to apply their new understanding during their science methods class (see later).

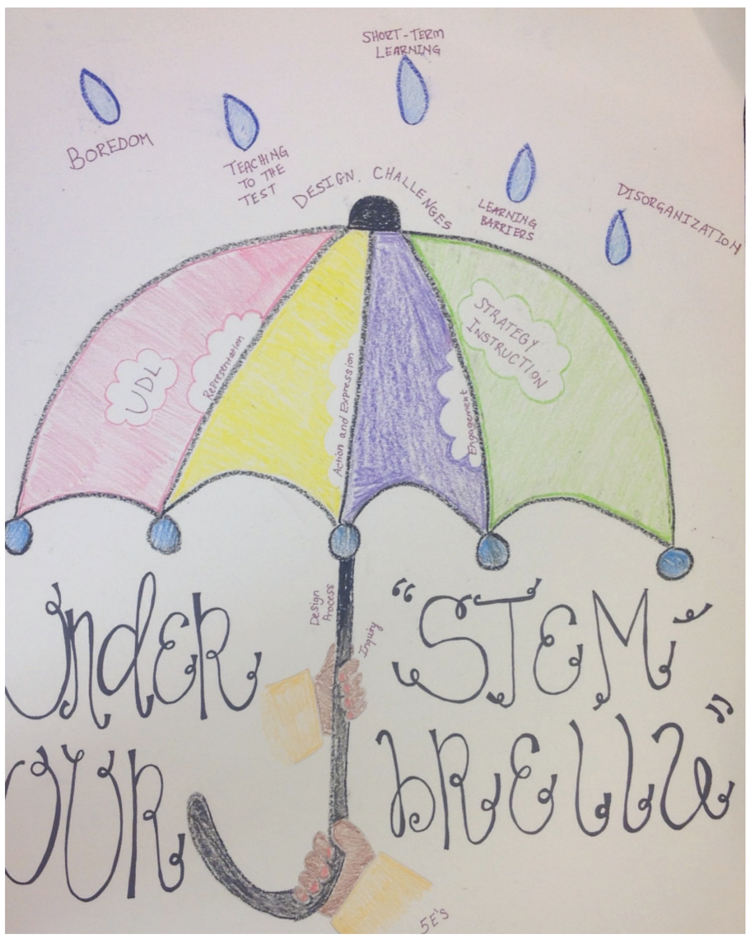
Science methods course. The bulk of the STEM focus for the cohort was presented during the science methods course. The elementary science faculty member and the SPED faculty member met weekly for approximately 1 hour to plan. Planning included specific content focus, related reading assignments, class activities, and selection of coteaching models to utilize during instruction. All lessons were actively cotaught by both instructors. Candidates were instructed about the importance of explicit modeling and step-by-step scaffolding procedures and engaged in an observational activity in which they compared and contrasted lessons with and without explicit strategy instruction.

The candidates also attempted to create a mnemonic to support the acquisition of the design process steps. Accommodations were also a major content focus. Candidates engaged in applying their new accommodation knowledge to case studies involving STEM learning activities and SWDs. Candidates were also asked to collaboratively create a graphic depiction (see Figure 1) to explain how STEM, the engineering design process, and strategies for student disabilities all worked together to facilitate STEM education. Finally, candidates worked on their final cumulative semester project and were required to address the needs of SWDs. The SPED and ECE instructors provided feedback during the development of these cumulative, interdisciplinary assignments.

Participants

Participants consisted of two cohorts of students; one participated in the collaborative initiative, elementary education STEM group (EESTEM). The other served as our comparison elementary education group (EE) and completed the courses in the traditional method. All participants were in their senior year and had completed the three-credit-hour course on SWDs. The collaborative initiative cohort (EESTEM) was composed of 21 female preservice teachers; the comparative cohort (EE) consisted of 13 female preservice teachers. All consented to participate in the study; however, four students did not complete both pre- and posttest. Both cohorts were enrolled in four methods courses (mathematics, science, language arts/reading, and social studies). During the first 10 weeks of the semester, participants ($N = 30$) attended classes at the university and were also assigned to a field experience at an elementary classroom 1 day per week. For the final 5 weeks of the semester,

Figure 1



preservice teachers transitioned into full-time student teaching in the same classrooms in which they were placed for their 1-day-per-week field experience. They remained in those classrooms for their final student teaching, which took place in the following (spring) semester.

