

# The Impacts that a Prolonged Professional Development has on Teachers Using Inquiry-Based Learning in the Classroom

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## Abstract

*Teaching with inquiry-based learning (IBL) can be used to increase high school students' science proficiency levels. Teachers must also be equipped and prepared to teach inquiry-based learning concepts. Therefore, this study aimed to evaluate how prolonged professional development (PD) about IBL impacts science and agriscience teachers' intent to use IBL animal science concepts in the classroom. The current evaluation identified the theory of planned behavior elements which provided a better understanding of teachers' attitudes, perceived behavioral control, subjective norms, and intent relating to implementing IBL into their curriculum. A total of two focus groups were conducted between Tennessee and Nebraska Using a semi-structured moderator's guide, participants were asked questions related to their confidence, motivation, and intent to integrate the IBL animal science concepts into their classroom. The findings from this study indicated that although teachers faced barriers to new teaching strategies concerning subjective norms and perceived behavioral control prior to the PD, they now perceive that they can control those barriers and further intend to integrate the IBL animal science concepts into their classroom after completing the PD. We recommend that future research is conducted to explore the students' experiences participating in the IBL lessons and pursuing a follow-up with teachers after implementation.*

## Introduction and Literature Review

On average, 41% of 12<sup>th</sup> grade students in the United States were not proficient in science (National Center for Education Statistics, 2019). More specifically, 52% of 11<sup>th</sup> grade students in Nebraska (Nebraska Department of Education, 2022), and 50% of all high school students in Tennessee lacked proficiency in science (Tennessee Department of Education, 2022). As the world continues to evolve, science literacy is crucial when making informed decisions, solving problems, analyzing information, conducting research, and evaluating scientific evidence (United States Department of Education [USDE], 2022). Researchers have consistently found that inquiry-based learning and instruction is one approach to positively influence

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students' science literacy (Abdi, 2014; Aulia et al., 2018; Gormally et al., 2009; Şahintepe et al., 2020). Inquiry-based learning (IBL) can be used as the strategy for teaching science because it allows students to develop their knowledge, understanding and interest in science (Calalb, 2018). "Inquiry-based teaching is a teaching method that can be used to combine the curiosity of students and the scientific method to enhance the development of critical thinking skills while learning science," (Warner & Myers, 2011, p.1). In addition to improving science literacy, IBL can improve basic skills that are required in the workforce, such as critical thinking, problem-solving (Savery, 2006), scientific research, collaboration, collection of information, analyzing and reasoning, and communication skills (Calalb, 2018).

Solving complex challenges and utilizing critical thinking skills is crucial to preparing students for the workforce (USDE, 2022). Improving science education can have a positive impact on society by creating well-informed citizens (Martín-Páez et al., 2019), and individuals' understanding of science can be improved when taught through the lens of real-world context (Skelton et al., 2018). Career and Technical Education (CTE) programs, specifically agriscience, can provide the context for teaching science and inquiry because it allows students to critically think and solve problems in real-world scenarios (Pearson et al., 2013; Phipps et al., 2008; Thoron & Myers, 2011; Thoron & Myers, 2012). Additionally, agricultural curriculum focuses on experiential learning, which aligns with inquiry-based principles (Warner & Myers, 2011). Therefore, inquiry-based instruction can be used to improve science literacy when teaching science through an agricultural context (Bailey & Meritt, 1997; Warner & Myers, 2011).

For teachers to effectively integrate IBL into curriculum, they must find value in using it (Ramnarain & Hlatswayo, 2018). Prior literature (Abell & Lederman, 2007; Crawford, 2014; Keys & Bryan, 2001) identified teachers' limited beliefs and knowledge about practicing inquiry-based learning as major barriers for implementation. Although inquiry-based instruction has great benefits for science literacy (Abdi, 2014; Aulia et al., 2018; Gormally et al., 2009; Şahintepe et al., 2020), teachers believe they are not well prepared to teach inquiry-based lessons and feel they lack the skills to facilitate inquiry activities in the classroom (DiBiase & McDonald, 2015). Many teachers alluded to needing professional training to prepare them to effectively teach and implement inquiry (DiBiase & McDonald, 2015). Researchers have also found that efficient professional development (PD) and teacher training is needed to alter teachers' attitude (Guskey, 2002) toward the inquiry-based teaching approaches, to increase teachers' confidence using inquiry (Kreifels et al., 2021), and to successfully teach inquiry-based instruction (Thoron et al., 2011; Thoron & Myers, 2011).

