E–6 Preservice Teachers and Elementary Science Teaching
Assessing Confidence and Content Knowledge

By Mamta Singh

The study assessed the science teaching confidence of preservice teachers in teaching elementary science by addressing two research questions: (1) Did preservice teachers understand the science concepts well enough to be effective in teaching elementary science content? (2) Did preservice teachers have the necessary science concepts and skills to teach elementary science? The study used science content knowledge pre- and post-course tests and a validated science teaching efficacy belief instrument to answer the questions. The findings suggest that preservice teachers strongly agreed that they understood science content well enough to be effective in teaching elementary science content and were comfortable in teaching elementary science. Overall, content knowledge pre- and post-course tests indicated a statistically significant difference, suggesting that preservice teachers had necessary content knowledge to teach elementary science. As we would like to see 100% positive outcomes among preservice teachers regarding content knowledge and effective elementary science teaching, the study suggests that science methods courses should expose elementary preservice teachers to more physical science and Earth and space science content and activities.

Self-efficacy beliefs of preservice teachers in teaching elementary science is an important issue to discuss. Self-efficacy beliefs help science educators build science teaching skills and attitudes and improve instructional strategies. Different theories about self-efficacy in preservice teachers have been developed (Bandura, 1977, 1982, 1993, 1997). Self-efficacy regarding teachers can be defined as a teacher’s “judgment of [their] capabilities to bring about desired outcomes of student engagement and learning...” (Tschannen-Moran et al., 1998, p. 783). By understanding this definition, one can fully understand how essential self-efficacy is related to positive teaching behavior and student reactions. Studies have suggested various ways that self-efficacy in science teaching affects students’ behavior of learning (Hoy et al., 1998; Riggs & Enochs, 1990; Tschannen-Moran et al., 1998; Woolfolk & Hoy, 1990). According to Woolfolk and Hoy (1990, p. 634), self-efficacy is “one of the few constructs about teachers that is related to the behavior of learning of students.” Having confidence in one’s self is essential in the student’s development, and this confidence also affects the student’s behavior. The preservice teachers need to ask themselves the following questions: Do the students like science? How can the teacher make science more beneficial to their students’ learning? What is the students’ attitude toward the subject?

“Teachers are now seen as the single most important factor in terms of school variables for producing student learning” (Porter, 2012, p. 36). Therefore, it is important to understand the best practices that should be used in teacher education programs specifically to help improve elementary science teachers’ content knowledge and self-efficacy. Several studies have been conducted on preservice teachers and science content knowledge (Al Sultan et al., 2018; Avery & Meyer, 2012; Bleicher, 2004; Bergman & Morphew, 2015; Baldwin, 2014; Bleicher & Lindgren, 2005; Catalano et al., 2019; Menon & Sadler, 2016). Furthermore, several studies have been conducted in the field of self-efficacy beliefs in teaching elementary science using the validated Science Teaching Efficacy Belief Instrument (STEBI-B; Al Sultan et al., 2018; Avery & Meyer, 2012; Bleicher, 2004; Bergman & Morphew, 2015; Baldwin, 2014; Bleicher & Lindgren, 2005; Catalano et al., 2019). However, a limited number of studies have been conducted on elementary preservice teachers and their science content knowledge in three domains along with science teaching efficacy. Therefore, the present study is important for addressing preservice teachers’ content knowledge of life science, physical science, and Earth and space science, along with their feelings of self-efficacy.
Literature review