Data Collection

Procedures. During the first class session, a member of the research team visited each cohort and provided an overview of the study and the consent process. Surveys contained no identifiable information (i.e., an ID number, which students provided, was used to match pre- and postsurveys), and instructors would not have access to any of the data until after grades for the course had been submitted. All students in both cohorts consented to participate in the study. Once consent was obtained, students were provided time to complete the survey.

Measure. Teacher candidates' perceptions of inclusion and STEM education were collected at two points in time using a modified version (see the appendix for full survey questions) of the Attitudes Toward Inclusion Survey (Alvarez McHatton & McCray, 2007; McCray & Alvarez McHatton, 2011). The survey was revised to include students' perceptions of and attitudes toward STEM education and was designed using a 5-point Likert-type scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*).

The surveys were administered during the first class session (Time 1) and at the end of the semester (Time 2). The survey contained 37 statements focusing on the following five domains: (a) perceptions of SWDs in inclusive settings, (b) perceptions of inclusion, (c) teachers' perceptions of their own ability, (d) teachers' perceptions of their own ability to embed STEM instruction, and (e) teachers' understanding of their role in enhancing their ability to meet the needs of SWDs. Details regarding the number of items per domain as well as sample statements within each domain are provided in Table 1.

Results

We calculated alphas for each of the five domains to assess reliability of the instrument (see Table 2). Results ranged from .73 to .88, indicating that responses to all five domains and groups exhibited adequate reliability at pre- and posttest.

We conducted an independent samples *t*-test to determine whether the change in scores from pre- to posttest for the EESTEM group (e.g., intervention group) was significantly different from the change in scores for the EE group (e.g., comparison group). We calculated difference scores for each domain by subtracting mean pretest scores from mean posttest scores. Table 3 summarizes the results of the independent samples *t*-test.

In addition, we conducted a paired samples *t*-test to determine changes between

Table 1
Number of Items and Sample Statement(s) per Domain

Domain: Perception of	No. of items	Sample statement(s)
SWD in inclusive settings	11	Inclusion will give students with disabilities a better chance to readily fit into their community.
		I believe most students with disabilities (regardless of the level of their disability) can be educated in the general education setting.
Impact of inclusion	7	Typical peers become accustomed to having students with disabilities in the school and naturally accept them as peers.
		Students with disabilities do not add to the workload of teachers.
Their own ability	9	I am able to design instruction that meets the needs of students with disabilities.
		I know how to plan for different academic levels.
Their own ability to embed STEM instruction	4	I know how to develop an integrated curriculum for a STEM-based classroom.
Their role in enhancing their ability to meet the needs of SWD	6	I understand the role of a special education teacher in meeting the needs of students with disabilities.
		As a teacher, I would be willing to complete additional professional development so as to better meet the needs of students with disabilities.

Note. STEM = science, technology, engineering, and mathematics. SWD = students with disabilities.

Table 2
Reliability Test by Domains

Domain	Pre	Post
Domain 1: Perceptions of SWD in inclusive settings	.809	.857
Domain 2: Perceptions impact on inclusion	.849	.747
Domain 3: Perceptions of their own ability	.727	.843
Domain 4: Perceptions of their own ability to embed STEM instruction	.76	.816
Domain 5: Perceptions of their role in enhancing their ability to meet the needs of SWD	.887	.881

Note. SWD = students with disabilities.

Table 3
Independent t-Test Results by Domains and by Group

	EESTEM		EE				
Domain	*M*	*SD*	*M*	*SD*	*t*-Value	*df*	Sig.
Domain 1: Perceptions of SWD in inclusive settings.	0.25	0.42	−0.09	0.345	−2.31	28	0.03
Domain 2: Perceptions impact on inclusion	0.27	0.824	−0.24	0.463	−1.94	28	0.06
Domain 3: Perceptions of their own ability	0.69	0.657	0.26	0.559	−1.84	28	0.08
Domain 4: Perceptions of their own ability to embed STEM instruction	1.49	0.945	1.06	0.873	−1.24	28	0.23
Domain 5: Perceptions of their role in enhancing their ability to meet the needs of SWD	0.17	0.37	−0.29	0.582	−2.64	28	0.01

Note. EE= comparison group, elementary majors no STEM focus. EESTEM= intervention group, elementary education major with STEM focus. STEM = science, technology, engineering, and mathematics. SWD = students with disabilities.