### **The Science and Agricultural Academy**

The purpose of this research was to explore how participation in The Science and Agricultural Academy, an IBL PD program, impacted science and agriscience teachers' intent to use IBL in the future. The Science and Agricultural Academy occurred in the summer of 2022 in both Tennessee and Nebraska. Agriscience and science teachers participated in this five-day PD to learn about using IBL to teach animal science concepts with in their agriscience and science curriculum. The research team worked with animal science experts to develop a series of IBL activities and associated resources to provide the teachers during the professional development. Each day, one member of the research team would facilitate the IBL lesson and the teachers would follow along as if they were students and would fully engage in the IBL process. Agriscience and science teachers also worked in pairs to develop new IBL lessons about specific animal science concepts that could also be widely shared and distributed.

### **Structuring a Professional Development Program**

Professional development is most beneficial when it allows teachers to better understand their teaching content, assess their own performance, and identify their students' needs to make necessary changes in curriculum (Patton et al., 2015). Desimone (2009) suggested using several features when designing a professional development program that include: content focus, active participation, coherence,

duration, and collective participation. Desimone's (2009) features were implemented when designing the professional development reported in this study.

### **Content Focus**

Content focus is the most important feature of professional development because previous studies have shown that focusing on improving teacher knowledge and practice, and understanding how students learn content and perform subject matter activities, positively influences student success (Desimone, 2009). A knowledge-centered approach can help teachers develop an understanding of their needs and that of their students, which strengthens their knowledge and planning skills (Brand & Moore, 2010). The Science and Agricultural Academy focused on increasing teachers' knowledge and self-efficacy to understand how to make current academic content more inquiry based (Ferand et al., 2020) and connect science content to animal science concepts.

### **Active Participation**

It is crucial that professional development is engaging and allows teachers to participate in active learning (Desimone, 2009). An effective professional development that enables the teacher to become an active learner (Patton et al., 2015) allows them to gain hands-on experience with the content and activities that they are expected to facilitate in their own classrooms (Garet et al., 2001). Additionally, when teachers are actively involved in professional development, they can assess their own learning needs and create effective content that satisfies those needs (Parker et al., 2012). In the professional development for this study, teachers were actively involved as they participated as if they were students and were asked to work alone and in groups throughout the week using inquiry and problem-solving skills. Furthermore, when designing their own lesson plans, teachers were given creative freedom to adapt their inquiry animal science lessons to meet their classroom needs.

### **Coherence**

Coherence emphasizes the importance of teacher knowledge and beliefs (Desimone, 2009). Appropriate professional development should align with both school and state standards (DeMonte, 2013). While the need for science education increases (National Research Council, 2007), it is crucial that teachers have access to high quality professional development to effectively plan and facilitate appropriate curriculum (Myers & Washburn, 2008). Coherence is a feature that was integrated into this professional development program by promoting teachers' recognition for the value of IBL as a way to increase science and agricultural literacy.

### **Duration**

Duration represents length of the professional development and the specific contact time for participants to immerse themselves in learning how to incorporate pedagogical concepts. (Desimone, 2009). The recommended contact time is 20 or more hours (Desimone, 2009). Previous researchers found that ability to teach with inquiry is positively influenced by the amount of time that educators participated in supportive professional development (Supotivz & Turner, 2000). The Science and Agricultural Academy professional development program was held over five days, Monday-Friday, eight hours daily. This prolonged professional development should enable teachers to increase their knowledge and confidence in teaching animal science concepts using IBL.

### **Collective Participation**

The final feature of an effective professional development is collective participation, which includes collaboration with other teachers (Desimone, 2009). Effective professional development encourages a working relationship with others (Wei et al., 2009), sharing knowledge (Darling-Hammond & McLaughlin, 2011), and engaging in feedback and discussion (Patton et al., 2012). The professional development program discussed in this paper encouraged collaboration between agriculture and science teachers within the same school system by asking participants to reach out to their teacher colleagues in

