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Professional development (PD) programs for science and agriculture teachers designed around the inquiry-based learning (IBL) teaching strategy could help to improve science proficiency amongst our high school students. PD that continues over a longer period of time is more effective than short-term workshops. The purpose of this study was to explore the impact of a prolonged PD program on teachers' confidence in using IBL strategies for teaching animal sciences content. The following research questions guided this study: RQ1: What were participants' perceptions of a prolonged PD program? and RQ2: How did the prolonged PD program influence the participants' confidence in using IBL? For this project, the teachers completed three online modules focused on best practices for using IBL in the classroom and then participated in a five-day in-person PD program that was offered in Tennessee and Nebraska during June and July of 2022. Basic qualitative methodology was used, and four focus groups were conducted. The following themes emerged: perceptions of the PD and confidence in using IBL. Allowing teachers to work through the IBL activities as students appeared to increase their confidence in using IBL to teach animal science concepts in the future.

Keywords: inquiry-based learning, professional development, animal science

Introduction

The Partnership for 21st Century Skills (2008) indicated more than 50% of U.S. high school students lacked science proficiency, and this has not improved. Out of 1.8 million high school graduates who completed the ACT test in 2019, only 36% met the benchmark for collegiate science readiness (ACT, 2019). In Nebraska and Tennessee, which require all graduates to

complete the ACT, only 33% and 27%, respectively, met college readiness benchmarks for science (ACT, 2019). Other testing further verifies inadequate science preparation; for 2021-2022, the Nebraska Student-Centered Assessment System determined that 52% of 11th-grade students lacked science proficiency (Nebraska Department of Education, 2022).

According to Conner et al. (2021), professional development programs for science and agriculture teachers designed around the inquiry-based learning teaching strategy could help to improve science proficiency amongst our high school students. IBL also allows individuals to practice and develop their critical thinking skills and their problem-solving abilities (Savery, 2006). More specifically, PD that continues over a longer period of time is supported by the current knowledge of how teachers learn, and prolonged PD is more effective than short-term workshops (National Research Council [NRC], 2000). “In order to teach in a manner consistent with new theories of learning, extensive learning opportunities for teachers are required” (NRC, 2000, p. 203). Prolonged PD programs have the opportunity to make meaningful impacts on teachers’ ability to utilize new teaching strategies in the classroom. Therefore, the purpose of the study was to explore the impact of prolonged PD on teachers’ confidence in using IBL teaching strategies.

Conceptual Framework

Guskey’s (2002) model of teacher change provided the framework for this research and guided the development of PD for this project. This model suggests that teachers will not truly change beliefs and attitudes related to a new teaching strategy until they see changes in the students themselves—a workshop alone is not sufficient to change teacher attitudes (Guskey, 2002). In order for teachers to fully commit to using a new teaching strategy, they need to be able to see how it will work in the classroom first (Guskey, 2002). Prolonged PD programs allow teachers to learn, implement, and evaluate how new teaching strategies impact students’ learning outcomes, which would likely lead to greater changes in beliefs and attitudes compared to a stand-alone workshop (Guskey, 2002). Kreifels et al. (2021) found that a 12-month PD program successfully prepared agricultural teachers to integrate IBL into the classroom and positively influenced teachers’ perceptions of IBL.

Additional best practices for PD programs include the use of active learning for participants that would allow them to engage with training content in a meaningful way as opposed to simply listening to instruction or speakers (Desimone & Garet, 2015). Having teachers participate in lessons as the students and engage in IBL is one way to implement active learning during PD programs (Colclasure et al., 2022). This approach has also been found to be successful at increasing teachers’ confidence and intent to integrate IBL activities in the classroom (Colclasure et al., 2022).

While prior research has demonstrated the utility of a prolonged PD program, data were collected after the conclusion of a 12-month PD (Kriefels et al., 2021). Prolonged PD programs

consist of multiple meetings and opportunities for development, so there is a need to understand teachers' confidence in using IBL in the classroom after they are trained on using the teaching materials but before they begin integrating it into the classroom. Understanding what approaches lead to increased confidence for teachers before they move forward to classroom instruction will aid in the development of future prolonged PD programs.

Purpose and Objectives

The purpose of this study was to explore the impact of a prolonged PD program on teachers' confidence in using IBL strategies for teaching animal sciences content. The following research questions guided this study:

RQ1: What were participants' perceptions of a prolonged PD program?

RQ2: How did the prolonged PD program influence the participants' confidence in using IBL?