Self-efficacy beliefs and preservice teachers

Self-efficacy beliefs provide essential information associated with the importance of teachers’ efficacy beliefs. Self-efficacy influences teachers’ behaviors in class and students’ achievement and motivates teachers’ perceptions of their roles and interactions with students and management orientations (Flores, 2015). Self-efficacy in teachers is discipline-specific (Ashton, 1984; Ginn & Watters, 1990; Tschannen-Moran et al., 1998). One’s personal efficacy in a given discipline or content area has been shown to impact a person’s career choice, vocational interests, and persistence in a chosen profession (Bandura, 1997). Self-efficacy is a construct that indicates a belief in one’s capability to organize and execute a task and perform a task in the face of obstacles (Bandura, 1977, 1982, 1993, 1997). Smolleck and Allison (2011) assessed preservice teachers’ self-efficacy at different stages of their educational career in an attempt to determine the extent to which self-efficacy beliefs may change over time. The study used the Teaching Science as Inquiry (TSI) Instrument. The TSI Instrument was administered to 38 preservice elementary teachers to measure the self-efficacy beliefs of the teacher participants regarding the teaching of science as inquiry. Based on the results and the associated data analysis, mean and median values demonstrate positive change for self-efficacy and outcome expectancy throughout the data collection period.

Self-efficacy beliefs and elementary preservice teachers

Studies regarding self-efficacy beliefs and elementary science teaching have revealed mixed outcomes. According to Czerniak and Chiarello (1990), elementary teachers with high ratings of science teaching efficacy were found to be more likely to use inquiry and student-centered approaches, while those with a low sense of efficacy typically use teacher-directed strategies based on science textbooks and lectures. Science methods training courses have led to significant increases in science teaching efficacy beliefs (Morrell & Carroll, 2003). According to Yılmaz and Çavaş (2008), teaching experience did not affect preservice elementary teachers’ science teaching self-efficacy; however, preservice elementary teachers’ classroom management tended to change with the teaching practice. Additionally, the result suggests that preservice teachers’ level of beliefs in instructional management decreases with teaching practice, and their people management beliefs and skills increase with their teaching practice. Whereas Plourde (2002) indicated that preservice elementary teachers enter their student teaching experience with a set of values, attitudes, and beliefs, their beliefs about science can play a role in shaping instructional behaviors. Before student teaching, teachers take pedagogy courses, and the knowledge they gain in the courses and fieldwork tends to influence their teaching methods for science classes. To test this hypothesis, the STEBI-B instrument was used to gather quantitative data. The author assessed 59 subjects with pre- and post-course tests using STEBI-B. The results were consistent with the author’s prediction that the teachers’ influences and experiences had a negative effect on their knowledge and beliefs in science. Several situational factors encountered while student teaching can result in a teacher feeling unprepared and unmotivated to teach science.

According to Menon and Sadler (2016), participants indicated statistically significant gains in science self-efficacy beliefs and science conceptual understandings. Their study also found a positive moderate relationship between gains in scientific conceptual understandings and gains in personal science teaching efficacy beliefs. The study by Yılmaz and Çavaş (2008) investigated the self-efficacy and teaching practice of preservice elementary teachers’ science teaching and classroom management beliefs. The subjects in the study were 185 preservice elementary teachers. STEBI-B and the Attitudes and Beliefs on Classroom Control (ABCC) instruments were used to collect data. Results indicated that the majority of the preservice elementary teachers had high self-efficacy regarding teaching science material. Although teaching experience did not affect preservice elementary teachers’ science teaching self-efficacy, preservice elementary teachers’ classroom management tended to change with the teaching practice. Furthermore, Flores’s (2015) study sample consisted of 30 preservice teachers enrolled in a field-based science methods course. The participants were placed at a public elementary school for their coursework and teaching practice with elementary students. Pre- and post-course test administration of the STEBI-B instrument was used to determine the preservice teachers’ general efficacy and personal science teaching efficacy (PSTE), which increased significantly.

Additionally, a study by Aydin and Boz (2010) measured self-efficacy of preservice teachers teaching science. The subjects in this study included
Preservice teachers’ efficacy beliefs were measured by using the Turkish version of STEBI, which was developed by Enochs and Riggs (1990). Attitudes toward science were assessed by using an attitude scale consisting of 34 items that were constructed by using items from various attitude scales. Results of the study showed that preservice elementary teachers’ science teaching efficacy beliefs were moderately positive at the beginning of the course and improved throughout the course. The study also revealed a moderate positive relationship between attitudes toward science and science teaching self-efficacy beliefs. Karaarslan and Ibrahim (2011) examined grade-level and gender differences concerning elementary students’ science and technology self-efficacy using the Science and Technology Scale instrument to collect the data. While results showed that there was no significant difference across grade level and gender, positive relationships were found between the number of books in a student’s home, frequency of buying a daily newspaper, and income as indicators of socioeconomic status and self-efficacy.