Table 4
Survey Results Means and Standard Deviations by Domain, by Group, and by Time

	Pre EESTEM		Pre EE		Post EESTEM		Post EE	
Domain	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Domain 1: Perceptions of SWD in inclusive settings	4.09	0.66	4.05	0.33	4.33	0.05	3.96	0.59
Domain 2: Perceptions impact on inclusion	3.66	0.89	3.54	0.55	3.93	0.62	3.29	0.59
Domain 3: Perceptions of their own ability	3.75	0.89	3.08	0.58	4.89	0.24	4.14	0.6
Domain 4: Perceptions of their own ability to embed STEM instruction	3.4	0.89	3.08	0.58	4.89	0.24	4.14	0.6
Domain 5: Perceptions of their role in enhancing their ability to meet the needs of SWD	4.58	0.677	4.38	0.41	4.75	0.5	4.09	0.64

Note. For analysis, negatively phrased statements were converted to positively phrased. EE = comparison group, elementary majors no STEM focus. EESTEM = intervention group, elementary education major with STEM focus. STEM = science, technology, engineering, and mathematics. SWD = students with disabilities. SWOD = students without disabilities pre- and posttest for the EESTEM group (e.g., intervention group) and the EE group (e.g., comparison group). Table 4 summarizes means and standard deviations for each group across domain and time.

The first research question addressed if perceptions of SWDs in inclusive settings differed between preservice teachers who participated in the collaborative initiative cohort (EESTEM) and preservice teachers who were in the comparative cohort (EE). EESTEMs' change from pre- to posttest in Domain 1 ($M = 0.25$, $SD = 0.420$) was significantly higher, $t(28) = -2.31$, $p < .05$, than EEs' change from pre- to posttest in Domain 1 ($M = -0.09$, $SD = 0.345$). In regard to the second research question, there was no significant statistical difference between groups in their perceptions of inclusion. For Research Question 3, participants in the EESTEM cohort had a significant difference, $t(17) = -4.42$, $p < .001$, in their perceptions of their own ability pre- to posttest ($M = 0.69$, $SD = 0.657$). Yet, there was not a significant change pre- to posttest for the preservice teachers in the comparative cohort. The fourth research question addressed the preservice teachers' perceptions of their own ability. Although EESTEMs, $t(17) = -6.67$, $p < .001$, and EEs, $t(11) = -4.21$, $p < .001$, showed significant differences between pre- and posttest, there was not a significant difference between groups. Finally, the fifth research question addressed preservice teachers' perceptions of their role in enhancing their ability to meet the needs of SWDs. A significant difference was found between the EESTEM and EE groups, $t(28) = -2.64$, $p < .05$.

Discussion

Findings from this study provide insight into the effects of embedding SPED faculty into a STEM-based elementary methods course on preservice teachers' attitude toward inclusion and STEM education. Results indicate that both groups (EESTEM and EE) had a positive increase in their perceptions of their own ability as well as their ability to embed STEM instruction. It is important to note that in addition to program course work, all participants completed a field experience. Thus it is possible that other variables may have attributed to participants' increased sense of efficacy.

Several findings within the specific domains of the survey warrant further discussion. Recall that Domain 1 measured personal beliefs regarding inclusion. The findings suggest that EESTEMs' change from pre- to posttest in Domain 1 ($M = 0.25$, $SD = 0.420$) was significantly higher than EEs' change from pre- to posttest in Domain 1 ($M = -0.09$, $SD = 0.345$). These findings demonstrate that EESTEM preservice teachers' perceptions of SWD in inclusive settings increased over the course of the study, while EE preservice teachers' personal beliefs regarding SWDs in inclusive settings decreased. The perceived challenges of inclusion were more evident in the EE cohort. These students did not have exposure to SPED faculty or additional resources and instruction in meeting the needs of SWDs, which may have impacted their perceptions regarding inclusion, specifically in regard to disruption to other students by SWDs, whether the teacher can give adequate time to all students if there are SWDs in the classroom, and the likelihood of additional workload for the teacher due to having SWDs in his or her classroom. This would suggest a lack of deep understanding regarding learning and behavioral characteristics of SWDs as well as instructional and behavioral supports, such as differentiation and UDL, that could assist SWDs in experiencing success within inclusive settings.

