How an Undergraduate Physical Science Course Influences Elementary Teachers' Longer-Term Intentions to Teach Physical Science

Abstract

Preservice science courses typically demonstrate valuable semester impacts on preservice teachers, but less is known about how such courses impact future teacher practice. Using the theory of planned behavior, this study investigates how an undergraduate Physical Science course, focused on the Next Generation Science Standards (NGSS), influences elementary teachers' longer-term intentions to teach Physical Science. Data sources include a questionnaire with credential-candidate teachers (n=31), who completed a Physical Science course as undergraduates, and interviews with teacher educators, professional development providers, and practicing elementary teachers (n=9). Findings illustrate that credential-candidate teachers did not teach Physical Science during their teaching placements. Such findings were further supported by stakeholders. We detail strategies that could support elementary teachers' teaching of Physical Science.

Objective

Studies show the value of preservice science courses to enhance preservice teachers' science self-efficacy and desire to teach science as inquiry in their future classrooms (Deehan, McKinnon, & Danaia, 2019; Karisan, Macalalag, & Johnson, 2019; Menon & Sadler, 2016). Such outcomes are particularly important in light of the science and engineering practices called for in the Next Generation Science Standards (NGSS, NGSS Lead States, 2013). However, less is known about how these intentions change over time as preservice teachers progress to their credential program and into classrooms as full-time teachers.

Studies can often portray negative narratives of elementary teachers in teaching science rather than focusing on positive supports that lead to consistent science teaching (Bradbury & Wilson, 2020). Despite the importance of a positive narrative, there are several important challenges for teaching science in elementary schools such as priorizations on reading and mathematics, insufficient planning time, and limited access to appropriate materials and resources, etc. (Johnson & Dabney, 2018; Milner et al., 2012). In light of the NGSS, there is renewed interest in determining how elementary teachers are being supported, adopting, and/or integrating the NGSS into their daily teaching practices (Smith & Nadelson, 2017).

Our overall objective for this study is to determine (1.) To what degree is Physical Science being taught in elementary schools by credential-candidate teachers?, and (2.) What factors are influencing the intentions of credential-candidate teachers to teach Physical Science? We believe understanding the answers to these questions will better inform the goals of our undergraduate Physical Science course for future elementary school teachers.

Theoretical Framework

We employ a commonly used theoretical framework (Karisan, Macalalag, & Johnson, 2019), the Theory of Planned Behavior (TPB; Ajzen, 1991; Fishbein & Ajzen, 1975), to understand credential-candidate teachers' intentions to teach Physical Science in their classroom and the factors influencing these intentions. The TPB model includes three important components that inform people's intentions and in turn, their likelihood of displaying a particular behavior if the three components are present and in alignment. The three components include attitudes, subjective norms, and perceived behavioral controls (Ajzen, 1991). Attitudes reflect if a person has a favorable perception of a given behavior while a subjective norm refers to the perceived social pressure to perform a behavior, and lastly, perceived behavioral controls consider the perceived ease or difficulty in performing a behavior (Ajzen, 1991). For example, in the context of teaching, TPB can help predict if a teacher will teach Physical Science if they have a favorable perception of teaching Physical Science (attitude), believe their peers and others expect them to teach Physical Science (subjective norms), and believe they have the required expertise to teach Physical Science (perceived behavioral controls).

Method

Participants

Teacher credential-candidates from a Western US Hispanic Serving Institution were surveyed across two semesters with a total of 31 respondents (21% response rate; 90% female; Fall 2019/Spring 2020). The participants had taken a Physical Science course as part of their undergraduate degree before enrolling in the credential program to become elementary school teachers. As part of the credential program, participants were involved in a semester teaching placement at a local elementary school.

Beyond the credential-candidates, we also interviewed relevant stakeholders to inform our survey findings. These stakeholders included three professors who taught courses to the teacher credential-candidates (three males), three science professional development providers to local schools (three females), and three practicing teachers who were teaching in local elementary schools (three females).

Research Design

This research followed a qualitative design to answer our research questions (Creswell, 2009). We first surveyed teacher credential-candidates and then interviewed relevant stakeholders to further inform our findings. The surveys for the teacher credential-candidates contained a total of 10 questions which consisted of a mixture of multiple choice and open-ended questions. Example questions included: How many Physical Science lessons have you taught this semester? Would you like to teach Physical Science more frequently? What components of the Physical Science course are useful to your current instruction? The interviews with professors, science professional development providers, and practicing elementary teachers involved similar questions to the survey, but were reformatted as appropriate for the participant being interviewed

(11-14 questions, as it followed a semi-structured interview format (Flick, 2007)). All survey and interview questions were discussed by all the study researchers to ensure face validity before sharing them with participants.