Methods

This current study is part of a larger research project. Agriscience and science teachers from Tennessee (TN) and Nebraska (NE) participated in a year-long PD program that started in the summer of 2022. For this project, the teachers completed three online modules focused on best practices for using IBL in the classroom and then participated in a five-day in-person PD program that was offered in Tennessee and Nebraska during June and July of 2022. During the PD, teachers played the role of high school students and were actively engaged in six different IBL activities. The IBL activities were designed to showcase animal science concepts and scientific principles that are commercially applicable and used in agriculture. The six animal science concepts included animal health, breeding and genetics, management, meat science, nutrition, and/or reproductive physiology. Additionally, each IBL activity demonstrated a basic scientific concept related to biology, chemistry, or physics. Participants were provided with the resources to implement the IBL activities in the classroom and were expected to teach these activities during the following school year.

Basic qualitative methodology was used to fulfill the purpose of this study (Merriam, 1998). After the conclusion of each in-person PD program during June and July of 2022, participants were broken into two focus groups per state (four focus groups in total). A semi-structured moderator's guide was used to ask participants questions about their motivation to participate in the program, their experience in the program, and their thoughts related to IBL. At the point of data collection, participants had completed the training portion of the prolonged PD but had yet to begin implementation in the classroom.

There were six to nine participants in each focus group, with a total of 30 participants combined. Twenty-one of the participants taught agriscience ($n = 21$), six taught biology ($n = 6$), and three

taught chemistry ($n = 3$). Participants in the program had been teaching for a range of one to 28 years ($M = 9.75$, $SD = 8.45$). Focus groups were used for this research to allow participants to express their opinions and thoughts in a social setting (Morgan, 1998). Each focus group lasted approximately 60 minutes and was recorded and transcribed for accuracy. After the focus groups were transcribed, the lead coder used Glaser's (1965) constant comparative method of analysis to identify emergent themes related to the teachers' perceptions of the PD.

To help address potential bias or assumptions of the coder that may threaten the validity of the study, a researcher subjectivity statement has been included (Merriam, 1998). The primary coder was a master's student studying agricultural and extension education at the University of Nebraska-Lincoln and has a bachelor's degree from the University of Tennessee, Knoxville, in agricultural education. In order to address the reliability of the analysis, the primary coder and a secondary coder independently analyzed one of the focus group transcripts. After analysis, the coders met to discuss their codes and, upon agreement, developed a code book to help direct analysis (Creswell, 2013). Peer debriefing was used during data analysis to help increase the validity of the study (Holloway, 1997). The peer debriefer was involved in the project but not present for the focus groups—she served as a devil's advocate during the coding process to challenge assumptions and provide alternative views for the lead coder. Additionally, an audit trail was created to track how codes were identified, defined, and condensed to increase the findings' dependability (Lincoln & Guba, 1985).

Findings

Participants' Perceptions of the PD

Participants' appreciation of participating in active learning during professional development emerged during the focus groups. One common theme was how PD provided immersive experiences for the participants. When asked to provide feedback on the professional development program, many of the participants described how beneficial it was to experience the activities from the student's perspective. Participant 2 (NE) stated, "I really like the sequencing [of the PD] and [how] it's replicated [to] what we might see in our actual classroom." When discussing how surprisingly immersive the PD program was compared to others, Participant 6 (NE) explained, "You are the students, you are actually going to put yourselves in these situations and do the [activities] ... so that way you understand your student's perspective when they are doing [the activity]." Participant 5 (NE) had a similar view stating, "My favorite part was actually getting to be the student and doing [the activities]." Additionally, Participant 9 (NE) added, "I love the fact that we got to try activities out as a student."

Participants also discussed how, by experiencing the activities as a student, they were able to identify areas of weakness that may occur in their own classrooms. Participant 6 (TN) explained,

I think the facilitators did a really great job of throwing us into the same situation that we would throw our students into. Some of us even turned into some of our lower level performing students ... [when faced with challenges] my brain just locked up [and] I cannot process through this right now. I really liked that they let us struggle for a little bit and then if we still needed help, they gave us the next little bit of information instead of just giving anybody the answer.

Other participants brought up the value and importance of learning by doing. Participant 7 (NE) stated, "Reading the lesson plan versus going through the lessons and doing them, you learn more if you're thinking about those [inquiry] questions and creating things, asking questions, exploring, and researching, etc." Overall, the participants enjoyed the structure of the PD program and getting to engage in the IBL activities themselves.

Participants' Confidence in Using IBL

As conversations progressed, many participants discussed how the immersive experience affected their confidence in teaching inquiry-based learning curriculum materials. Most participants' confidence increased after participating in the professional development program, especially first-year teachers. Participant 6 (NE) said, "[Inquiry-based learning] was my weak area. And as a first-year teacher, this certainly improves my ability to teach that not only in the animal science context but also with the science focus as well." Similarly, Participant 4 (NE) expressed,

These are the lessons that we were doing throughout the week. Getting to do them is really helpful. Being taught them before you have to teach the lesson gives me a lot of confidence going into my first year of teaching.

Participants with more teaching experience also conveyed their increased confidence in teaching with inquiry-based learning. Participant 2 (TN) shared, "Being able to participate in [the professional development], both as a student and a teacher at the same time, I think that's really where that confidence comes in terms of being comfortable with the material in particular."