Although several studies have been conducted in the field of self-efficacy beliefs in teaching elementary science, no studies thus far have applied a comprehensive approach such as using both STEBI-B and science content knowledge (based on life science, physical science, and Earth and space science). The present study therefore investigated the self-efficacy beliefs of preservice teachers in teaching science in elementary school by posing the following research questions: 1. Do preservice teachers understand the science concepts well enough to be effective in teaching elementary science?

2. Do preservice teachers have the necessary science skills to teach elementary science?

Methodology

Participants

The research sample consisted of preservice teachers enrolled in the undergraduate science methods for teachers course at a large public university in the southern United States. Seventeen preservice teachers participated in this study. The preservice teachers were not rewarded any extra credit points for their voluntary participation, but a $5 Sonic gift card was awarded to all preservice teachers who took the content knowledge pre- and post-course tests and completed the STEBI-B survey at the beginning and end of the semester ($n = 17$). The study was approved by the university-mandated Institutional Review Board.

Instruments

Two validated instruments were used in this study. A science content knowledge test was retrieved from a teacher preparation manual and other relevant resources that covered science competency questions, which included questions from life science, Earth and space science, and physical science sections. A total of 23 questions were used for this study. Out of 23 questions, 7 questions were from the life science domain, 8 questions were from physical science, and 8 questions were from Earth and space science. This instrument was used to address the first research question: Did preservice teachers understand the science concepts well enough to be effective in teaching elementary science content? The STEBI-B instrument developed by Riggs and Enochs (1990) was administered to address the second research ques-
1. Did preservice teachers understand the science concepts well enough to be effective in teaching elementary science content?

To address this research question, the preservice teachers who participated in both pre- and post-course tests and one-time efficacy survey were included in this study. As expected, the students’ scores improved at the end of the semester (Figure 1) and the difference was statistically significant ($n = 17, p < .05$). Based on descriptive statistics, 46% of participants had an average score of C or better on the science content knowledge pretest and 89% had an average score of C or better on the content knowledge posttest, with Cohen’s $d$ being relatively high (1.23), which indicated that the preservice teachers gained necessary science content knowledge to teach elementary science at the end of the semester (Table 1).

The analysis in Table 1 was conducted based on the overall response to all three science domain questions. Furthermore, the analysis of questions based on the post-course test results was divided into percentage of correct and incorrect responses to questions in all three domains: life
science, Earth and space, and physical science. The percentages of correct and incorrect responses are shown in Figure 2.

The results indicated that preservice teachers’ life science (72.3%) content knowledge was stronger than their knowledge in Earth and space science (66.7%) and physical science (63.5%). The mean percentage for correct responses was 67.5%.

2. Did preservice teachers have the necessary science concepts and skills to teach elementary science?

Similar to the first research question, for this research question, the preservice teachers who participated in both pre- and post-course tests and one-time efficacy surveys administered at the end of the semester were included in this study (n = 17). Results suggest that preservice teachers’ attitudes toward science and science teaching were positive, as 100% of the participants (preservice teachers) showed a passion for teaching at the elementary level. Tables 2, 3, and 4 show the percentage of preservice teachers’ responses to select STEBI-B statements.

The results suggest that 53% of preservice teachers strongly agreed that they understand science content well enough to be effective in teaching elementary science, and 63% indicated they were comfortable with teaching elementary science. Content knowledge pre- and post-course tests results indicated that preservice teachers’ life science (72.3%) content knowledge was stronger than their Earth and space science (66.7%) and physical science (63.5%) knowledge. The mean correct response was 67.5%. On average, the content knowledge on the pre-and post-course tests indicated a statistically significant difference in knowledge pre- and post-course, suggesting that preservice teachers had the necessary content knowledge to teach elementary science.