Data Collection and Management

Surveys were collected using a Google form that were sent via email to the teacher credential-candidates by the first author. Interviews were conducted in-person (pre-COVID), over email, or by phone depending on the preferences of each participant. Data collection began in Fall 2019 and continued to Fall 2020. All interviews conducted in-person or over the phone were recorded by the first author and transcribed at a later time.

Data Analysis

With all of the survey and interview responses, the first and second authors independently and deductively coded what each participant said using the TPB components as a guide (See Figure 1). The first and second authors reviewed each other's coding until agreement was reached on all responses.

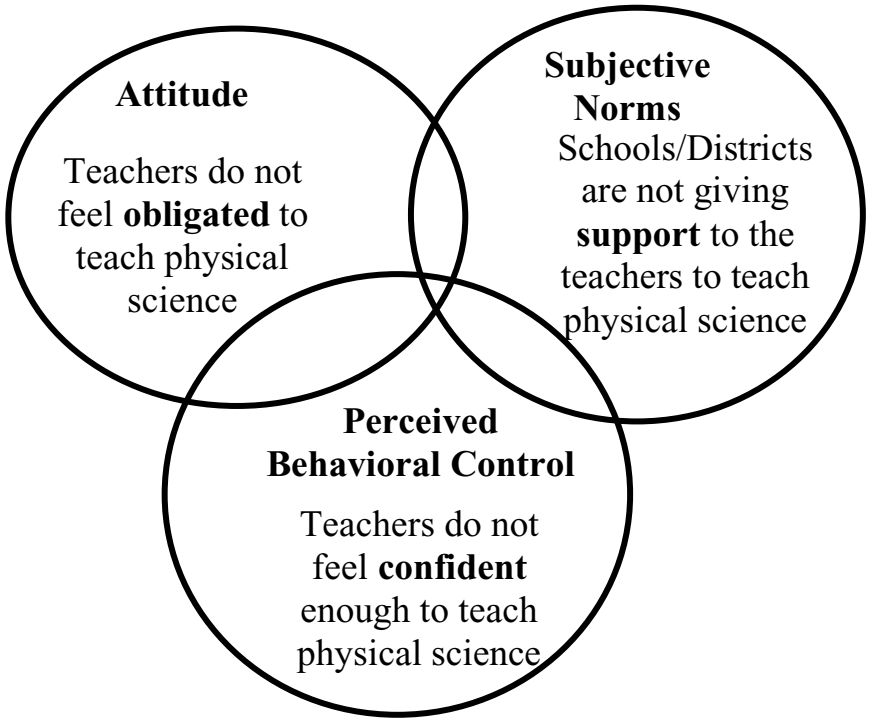

Figure 1: Theory of Planned Behavior Categories

Results

Based on our deductive analysis using the TPB framework, we identified three themes across the data. The themes are 1. Obligation, 2. Support, and 3. Confidence.

Theme 1: Obligation

As a reflection of a person's attitude according to TPB, teachers need to feel obligated to teach science. If a teacher has no intent to teach physical science to their students, they are likely to not include the subject in their curriculum. Some teachers have the knowledge and resources to learn and become confident in teaching physical science but one obstacle they face is their desire to teach it. For example, in interviews with two teachers, they state:

> *"But I teach in the team of 4, the other 3 don't ever want to teach science, they are like no. That would be too hard. So could they do it, absolutely I think it is the willingness."*
>
> Teacher 1, Female.

> *"A high demand of teaching ELA and math and just because the kids are so significantly low in those subjects are heavily emphasized, so science was always kind of in the back"*
>
> Teacher 2, Female.

Two teacher credential-candidates (TCCs) also commented:

> *"My students are only exposed to math and ELA [English Language Arts]. We have not once touched science because that is not an ESPAC (Special Ed.) focus area my mentor wishes to touch on at the moment."*
>
> TCC 6

> *"It is important for students to learn about science and I would like to incorporate more science into my classroom."*
>
> TCC 18

These comments illustrate contrasting views dependent on differing teachers in terms of their desire to teach Physical Science. In terms of teacher credential-candidates, their desires are dictated by their mentor teachers, while practicing teachers illustrate competing priorities. Thirteen out of 31 (42%) of the teacher credential candidates reported teaching a science lesson during their placement. However, nearly all of these lessons were Life Science lessons and it was mostly only one science lesson taught over the course of the teaching placement.