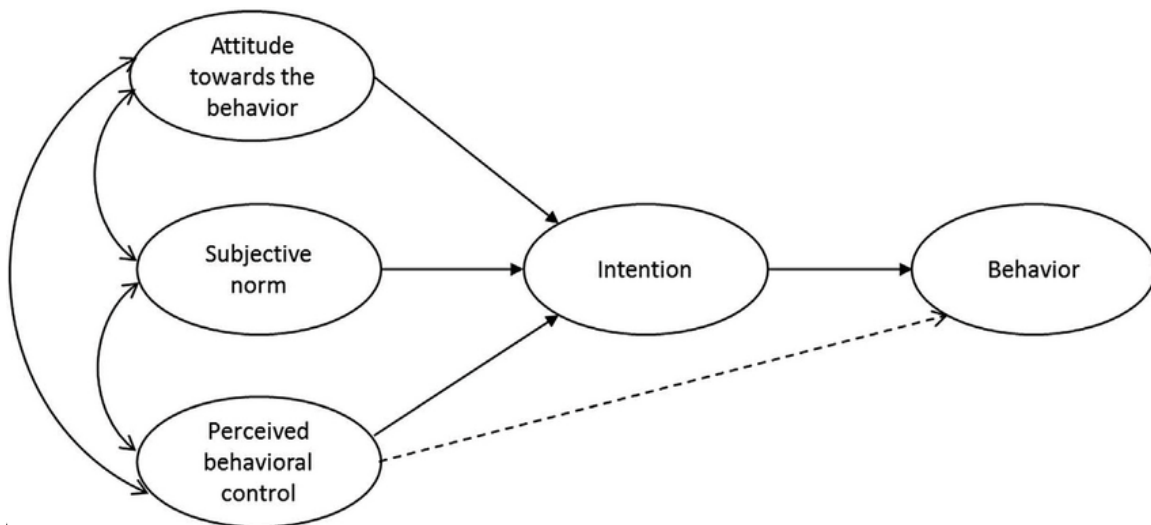
their school to participate in the PD as a science teacher and agriscience teacher pair. This provided both a science and agriculture dynamic and allowed both teachers to work together to create inquiry-based lessons that connect with one another and adapt their lessons to fit their specific school and student needs. Furthermore, teachers were given time to collaborate with other teachers from different schools to gain a broader understanding of concepts and build relationships.

### Theoretical Framework

The theory of planned behavior (TPB) provided the theoretical framework for this study to better understand motivating factors of teachers' intent to utilize IBL for teaching animal science concepts after participation in a prolonged professional development (Ajzen, 1991). Using Ajzen's (2012) TPB model shown in Figure 1, attitude, perceived behavioral control, and subjective norms are predictive of behavioral intent (Ajzen, 1991). Attitude refers to having a favorable or unfavorable perception of a behavior (Ajzen, 1991). Subjective norm is social pressure from peers to perform a behavior or not (Ajzen, 1991). Perceived behavioral control is one's perception of their own ability to perform and control a behavior (Ajzen, 1991). An individual's intent to perform a behavior is more likely if their attitude, behavioral control, and subjective norms are favorable, and behavioral intent is a direct predictor for behavior (Ajzen, 1991).

**Figure 1**

*Ajzen's (1991) Theory of Planned Behavior Model*



Previous research supports that attitude, subjective norms, and perceived behavioral control influences teachers' intent to integrate IBL into their classroom (Conner et al., 2021). Prior literature also proposed that additional school expectations and classroom management factors increase the complexity to successfully teach with inquiry (Crawford, 2007). Additionally, Ajzen (1991) expressed the importance of behavioral achievements being dictated by available opportunities and resources. Teachers often lack the necessary resources that equip them to effectively integrate new teaching strategies into their curriculum (Myers & Washburn, 2008). Factors related to TPB elements, including limited access to resources and supportive administration, class sizes, and state curriculum pressure, can act as barriers to teachers' intent of using inquiry-based learning (DiBiase & McDonald, 2015; Ramnarain, 2014), which would subsequently decrease the likelihood they actually engage in the behavior of using IBL (Ajzen, 1991). Further exploration is needed using TPB to better understand how teachers' attitudes, subjective norms,

and perceived behavioral control influence their intent to integrate IBL animal science concepts into their classroom after participating in a professional development.

### **Purpose & Objectives**

The purpose of this study was to explore how participation in an inquiry-based learning professional development impacts science and agriscience teachers' attitudes, perceived behavioral control, subjective norms, and intent. The following research questions guided this study.

RQ1: What are Science and Agricultural Academy participants' attitudes, behavioral control, and subjective norms toward integrating inquiry-based learning animal science concepts and activities into their curriculum?

RQ2: What are Science and Agricultural Academy participants' intent to integrate inquiry-based learning animal science concepts and activities into their curriculum?

### **Methods**

This study is part of a larger project that collected both qualitative and quantitative data at the end of The Science and Agricultural Academy, but only the qualitative focus group data have been reported to fulfill the purpose of this study.