There was also a significant difference in change in scores for Domain 5, which measured teachers' beliefs in their role in strengthening their ability to work with SWDs. Results indicate that the change from pre- to posttest in Domain 5 ($M = 0.17$, $SD = 0.370$) was significantly higher than EEs' change from pre- to post-test in Domain 5 ($M = -0.29$, $SD = 0.582$). These findings demonstrate while both groups believed in an academic program where all students have access to the same standards, fewer participants indicated that SWDs can be educated in the general education classroom regardless of their disability category. Furthermore, there was not consensus on whether SWDs possessed the skills to be successful in the general education curriculum. This would indicate the need to further explore the dissonance between access and engagement within the general education classroom and curriculum for SWDs. Equally troubling was the shift in the EE group regarding academic programs where all students are held to similar expectations. Given the realty of low expectations for SWDs, this is an area in need of increased attention by teacher preparation programs. The low agreement regarding whether a SWD is likely to be socially isolated by typical peers is also of concern, as it may indicate a personal belief or bias that could impact how typical peers respond to SWDs in inclusive settings based on teacher behavior toward or response to SWDs. The fact that a low number of EEs indicated agreement or strong agreement that they would be willing to have a SWD in their classroom may speak to continued challenges expressed by general education teachers regarding their sense of efficacy in teaching SWDs.

In addition, high percentages of both groups believed that teachers should be able to make the decision as to whether to have SWDs in their classrooms (EESTEM = 61%; EE = 83%). This also suggests that while the idea of inclusion, conceptually, is acceptable to participants, teachers may have some concerns regarding their own ability to meet the needs of these students. Their responses here may also be indicative of particular stereotypical views based on disability categories, meaning that teachers may be more amenable to having SWDs in their classrooms versus having students identified as having emotional or behavioral disorders.

Another area of concern is the lack of understanding by EEs of the process for implementing response to intervention (RTI). Given that RTI is a general education initiative, it is necessary for general education graduates to be fully versed in RTI and their role in it. EEs expressed a low understanding of this as compared to EESTEMs, who exhibited higher confidence levels in their understanding. It may be that general education faculty within the college would benefit from professional development in

RTI to better infuse it across the program of study. Enhanced collaboration between SPED faculty and general education faculty would also address this need.

In the domains of STEM instruction, it is interesting that both groups expressed strong confidence in their ability to develop and deliver STEM-based instruction and the role of STEM in providing SWDs access to the curriculum, especially since the EEs did not have a focus on STEM. While EEs expressed their ability in STEM-based instruction, only 58% indicated they knew the difference between a STEM classroom and a traditional classroom, leading us to question whether they truly have an understanding of what STEM-based instruction consists of.

The results of this study provide some indication of the need to grant general education preservice teachers multiple opportunities to learn about SWDs (Basham & Marino, 2013; Brown et al., 2008). These opportunities must take into account the learner, content, and context to develop a sense of efficacy in meeting the needs of diverse learners. That said, the study has several limitations. The sample size of the study is small and drawn from one institution; therefore the ability to generalize is limited. Although researchers who were not part of the instructional team collected data, it is possible that participants' responses were based on assumptions regarding instructor expectations rather than their own belief systems. There is also the possibility that social acceptance bias may have played a role in how some participants responded to particular survey items.

This study was designed to purposefully provide instruction that simultaneously merged learner, method, and content (García & Tyler, 2010) with SPED and STEM content. Overall, findings from this study reflect a positive impact on teacher attitudes and understandings of teaching in inclusion classrooms and meeting the needs of SWDs. When teachers have a stronger sense of self-efficacy and ability, they reveal a more positive attitude and outlook on inclusive practices (Brownell & Pajares, 1999; Lifshitz et al., 2004; Lopes et al., 2004). Such skills are crucial for preservice teachers to feel equipped to adequately address the diverse needs of all their students.

Conclusion

This study explored whether a collaborative endeavor in which SPED faculty were embedded in methods courses would enhance candidates' attitudes regarding SWD and their sense of efficacy in differentiating STEM instruction for this population. In addition, we were interested in seeing if this partnership could also serve as a vehicle for creating a viable, sustainable community of practice between SPED faculty and faculty from varied disciplines. Thus this study has brought to light the positive impact that a cotaught methods course has on teacher candidates' perceptions of SWDs.