Theme 2: Support

As a reflection of the subjective norms according to the TPB, schools and districts need to adequately support teachers in teaching science. In some of the survey responses and across all of the interviews, we found that teachers report a lack of sufficient planning and teaching time for science. As stated by a science professional development provider:

> *"time ... their allotted minutes maybe for all of the different subject areas … science is not included in that and so teachers are really struggling with where do I put these*

science minutes into my schedule. I am required to teach all of these other minutes, but science isn't included in that."

Science Professional Development Provide 1, Female.

In terms of subjective norms, teachers feel a requirement to prioritize other subjects and in turn, struggle to include science.

Another need that teachers have that schools and districts can possibly support is the materials to teach science. When asked what would help support more science teaching, a teacher said:

"Materials, a lot of these teachers don't have the materials or just the resources to teach that in the classroom and also the support."

Teacher 2, Female.

A professor also mentioned:

"Teachers do not have enough resources that they can use for science or STEM teaching. Most of the textbooks are outdated, they don't have any hands-on activity educational kits. There's no budget to buy those materials, so that's definitely why they don't have money to buy those resources."

Professor 2, Male.

It is apparent that teachers need outside support in order to bring the science teaching inside the classroom. A teacher credential-candidate reflected similar sentiments as other participants:

"It is hard to find time [to teach science] unless it is integrated"
TCC 2

Theme 3: Confidence

As a reflection of perceived behavior controls according to the TPB, teachers need to feel confident enough to teach science. Our findings suggest this is a common issue in supporting teachers to teach science.

"...not many ... teacher candidates have confidence in teaching science, of course there are many different reasons. Many of them do not feel like they belong to science or they can teach it. It may be the lack of the knowledge or a terrible experience they had in learning science in their schooling"

Professor 2, Male.

The lack of confidence can come from many different reasons like the professor stated, but other participants note that teachers can overcome these challenges with guidance:

"There seems to be an underlying fear that people have of science but science leaders noticed that once the teachers had that final push of help, resources the confidence of the

> *teachers went up and their students were being taught science. And that very first meeting with them I think there was a lot of hesitation... and I don't know if all of that comes from not knowing the content or not feeling comfortable with it but I think that was a big piece of it. And now that I have been with them and walked them through this, I would say 90% of them are just all in with science."*
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> Science Professional Development Provider 1, Female.

From the teacher credential-candidate surveys however, 23/31 respondents (74%) noted that they felt confident in teaching a Physical Science lesson, thus illustrating the impact of their undergraduate and credential program experiences.

Discussion

Our findings illustrate important factors influencing the teaching of Physical Science in elementary schools from a TPB perspective in relation to obligation, support, and confidence, and these findings can inform undergraduate Physical Science courses for future teachers. Taking a positive narrative (Bradbury & Wilson, 2020), science is being taught by close to half of the teacher credential-candidates, even if for only one lesson during teaching placements and focusing predominantly on Life Sciences. Their credential experiences are largely determined by their mentor teacher's goals and the competing obligations these mentors have for class time.

In terms of support for teacher credential-candidates, there is clearly a need for more integrated curriculum units that span disciplines in undergraduate and credential programs (Zwiep & Straits, 2013). Comments from participants highlight the lack of time to include all areas and hence, integration is the most realistic way to have Physical Science included in lessons. Undergraduate Physical Science courses for future teachers would be valuable if integrated units were implemented and modeled within coursework.

For confidence, most teacher credential-candidates are confident and also desire to teach Physical Science based on their undergraduate experience and credential experiences. Our findings suggest that confidence may be more of an issue for practicing teachers. However, the professional development providers note positive outcomes for teachers seeking support in improving their science instruction, consistent with other studies (Denisova et al., 2019).

Conclusion

Overall, teacher credential-candidates desire to teach Physical Science and feel confident in teaching Physical Science. However, these features of teacher credential-candidates are mitigated by requirements from their mentor teachers during teaching placements. Undergraduate courses may better serve future teachers by incorporating and modeling more integrated curriculum units that allow teachers to cover science alongside reading and mathematics. Future research should investigate how such units can be translated into classroom practice and/or are perceived and adopted by mentor teachers. Professional development providers can also play an important role in supporting these goals for practicing teachers.

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