Discussion

The mean correct response on science content knowledge post-course tests was also the reason that preservice teachers had a positive sense of self-efficacy for teaching elementary science. This finding is also supported by Smolleck and Allison (2011), Bayraktar (2009), Enochs and Riggs (1990), and Karaarslan and Ibrahim (2011). Conducting this research helped the researcher evaluate science content knowledge in the beginning of a course, then compare participants’ results to the end of the course to determine whether the preservice teachers had improved their confidence in teaching science content at the elementary level. Additionally, participants received a questionnaire that rated their self-efficacy level individually so they could be aware of this rating and learn how they could improve this rate before entering a classroom. The results also helped the preservice teachers promote self-efficacy in their science lessons. The literature supports the observation that when it comes to science, elementary teachers do not seem to be excited or as knowledgeable as possible, as they feel underprepared to teach science, especially physical science. This study allowed those who are preservice teachers to become aware of their own confidence and attitudes in the classroom. When the teacher is confident, the students will trust the teacher.

Conclusion

Assessing elementary preservice teachers’ content knowledge in three science areas is essential because elementary teachers are generalists who teach all disciplines in addition to different science domains. Furthermore, if preservice teachers do not have solid science content knowledge in all three domains of elementary science, they could teach their future students inaccurate science that can lead to science mis-
conceptions. To achieve the desired 100% positive outcomes among pre-service teachers, science methods courses should expose elementary preservice teachers to more physical science and Earth and space science content and activities. Furthermore, to understand preservice teachers’ self-efficacy, additional studies that assess preservice teachers’ own confidence and attitude must be conducted.

### TABLE 2

Percentage of participants who strongly agreed with select STEBI-B statements.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Percentage of participants who strongly agreed with statement (%)</th>
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<tbody>
<tr>
<td>I will continually find better ways to teach science.</td>
<td>62.5</td>
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<tr>
<td>When teaching, I usually welcome students with questions.</td>
<td>56.3</td>
</tr>
<tr>
<td>When the science grades of students improve, it is often due to their teacher having found a more effective teaching approach.</td>
<td>22.31</td>
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</tbody>
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### TABLE 3

Percentage of participants who strongly agreed with select STEBI-B statements.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Percentage of participants who strongly agreed with the statement (%)</th>
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<tr>
<td>When a student does better than usual in science, it is often because the teacher exerted a little extra effort.</td>
<td>68.8</td>
</tr>
<tr>
<td>I know the steps necessary to teach science concepts effectively.</td>
<td>50.0</td>
</tr>
<tr>
<td>When a low-achieving child progresses in science, it is usually due to extra attention given by the teacher.</td>
<td>56.2</td>
</tr>
<tr>
<td>I will typically be able to answer students’ science questions.</td>
<td>43.8</td>
</tr>
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</table>

### TABLE 4

Percentage of student participants who agreed with select STEBI-B statements.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Percentage of participants who agreed with the statement (%)</th>
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<tr>
<td>I will find it difficult to explain to students why science experiments work.</td>
<td>56</td>
</tr>
<tr>
<td>When a student has difficulty understanding a science concept, I will usually be at a loss as to how to help the student understand better.</td>
<td>53.2</td>
</tr>
<tr>
<td>I will not be very effective in monitoring science experiments.</td>
<td>44.1</td>
</tr>
<tr>
<td>I will generally teach science ineffectively.</td>
<td>43</td>
</tr>
<tr>
<td>Increased effort in science teaching produces little change in some students’ science achievement.</td>
<td>41.5</td>
</tr>
<tr>
<td>Given a choice, I will not invite the principal to evaluate my science teaching.</td>
<td>13.75</td>
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Acknowledgments

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References


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