Specifically, we sought to answer five research questions. Findings indicate that (a) the EESTEM cohort's perceptions of SWDs in inclusive settings were significantly higher across time compared to the comparative cohort, (b) there was no significant difference in perceptions of inclusion between the groups, (c) the EE-STEM cohort's perceptions of their own abilities to teach SWDs were significantly different across time and there was no significant difference for the comparative group, (d) both cohorts' perceptions of their ability to embed STEM instruction changed significantly over time and there was no significant difference between groups, and (e) there was a significant difference between groups pertaining to their perceptions of their role in enhancing their ability to meet the needs of SWDs. Another outcome of the project was an increased understanding by science faculty of the need to more meaningfully address diverse learners within their programs as well as increased understanding by SPED faculty of the need to improve the service course to be more responsive to individual content areas. These benefits spanned well beyond science faculty.

STEM has been identified as integral to economic development and global competitiveness. As a result, there has been significant emphasis on preparing individuals to enter these fields coupled with a need to increase participation by underrepresented groups, including SWDs. Given the continued disparate outcomes for SWDs within and beyond K–12 settings, determining how to prepare teachers to meet the needs of this population may play a role in increasing SWDs' representation in the STEM areas.

Additional research is necessary to determine the extent to which the model described in this study can be scaled up given the confines of how workload is calculated for higher education faculty as well as financial constraints due to continued budget cuts for many institutions of higher education. Exploration of other models (e.g., mixed-reality simulation environments, online modules) of instruction that may yield similar or better results is needed, along with development of curriculum that addresses STEM knowledge and skills at the nexus of learner, method, and content. To create equitable access in STEM education for all students, teacher preparation programs need to design programs in which preservice teachers have the opportunity to see, demonstrate, and reflect on SPED and STEM content and pedagogical skills that are purposefully infused. This study created such an environment by embedding SPED faculty within the general education methods courses.

Note

[1] See http://iris.peabody.vanderbilt.edu/module/acc/

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Appendix
Sample Statements per Domain

Perceptions of SWD in inclusive settings

Including students with disabilities will promote their independence.

Students with disabilities will find it much easier to interact with their peers after leaving school if they have been taught together in general education classrooms.

Inclusion will give students with disabilities a better chance to readily fit into their community.

*A child with a disability is not likely to be socially isolated by students without disabilities.

With the help of experienced teachers, support services and special equipment, students with disabilities can do well in a general classroom environment.

*Being placed in a general education classroom positively impacts the learning of students with disabilities.

I believe most students with disabilities (regardless of the level of their disability) can be educated in the general education setting.

*I do not believe many students with disabilities lack skills needed to master general education curriculum.

I believe inclusion is a desirable educational practice.

I believe in an academic program where all students are held to similar expectations.

I believe in an academic program where all students have access to the same standards.

Perceptions of SWD impact on the education of SWOD

*Having students with disabilities in the general education classroom positively impacts the learning of typical peers.

Typical peers become accustomed to having students with disabilities in the school and naturally accept them as peers.

*Educating students with disabilities in the general education classroom is not disruptive to other students.

The inclusion of students with disabilities in general education classes is beneficial to all pupils.

*The teacher can give adequate time to all students if there are children with disabilities in the classroom.

Perception of their own ability

I know how to plan for different academic levels.

When a child is disruptive in the classroom, I have various behavior management strategies to choose from.

I understand the process for implementing Response to Intervention.

Teacher perceptions of their own ability to embed STEM instruction

I know how to develop integrated curriculum for a STEM-based classroom.

I know the difference between a STEM-based classroom and a traditional classroom.

I know how to implement instructional strategies within a STEM classroom (e.g., inquiry-based learning, design challenges).

I believe STEM-based education can provide students with disabilities access to the curriculum.

Impact of inclusion on the general education teacher

*Students with disabilities do not add to the workload of teachers.

*In the classroom, students with disabilities will not take more than their share of the teacher's time.

Understanding their role to enhance their ability to meet the needs of SWD

As a teacher, I would be willing to have a child with disabilities in my classroom.

As a teacher I would be willing to complete additional professional development so as to be better meeting the needs of students with disabilities.

I am willing to make needed instructional adaptations for students with disabilities.

I understand the role of a special education teacher in meeting the needs of students with disabilities.

*for analysis negatively phrased statements were converted to positively phrased