Effects of Informal versus School-Based Field Experience on Elementary Preservice Teachers' Self-Efficacy for Teaching Science

Subject/Problem

This project was a joint venture between the Engineering and Education departments at Pennsylvania Collegiate Institute (PCI, name anonymized). PCI is a mid-sized liberal arts college in the south central section of the state. The project was largely funded by an internal grant from PCI and supported by an external grant from a local non-profit organization.

Ashton and Webb (1986) built on Bandura's (1977) idea of self-efficacy by adding two types of self-efficacy for teaching. These were expanded to content specific areas. In science, these two types are personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE). PSTE is the teachers' belief that they can effectively teach science. STOE is the idea that effective teaching will positively impact K-12 student learning (Bursal, 2012). Prior research has determined that a large percentage of elementary teachers (both preservice and inservice) have low science teaching self-efficacy on both types (Bursal, 2012). This low self-efficacy has been linked to heightened anxiety about and negative attitudes toward science (Bursal, 2012; Ramey-Gassert & Shroyer, 1992). High levels of science anxiety and feelings of low self-efficacy cause elementary teachers to avoid teaching science in K-8 classrooms (Bursal, 2012). In today's fast-moving world of STEM innovation, avoidance of science is detrimental to elementary student populations.

Research has found that there are ways to increase self-efficacy for teaching science among elementary science preservice teachers. It is important to note, however, that science anxiety, attitudes, and self-efficacy are all linked. Increasing positive attitudes toward science and/or reducing anxiety around science content have been shown to increase self-efficacy for teaching science (Ramey-Gassert & Shroyer, 1992). Attempts to grow positive attitudes, increase self-efficacy, and reduce anxiety should occur in teacher preparation courses. Science methods courses that utilize hands-on inquiry approaches and firsthand teaching experiences appear to be the best at increasing preservice teacher self-efficacy (Bursal, 2012). Positive student teaching experiences implementing science lessons have been shown to reduce anxiety around teaching science (West, Watson, Thomson, & Parke, 1993). There has been research that supports the idea of providing preservice teachers with real world contexts for teaching science increases their self-efficacy (Kazempour, 2018; Novak & Wisdom, 2018; Valente, Maurício, & Faria, 2018; Yu & Bethel, 1991). Generally, prior research demonstrates that teacher educators need to use methods courses to help preservice teachers reduce anxiety and develop positive attitudes toward science. This will lead to increased science teaching self-efficacy.

All elementary education (PK-4) majors at PCI must successfully complete a science methods course, ECH 330: Teaching Science at the Early Childhood Level. This course has a 20 hour field experience requirement. Prior to the fall semester of 2017, the preservice teachers enrolled in this course completed their field experience hours in a variety of settings, mostly engaging in informal science instruction. One component required students to attend a volunteer training for the nature center at a local state park and then assist a group of students on a field trip. A second component involved delivering a lesson designed by a national program. Some of these programs took place in classroom settings, some took place in after school settings, and some took place at the local branch of the county library.

The lead author inherited the ECH 330 course in the fall semester of fall 2017 after a colleague's retirement. While the course continued to utilize a hands-on inquiry approach, the

author added the component of an authentic classroom experience that did not exist before. After the fall semester of 2017, all preservice teachers enrolled in ECH 330 completed their field experience hours in formalized classroom settings. The details of the classroom placements in the subsequent four semesters is described in the methods section below. According to prior research, the utilization of the garden at Goode in conjunction with hands-on inquiry based pedagogies in the science methods course and formalized, authentic field experiences in K-4 classrooms should result in higher PSTE and STOE for preservice elementary teachers. This paper asks three questions:

1. Does the type of field experience placement, formal or informal, have an impact on overall self-efficacy for teaching science among elementary preservice teachers?
2. Does the type of field experience placement, formal or informal, have an impact on self-efficacy for teaching science among elementary preservice teachers in two sub-categories: Personal Science Teaching Efficacy Belief (PSTE) and Science Teaching Outcome Expectancy (STOE)?
3. What role does the type of field experience placement, formal or informal, have on elementary preservice teachers' perceptions about their self-efficacy for teaching science?

Procedure

All participants were preservice teachers at PCI. Starting in the fall semester of fall 2017, preservice teachers enrolled in ECH 330 completed their field experience hours in classroom settings. As we assumed the greenhouse would be operational by fall 2017, the education department began placing students in ECH 330 at the partnership school at that time. If preservice teachers were not placed at the partnership school, every effort was made to place them in the same urban district. However, not all students enrolled in the course were placed at the partnership school nor in the urban district. There are a number of reasons for this, mainly having to do with logistics with field experience placements coordinated by PCI.

Beginning in the fall semester of 2016, students enrolled in ECH 330 were asked to participate in the current research study. At the front of each semester, students who volunteered to participate were asked to sign an informed consent form and complete the STEBI-B, a measure of self-efficacy for teaching science in preservice elementary teachers (Bleicher, 2004). Initially designed by Enochs and Riggs (1990), Bleicher (2004) edited the instrument to revise or remove items were found not to be reliable, thus making the overall instrument more valid for use with preservice teachers. A copy of the STEBI-B can be found in the methods supplement. The same participants were asked to complete the STEBI-B at the end of the semester as well. The STEBI-B was administered by the lead author every semester. Students were instructed to use the same alphanumeric code for both the pre- and post-test so that their data would be anonymous but still trackable for comparison. These data were compared using the SPSS Statistics program.