Participant 14 (TN) had a similar opinion stating,

It did improve my confidence ... just being here and the way the PD was presented put me in the student's seat, and I wasn't necessarily in that teacher hat mode. I was a student, so I was like this is what I need to be doing with my student. It gave me that confidence that I need.

Furthermore, some participants agreed that their confidence slightly increased, as Participant 8 (NE) shared, "This [professional development] certainly increased my confidence to be able to

for sure teach the lessons that we went through, and [I'm] somewhat confident in the ability to write and create inquiry lessons."

However, a few participants indicated their confidence was not heavily influenced by the professional development. When discussing the participants' confidence levels with animal science and inquiry-based learning concepts, some participants admitted they were already confident prior to the professional development. Participant 12 (NE) stated, "I would say that this PD didn't necessarily increase my ability, as again, [inquiry-based learning has been] a part of [our] practice for several years." Although some participants already possessed confidence, Participant 5 (TN) shared, "But now [after the professional development], I feel more highly qualified."

As the discussion moved to reflect on the overall impact of the in-person professional development, Participant 8 (TN) said,

This is the first professional development that I have ever been to where they took us through the entire lesson, let us do the lesson ourselves and then gave us the materials to take it back to our kids. That is one of the biggest things that has made this the best professional development that I have gone to, because I'm able to take what I learned, and what I implemented, home and I can do it seamlessly.

By the end of the in-person PD program, the participants reported they were confident in using IBL in their classes in the future.

Conclusion and Discussion

The purpose of this study was to explore the impacts of a prolonged PD on teachers' confidence in teaching with IBL strategies in the classroom. Specifically, this study explored teachers' confidence after completion of the in-person PD meeting of a year-long program but prior to teachers implementing IBL in the classroom. Many of the participants commented on how they enjoyed the immersive aspect of the PD. Instead of passively learning about IBL strategies and receiving lesson materials, participants were asked to play the role of the student as they engaged in the IBL activities themselves. This immersive role-playing approach to PD appeared to influence the participants' satisfaction with the workshop, which reflects best practices for incorporating active learning into PD programs (Desimone & Garet, 2015). Many of the participants commented about how playing the role of the student allowed them not only to understand better how to implement IBL teaching strategies but also how students would likely be engaging with the content. While Guskey's (2002) model of teacher change proposes that teachers need to see their students engage with new teaching strategies before changing beliefs and attitudes, the findings from this study indicate that using active learning strategies that immerse teachers in the role of the student during the PD program may yield similar results. This

role-playing would allow teachers to see how IBL could be implemented and allow them to experience it themselves before implementing it in the classroom.

Allowing teachers to work through the IBL activities as students did appear to increase their confidence in using IBL to teach animal science concepts in the future, which was in line with past research (Colclasure et al., 2022). Some of the teachers pointed out that this teaching strategy was a weakness of theirs, but getting to spend an entire week learning the content and engaging in IBL helped to increase their confidence. Even teachers who started the workshop with some understanding of IBL walked away feeling like they had increased their expertise in executing the strategy. As teachers integrate IBL into their classes and see the impacts on student learning outcomes, the teachers' confidence and appreciation for using IBL is expected to increase further (Guskey, 2002; Kreifels et al., 2021). Overall, using the active learning strategies during the in-person PD meeting did appear to positively influence teachers' confidence in using IBL during the next stage of the prolonged PD program.

Recommendations

Due to the qualitative nature of this study, the findings are not generalizable. However, they do provide meaningful insight into the development of teacher PD programs. The findings from this study indicate there are benefits in allowing teachers to experience lessons both as a student and a teacher during a prolonged PD program. When developing PD programs, agricultural teacher educators should think beyond the length of the program to consider how the content will be delivered to teachers as well, thus ensuring active learning strategies are utilized. Allowing teachers to participate in the developed lesson plans and engage with the teaching materials as students would allow them to understand better how to facilitate the lesson while seeing it from the perspective of the student. This strategy helps to increase confidence and could also serve to help teachers begin to move through Guskey's (2002) model of teacher change before implementing IBL in their classes.

Given the data in this study were collected at the completion of the in-person PD, it would be important to collect data at the end of the one-year program to understand how the PD influenced teachers' actual ability to integrate IBL into their curricula. While the findings are specific to IBL with animal science concepts, there could be value in replicating a similar IBL professional development in other areas of agriculture, such as plant science, agricultural business, or agricultural mechanics. Additionally, as some participants already possessed confidence before the professional development, further research could be explored on whether being traditionally or alternatively certified influences teachers' self-efficacy and confidence in teaching IBL. This study should be conducted in other states to gain a broader insight into the impacts immersive professional development has on high school science and agricultural teachers across the country.

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