### **Context**

A total of 33 agriscience and science teachers from Tennessee (TN) and Nebraska (NE) participated in The Science and Agricultural Academy, a year-long professional development program that began in the summer of 2022. Prior to the in-person program, teachers completed three online modules related to using IBL in the classroom. Following the online modules, the teachers participated in a 5-day, in-person professional development program where they gained experience from both student and teacher perspectives with IBL animal science concepts that included animal health, breeding and genetics, management, meat science, nutrition, and reproductive physiology designed to connect basic scientific concepts of biology, chemistry and/or physics to an agricultural application. The professional development program was offered in both Tennessee and Nebraska during June and July of 2022. Participants were provided the resources and materials needed to implement the IBL animal science activities throughout the school year. Additionally, each participant received training for how to create their own IBL activities and were asked to work in pairs to create new lesson plans utilizing IBL.

### **Data Collection and Analysis**

Qualitative data were collected through a series of focus groups on the final day of the program in both states. Three participants left the PD prior to data collection; therefore, there were 30 participants who participated in focus groups. Participants were broken into two focus groups per state (four focus groups in total) to debrief and discuss after the in-person professional development program was concluded. Using a semi-structured moderator's guide, the participants were asked questions related to their confidence, motivation, and intent to integrate inquiry-based learning animal science concepts. At the time of data collection, participants had completed the 5-day program but had not begun their own implementation of the activities in the classroom.

Each focus groups consisted of six to nine participants (30 participants in total). Focus groups are to be used when interviewees are similar to one another and when their interaction enhances desired discussion (Kruegar & Casey, 2014; Morgan, 1997), which is why this approach was selected. Each focus group lasted 60 minutes and were recorded to be accurately transcribed. The transcriptions were analyzed using *a priori* coding where the lead coder matched the data to pre-determined codes (Creswell & Creswell, 2018). The theory of planned behavior variables, including attitude, perceived behavioral control,

subjective norms and intent, were the pre-determined codes used in the *a priori* coding process. A code book was developed and reviewed by a panel of experts prior to data collection.

### Trustworthiness and Credibility

The researcher used multiple validation strategies during the data analysis process that included an keeping an audit trail (Creswell & Poth, 2018) and peer debriefing (Creswell & Creswell, 2018). To increase the trustworthiness and credibility of this research, an audit trail was provided as the coder documented how they identified, interpreted, and combined codes (Creswell & Poth, 2018). Additionally, a peer debriefer was used to challenge, assess, and provide further interpretation of the findings (Creswell & Creswell, 2018). The peer debriefer was a colleague that was involved in the study but was not present for the professional development program. The primary researcher received their bachelor's degree in agricultural education from the University of Tennessee, Knoxville and was pursuing their master's in agricultural and extension education from the University of Nebraska-Lincoln at the time of this study.

## Findings

### RQ1: What are Science and Agricultural Academy Participants' Attitudes, Behavioral Control, and Subjective Norms Toward Integrating Inquiry-Based Learning Animal Science Concepts And Activities Into Their Curriculum?

#### Attitude Toward IBL

Attitude was defined in this study as participants' personal feelings toward IBL and the professional development. Overall, most of the participants expressed positive attitudes toward participating in the IBL professional development and integrating animal science-based concepts into their curriculum. Sub-themes emerged during the focus groups, including *excitement*, *personal interest*, and *values*.

**Excitement.** When the participants were asked why they wanted to participate in The Science and Agricultural Academy, many participants expressed their excitement. Participant 7 (NE) said,

I really love animal science and was looking for some new [and] exciting ways to make it more fun [and] interactive for my students. I had attended [a prior professional development] few years back and got a lot out of that and was excited [about] the opportunity to do an animal science related one this time.

Participant 18 (TN) shared their reasoning by stating, "I truly felt like this was something that I could benefit from and be able to actually apply in my classroom and have kids that [are] interested. So, I was very excited to jump on [the PD]." Additionally, discussion formed about the desire to incorporate animal health in the participant's program as Participant 5 (NE) said, "I was excited because there's a lot of [animal health content.]"

Other participants expressed excitement toward collaborating with their science or agriscience teacher colleagues. Participant 3 (TN) said,

I'm a science teacher, and I was very excited when our agricultural teacher that I communicate with said that there was this [professional development] opportunity. I immediately looked at my schedule that same afternoon and told her 'Yes, please sign us up.'