Additionally, a subset of participants each semester were invited to join a focus group to discuss their field experience placements. The questions asked during the focus group are available as supplementary material accompanying the online article. Initial focus groups were conducted by the lead author on this paper. Later focus groups were conducted by student research assistant who was unaffiliated with the class, since the lead author was the professor for ECH 330. Focus groups were recorded and transcribed. Most transcriptions were sent out to a service, but two were transcribed by a student research assistant. There were two supplementary

pieces of qualitative data collected as well. In the fall semester of 2017, students were asked to volunteer to submit responses to a set of questions about their experience at urban placements. Fourteen students opted to complete this assignment. This list of questions is available as supplementary material accompanying the online article. In the spring semester of 2019, some students made mention of their experiences at the partnership school as a part of an unrelated assignment. These students granted permission to use their comments as part of this study. Qualitative data were coded for patterns by the lead author on this paper.

Analyses & Findings

Bursal (2012) found that science methods courses that utilize hands-on inquiry increase teacher self-efficacy. Data from this study support this finding. Although taught by different professors, both Cohort A and Cohort B were enrolled in a science methods course that employed a hands-on, inquiry model of teaching. When data for both cohorts was combined, there was a highly significant increase in overall self-efficacy for teaching science. Data also show a highly significant increase on both subscales of the STEBI-B, PSTE and STOE. Cohort B demonstrated significant growth overall and in both subscales between pre- and post-test scores. Although Cohort A showed an increase in overall self-efficacy and STOE, Cohort A did not show a significant difference in PSTE between pre- and post-tests. For Cohort A, it seems the course and its accompanying informal field experiences did not have an effect on the preservice teachers' belief that they could effectively teach science. Cohort B completed field experience in formal classroom settings whereas Cohort A completed their field experience in informal science settings. Several studies have found that providing preservice teachers with firsthand experiences and real world contexts for teaching science reduces anxiety around teaching science and increases self-efficacy for teaching science (Bursal, 2012; Kazempour, 2018; Novak & Wisdom, 2018; Valente et al., 2018, West et al., 1993 Yu & Bethel, 1991). Data from this study support these findings.

While a combined analysis of cohorts showed an increase in self-efficacy for teaching science, there was a difference between the two cohorts when their STEBI-B scores were compared. On overall self-efficacy for teaching science, the data show that Cohort B reported higher self-efficacy than Cohort A. When subscale scores for Cohorts A and B were compared, Cohort B reported a higher PSTE than Cohort A. However, there was no statistical difference between Cohorts A and B on the STOE subscale. Science teaching outcome expectancy (STOE) is the idea that effective teaching positively impacts K-12 student learning. Although Cohort B felt they were better able to effectively teach science (as measured by the PSTE subscale), neither cohort felt that they would positively impact student learning.

Qualitative data collection from fall 2016 through spring 2019 is completed, but not yet fully analyzed. Analysis from these semesters, with the addition of fall 2019, will be completed prior to the NARST conference in March. Informally, students who completed a formal, classroom-based field experience express higher feelings of self-efficacy than those who completed an informal field experience. Finalization analysis of the qualitative data should support that statement.

Contribution

At the outset of the project, the study aimed to compare the self-efficacy for science teaching of the elementary education preservice teachers pre- and post-greenhouse implementation. However, the construction of the greenhouse was delayed and thus created a

third cohort of students in addition to pre- and post-greenhouse. This study compared those preservice teachers who completed their field experience hours for ECH 330 at informal settings (pre-greenhouse) to those who completed their field experience hours in a K-8 school setting but without access to the greenhouse. The greenhouse construction and automation was completed in August of 2019. The final phase of this project is currently underway now that preservice teachers enrolled in ECH 330 can utilize the greenhouse as intended. Future research will compare three cohorts of preservice teachers: those who completed informal field experiences, those who completed formal field experiences without use of the greenhouse, and those who completed formal field experiences with the use of the greenhouse. The addition of the greenhouse will further increase the hands-on inquiry experiences and real world contexts for our preservice teachers. Data collection is slated to continue through 2021, so there will be four semesters of data with preservice teachers utilizing the greenhouse. This additional data will be compared to data presented in this study. We hope a comparison of the three phases of the education piece of this project will continue to show an increase in self-efficacy for teaching science among elementary preservice teachers.

General Interest

Science, technology, engineering, and math (STEM) fields are an ever-growing part of today's workforce (Casey, 2012). However, STEM education in K-12 schools has been sparse (National Research Council, 2012). In order to increase the number of college graduates in STEM fields, K-12 schools must engage students in STEM from a young age. Unfortunately, this does not happen to the extent necessary, particularly in elementary schools. This is largely due to the fact that many elementary teachers have low self-efficacy for teaching science. This study examines ways to increase self-efficacy for teaching science among elementary preservice teachers through structured field experience placements.

Furthermore, this paper is a follow up to a previous study that examined the benefits and challenges of developing community partnerships (Forsyth & Hesson, 2017). The Engineering Department at PCI worked diligently to coordinate with the local urban school district in order to design and build a greenhouse at the designated partnership school. Although the completion of the greenhouse was delayed, it ultimately resulted in a product that should have positive impacts on multiple populations. The Engineering students were able to experience a real-world application of theoretical systems and learned how to navigate the intricacies of a moderately sized bureaucracy. The preservice teachers at PCI have gotten to practice teaching science in a school setting and will get to design and implement lessons specifically for the greenhouse. Lastly, the K-8 students at the partnership school will get to utilize the greenhouse as part of their school curriculum. Ultimately, the entire project was aimed at improving the science teaching and outcomes for students at the partnership school and we have already seen the fruits of our labor.

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NSTA Appendix

1. Effects of Field Experience on Elementary Preservice Teachers' Self-Efficacy for Teaching Science
2. Many elementary teachers have a low self-efficacy for teaching science. Our college-school partnership aims to increase science teaching self-efficacy for our preservice teachers.
3. Presentation
4. 30 minutes
5. Elementary teachers, teacher educators