**Personal Interest.** Participant 6 (TN) shared, "When [the agriscience teacher] sent out an email to our science department of [needing] a science teacher and describing the program, it kind of piqued my

interest.” This personal interest was evident throughout the discussions. Participant 10 (TN) explained, “We actually saw Nebraska’s science and agricultural academy circulating, and we were very interested in that [so] we actually asked our county to send us to that one.” Also interested in enhancing their current program, Participant 7 (TN) stated, “It was such an interest to me to be able to take our animal science pathway a little bit further.”

**Value.** The value of using animal science concepts and IBL as a context for teaching science also emerged during the focus groups. Some participants had previously established the value of using animal science concepts as Participant 11 (NE) shared, “I already see the increasing need to show students the connection [of] agriculture and science.” Additionally, Participant 10 (TN) explained, “For [the students] to use those inquiry skills, pulling that real-world connection, and seeing it from one science class to an agricultural class is very powerful and impactful.” The importance of broadening knowledge was also discussed as Participant 15 (TN) said, “I think that broadening our horizons [as teachers] and [being] able to share that [knowledge] with students [is] a benefit.”

As participants reflected on the professional development program, positive attitudes about the program surfaced. Participant 2 (NE) shared, “I love this training because it just provides a framework for how we take these [animal science] concepts that are really important and make relevant and applicable to students in their own lives.” Participant 5 (NE) expressed a similar attitude by stating, “It was a very good experience. [It was] probably the best professional development [that] I’ve done in a long time.” Other participants reported looking forward to future, similar professional development programs as Participant 1 (TN) said, “I love animal science lesson plans. Let’s do plant science. Let’s do environmental science. Let’s do all other sciences...I would come to every one of those.”

Overall, participants possessed positive attitudes toward participating in the PD and integrating IBL animal science concepts to enhance their current curriculum due to their excitement, personal interest, values associated with the program.

### Subjective Norms

Subjective norms were defined as any time participants discussed external pressure or influence that would impact whether they utilized IBL animal science concepts or participated in the program. As participants described their interest in utilizing the IBL animal science concepts, many discussed how subjective norms relating to occupational expectations and social influences affected their intent to integrate animal science concepts into their curriculum. Two sub-themes emerged during analysis relating to *state-level expectations* and *collaboration*.

**State-level Expectations.** Some participants alluded to being influenced by state-level testing and standards when asked about their ability to use animal science as a context for teaching science. Participant 6 (TN) said “In the two science classes that I teach, I have the benefit of not being state tested.” Participant 9 (TN) shared,

I agree with that wholeheartedly... I teach one state tested class and one non state tested class. I actually plan to use [the animal science concepts] a lot more freely in my non [state] tested class because I have the freedom to really mold that class a lot.

Participant 11 expressed, “I personally really like that we don’t have set standards that we’re tested on and that we’re required to teach.” Similarly, Participant 13 (TN) shared, “I teach anatomy and physiology [and] we [are] not bound by an [end-of-course test]. So I don’t have that constraint, and I really appreciate [that].” Contrary to not having limitations resulting from state testing, Participant 5 (NE) discussed their concern with combining agriculture and science in a science class by asking, “Are [science teachers] going to be able to teach [the animal science concepts] along with the other [standards and expectations] that they

need to meet for the year?” When participants continued to discuss using animal science concepts in their curriculum, Participant 15 (TN) stated,

As a biology teacher with an [end-of-course test], I feel like it’s a different challenge for biology teachers with all the state standards, pacing and everything that we have to cram into our time with our kids...the teacher in me says one or two [concepts] may be about as much as I can do in a biology class.

**Collaboration.** As conversations progressed toward how social influences affect teachers’ intent to integrate animal science concepts, collaboration and relationships with fellow teachers and school administration were discussed. Participant 10 (TN) shared, “You have to have administration that’s willing to allow [collaboration] to happen.” Participant 12 (NE) said, “Sometimes [administration] doesn’t see the need for [agriscience and science teacher] collaboration, and the power of it.” Similarly, Participant 11 (NE) stated,

We’ve wanted to do a co-taught class this year and our administration didn’t see a place for it. So, this [professional development] is a tool and a resource [that allows us] to go through and say we did [collaborate] and it worked out really well.

Other participants discussed relationships with their colleagues. Participant 1 (TN) said,

I’m really jealous of everybody’s relationship between the science teachers and their agricultural teachers, because all the agricultural teachers in my county really struggle with the look of ‘you teach cows.’ [Agriculture is] not looked at as a science, but it is... That’s kind of given me the extra umph that I needed to be like okay we really [have] to push this program, because it’s important [and] very much science based.

Participant 5 (TN), who also taught agriculture, agreed by adding,

I really struggle in my school being able to have [the] science department take me seriously...I feel like implementing some of these [IBL animal science] lessons [are] going to also bring a lot of questions, whether [science teachers] see it from the science side or my side. I think that it will help with that relationship building.

Participants further discussed seizing the opportunity to collaborate. Participant 11 (NE) said, “[This professional development] was the perfect opportunity for us to come together and collaborate teaching in both agriculture and science.”

After reflecting on the professional development, Participant 11 (TN) also said, “I feel like after this training, it will be more beneficial for me to work with a biology teacher.”

Participants were influenced both positively and negatively by perceived subjective norms. State-level expectations, such as testing and subject standards, impacted whether teachers felt they could integrate IBL animal science-based concepts into their classroom. Additionally, participants’ desire to collaborate with other teachers in their own school, along with their desire to continue those collaborations after the professional development, appeared to have a positive impact on their intent participate in the program.

### Perceived Behavioral Control

Perceived behavioral control was defined as personal and system factors that would influence the participants’ ability to utilize IBL animal science concepts in their classes. *Knowledge*, *resources*, and *adaptability* were the three sub-codes that emerges from these discussions related to perceived behavioral control.

**Knowledge.** When discussing whether participants felt that they possessed the knowledge to use animal science concepts in their classes, Participant 5 (NE) said, “I think it will help my ability to teach in those [science-based] areas that maybe I’m not very comfortable with because then [the science teacher] can help as well.” Participant 3 (NE) had a similar opinion stating, “I didn’t have those [connecting science to animal science] skills yet... [now I] see how it will be done [and] how inquiry learning, and more scientific application can be done on the agriculture side.” Additionally, Participant 16 (TN) described,

I am an animal science teacher so to be able to take even those more scientific concepts in animal science, I think it’s going to be something where I can just further increase areas [I’m] already teaching. I’m already teaching genetics...but I can bring even more specific science concepts that I wouldn’t have thought to put in there.

Other participants indicated that due to the training, they could now construct other lessons outside of the ones that were created during the professional development. Participant 8 (TN) explained, “The component of actually creating our own lesson plan, while it seemed like a really heavy task, was really beneficial to hone in on how I can replicate this in other areas of my agriculture program.”

From the science teacher perspective, Participant 9 (TN) said, “Teaching science, I bring in some of those [animal science] ideas, but I think I’ve gotten more specifics on how to bring them into certain topics.” Participant 10 (NE) similarly shared, “I don’t know the agricultural principles in animal science and how they necessarily connect to the science, so giving me a specific way that I can connect animal science to science helps.” Participant 7 (NE) also explained, “[This professional development] did help me with more ideas on how to show students those [science and animal science] connections.”

**Access to resources.** Access to resources was an external factor that influenced whether participants believed they could integrate animal science concepts into their curriculum. One resource often mentioned were lesson plans. Participant 6 (NE) said,

The lessons that we created with our science teacher [has] given me a framework... [I can] take this process that we did with creating this lesson and apply it to the other lessons that potentially have those science concepts in them.

Participant 8 (NE) had a similar opinion by explaining, “I feel like I have the framework now for a lot of those [science-based] lessons.” Furthermore, Participant 9 (TN) said, “It’s going to give me a different way to teach physics concepts, using topics that are probably going to be more interesting to my high school students...everybody likes animals.”

Another important resource that participants discussed was having the necessary tangible supplies for teaching with IBL. Participant 12 (TN) said, “I think it helped my ability [to teach these concepts] because you gave us the tools that we needed instead of just giving us a concept. You gave us the tools that we need to use to implement [animal science] in our classroom.” Participant 5 (TN) also explained, “I’ll tell you that I think having the tools to be able to teach reproduction, now having a 3-D cervix, and the supplies that have been given here are invaluable to me.”

Other participants expressed how having the supplies decreased the worry of time and financial burden. Participant 3 (TN) said, “You had a lot of nice materials that we don’t have to beg, borrow, and steal and get from our budgets to be able to do [the lessons].” Likewise, Participant 8 (TN) shared,

I don't have to worry about going and asking for money to buy supplies...We have everything we need. I could go [on the] first day of school and do one of these lessons and that has been the best part. The after implementation is phenomenal.

Also, Participant 7 (NE) explained,

It's one thing if you give us [a] lesson and even help us learn [to teach] the lesson, but it's another thing to have those resources to take home because as we get busy, and things happen and budgets... To have [the supplies] in the box and be able to take [the supplies] out and utilize it, that's huge.

Other participants shared how having supplies supports more than just one class as Participant 17 (TN) said, "I have stuff [that] I can use for multiple classes...I knew that would be a big benefit." Also, utilizing other colleagues' supplies was mentioned as Participant 6 (NE) explained, "[It is helpful to have] the supplies and being able to actually bring the supplies home with us for these [animal science] lessons, especially [when] you have three teachers from the same school."

**Adaptability.** The idea of adaptability of the lesson plans was also brought up in relation to perceived behavioral control. Most participants appreciate how adaptable the lesson plans were for their classrooms. Participant 3 (TN) mentioned the importance of having the freedom to lesson plan according to their students' needs and said, "I think [adaptability] was well done to make us feel comfortable to be able to [alter the lesson plans]." Participant 16 (TN) had a similar opinion stating,

I liked as we went through [the professional development], we [were] able to make our own adjustments for our classrooms...I think that gave me a lot more confidence too because as we were going through, I was making my own edits on my own lesson plans and saying 'Okay, this is how I want do it in my room.'

Participant 8 (TN) expressed their appreciation and said, "[The] flexibility to mold and change as we needed, that's very helpful whenever it comes to meeting our student's needs, especially whenever it comes to a class-by-class basis." Likewise, Participant 9 (NE) said, "I have the freedom to adapt [the lessons] to what we're doing in my class, my course, and fit my student's needs." Additionally, Participant 9 (TN) expressed, "We can't turn our teacher brains off. Every time I look at a lesson, I'm like 'How would this actually work in my room?'... Having that freedom and you all being receptive to those changes was very helpful."

When participants were discussing the benefits of using animal science as a context for teaching science, Participant 12 (NE) shared, "I think [animal science concepts] gave us a tool to adapt things that were already happening in the science classroom."

Throughout the discussion, conversations related to knowledge, access to resources, and adaptability emerged. The professional development program positively influenced the participants' perceptions of these areas, which in turn positively influenced their perceptions of behavioral control related to teaching IBL animal science concepts.

## **RQ2: What are Science and Agricultural Academy participants' Intent to Integrate Inquiry-Based Learning Animal Science Concepts and Activities into Their Curriculum?**

For the purpose of this study, *behavioral intent* was defined as how likely the participants were to actually use IBL animal science concepts in their classes upon completion of the program. As conversations advanced, participants were asked if they would continue using agriculture as a context for teaching science, and many participants expressed their intent to use and integrate the IBL animal science activities they learned during the professional development program. Participant 7 (NE) said, "Yes. I feel it makes learning

more real.” Others shared similar opinions as Participant 3 (TN) stated, “Absolutely! [I] did before, [and I] will always,” and Participant 2 (NE) shared, “I absolutely see myself doing this!” Some participants even had intentions to quickly use an animal science inquiry-based lessons upon returning to the classroom. Participant 6 (TN) said, “We are planning on doing one of these [lessons] the second week of school.”

Furthermore, when discussing intentions, Participant 16 (TN) explained, “I like to be really intentional with my time...When I think about spending that time to form those [science and agriculture] cross curriculum bonds, this is something I see as intentional.” Participant 9 (TN) also had intentions to use the animal science lessons and stated, “I don’t know if I will use all the parts, but I will definitely use some of it.” Participant 9 (TN) later added, “I’ve actually planned to use a lot these activities in [my ecology] class where I might not have the time to put them into my biology [class], which is state tested.” Other participants agreed to still using agriculture as a context for teaching science as Participant 5 (NE) said, “It’s really the only avenue that I have to teach science concepts.”

Although many participants had immediate intentions to integrate animal science concepts into their curriculum, others indicated they were now more aware of IBL and linking animal science concepts to science topics. Participant 13 (TN) shared “If not more ‘motivated’ [to use animal science concepts], the right word might be just more aware and inspired to incorporate into my own anatomy and physiology teaching.” Later, Participant 13 (TN) added, “I might be much more aware of [linking] everything towards the animal science...Maybe that’ll be a hook [for students].”

After the professional development program, participants reported intending to integrate the IBL animal science concepts that they learned into their curriculum. They also appeared to have a better understanding of the need for IBL and how to connect science and agriculture in the classroom.

### **Conclusion and Discussion**

The purpose of this study was to explore how participation in an IBL professional development program impacted science and agriscience teachers’ intent to use IBL in the future. This study specifically explored TPB elements that included how attitudes, perceived behavioral control, and subjective norms influenced teachers’ intent to integrate IBL animal science concepts into their classrooms. Overall, participation in this prolonged professional development that focused on content, active learning, coherence, duration, and collective participation (Desimone, 2009) appeared to positively influence the teachers’ intent to utilize IBL in the future.

After the PD, the participants expressed positive attitudes toward the PD and using IBL animal science concepts. These positive attitudes were mostly linked to their prior views of using IBL and reflected the participants’ personal interest, values, and excitement regarding IBL. Based on the findings from this study, the participants’ attitude toward IBL was already positive and likely not changed by the program but perhaps strengthened. These positive attitudes also likely reflected the voluntary participation in this program as the training was not required for teachers in the two states. These positive attitudes would also be expected to have a positive influence on behavioral intent if subjective norms and perceived behavioral control regarding IBL were not negative (Ajzen, 1991).

Throughout the discussions, participants identified state-level expectations as a common subjective norm that would negatively impact their ability to integrate IBL animal science concepts into their classes. However, participating in the PD helped participants feel prepared to build collaborations between science and agriculture faculty to facilitate IBL lessons, which positively influenced subjective norms. While the PD program could not diminish the pressures from state-level expectations, it did appear to positively enhance perceptions of subjective norms through collaboration, which would positively influence behavioral intent as well (Ajzen, 1991).

When it came to perceived behavioral control regarding the use of IBL animal science concepts, the participants stated that before the PD, their knowledge and access to resources served as limiting factors, which aligned with prior research (DiBiase & McDonald, 2015). However, participants felt a greater sense of behavioral control after completion of the PD due to increased knowledge levels and access to resources to help implement IBL activities. Based on these findings, the PD likely had a positive influence on perceived behavioral control, which would lead to increased intent to engage in the use of IBL (Ajzen, 1991).

This assumption of increased intent was reflected throughout the discussion, and participants shared how the PD provided them a better understanding of IBL, the ability to recognize the connection between science and agriculture, and increased their intent integrate the IBL animal science concepts into their curriculum. By the end of the PD program, it was evident that positive attitudes, state-level and social subjective norms, and perceived behavioral control related to knowledge, resources and adaptability affected science and agriscience teacher's intent to integrate animal science concepts into their curriculum. Promisingly, the PD positively influenced these TPB variables, especially related to subjective norms and perceived behavioral control. Teachers' increased intent on integrating IBL in their classrooms ensures that they are equipped to use the IBL teaching strategy in the context of teaching science and animal science concepts, which would allow students to increase their science literacy and gain the skills needed to prepare them for their future careers (Abdi, 2014; Aulia et al., 2018; Gormally et al., 2009; Şahintepe et al., 2020).

### **Recommendations**

While the findings from this research are not generalizable due to the qualitative nature of this study, they do provide a better understanding for the impact of prolonged teacher PD programs. The findings from this study can also serve as a tool for agricultural teacher educators to guide the development of future IBL trainings and programs. The PD program in this study appeared to have the greatest impact on teachers' perceived subjective norms and behavioral control when it came to IBL. By partnering agriscience and science teachers together as a way to foster collaboration, teachers may be more likely to actually utilize IBL. While this collaboration would not necessarily address all negative subjective norms, like state-level expectations, it is still one strategy to positively influence these norms. Additionally, perceived behavioral control can be positively influenced by the knowledge gained in the training. However, access to appropriate resources appeared to be the biggest limiting factor, so prioritizing increasing access to materials is another way influence behavioral control.

To gain a more in-depth understanding for teachers' intent to use IBL, a quantitative study should be conducted to determine how teachers' attitudes, behavioral control, subjective norms, intent, and confidence change before and after a teacher PD program (Moustakas, 1994). While the findings are relevant to IBL and animal science concepts, there could be value in replicating a similar IBL PD program that focuses on other diverse agricultural areas, such as plant science or agricultural mechanics. To further explore the impacts that an IBL professional development program has on agriscience and science teachers nationwide, this study should be conducted in other states. As future studies are conducted, it would be beneficial to explore students' experiences participating in these IBL animal science lessons in the classroom. Additionally, the timing of the data collection being immediately after the PD may have skewed the findings and would provide a narrow snapshot of teachers' perceptions of the program. Pursuing a follow-up survey or interviews with the teachers after implementation of the IBL lessons would provide better insight related to implementation from the classroom perspective.

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