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Predicting Teachers' Intent to use Inquiry-Based Learning in the Classroom After a Professional Development

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Abstract

In the United States, there is an increasing need for high school students to enhance their science proficiency. Inquiry-based learning (IBL) can serve as a teaching strategy to increase students' science proficiency levels, but it is critical that teachers are equipped with the knowledge needed to teach IBL. In this study, we aimed to describe the impact that a professional development (PD) about integrating IBL into curricula has on science and agriscience teachers' intent to use IBL. The theory of planned behavior, as well as confidence, guided this evaluation. A paper survey was distributed to the PD participants after the in-person part of a prolonged PD. Survey questions were related to respondents' confidence, attitude, perceived behavioral control, subjective norms, and intent in using the IBL animal science concepts. Findings from this study indicate that teachers developed an increased confidence, possessed positive attitudes, were influenced by subjective norms, and felt that barriers could be controlled. However, attitude was the only significant predictor of intent to integrate the IBL animal science concepts. We recommend pursuing a follow-up with the teachers after implementation of the IBL lessons to gain a better understanding of the practicality of IBL in the classroom.

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Introduction and Problem Statement

Approximately half of all high school students in Tennessee (Tennessee Department of Education, 2022), and Nebraska are science proficient (Nebraska Department of Education, 2022). As students graduate and pursue higher education or enter the workforce, it is important that they are science literate so they can effectively problem solve and make informed decisions (United States Department of Education [USDE], 2022; Zen, 1990). Science can be taught using inquiry-based learning which would help students enhance their critical thinking and science literacy skills (Warner & Myers, 2011). IBL prepares students to become productive citizens of society as they gain crucial skills such as problem solving, collaborating, analyzing information, and effective communication (Calalb, 2018; Savery, 2006).

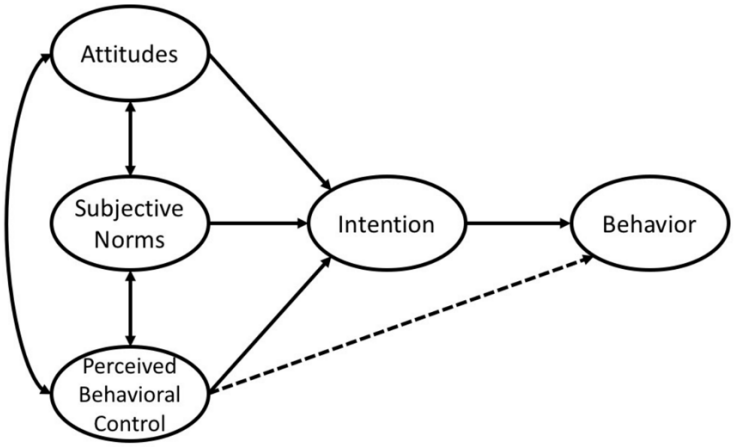
Students can enhance their science literacy (Zen, 1990) and foster their critical thinking and problem-solving skills through applying science to real-life contexts within career and technical education (CTE) (Pearson et al., 2013; Thoron & Myers, 2011; Thoron & Myers, 2012). Previous research alludes to teachers recognizing the value of IBL but do not have the appropriate instructional knowledge and skills to use IBL in their classroom (DiBiase & McDonald, 2015). Professional development is an effective method to change teacher's attitudes (Guskey, 2002), and boost their confidence in their ability to use IBL (Kreifels et al., 2021; Thoron et al., 2011; Thoron & Myers, 2011). Prolonged PD programs over several months can be particularly useful in preparing teachers to integrate IBL into their classes (Kreifels et al., 2021). Therefore, the Science and Agricultural Academy was developed as a 12-month long PD program for science and agricultural teachers to learn how teach using IBL within the context of animal sciences. The PD program consisted of a 5-day, in-person training during the summer followed by continued support over the academic year as teachers integrated IBL into their classes. The purpose of this research was to describe the impact that the in-person PD program had on science and agriscience teachers' intent to use IBL during the following academic year.

Theoretical and Conceptual Framework

The theoretical framework used for this study was the theory of planned behavior (TPB) (Ajzen, 1991). TPB was used to describe the impacts that an IBL PD has on science and agriscience teachers' intent to integrate IBL animal science concepts. Ajzen's (2012) TPB model shown in Figure 1 emphasizes that a person's behavioral intent is influenced by their attitude, subjective norms, and perceived behavioral control (Ajzen, 1991). Attitude is defined as how one feels toward a behavior and whether their perception of a behavior is advantageous (Ajzen, 1991). Performing a behavior due to social pressure from peers is subjective norm, and perceived behavioral control refers to how a person perceives they can perform or control a behavior (Ajzen, 1991). Specifically, favorable attitudes, subjective norms, and a high perceived behavioral control positively influence an individual's intent to perform a behavior (Ajzen, 1991).

Figure 1.

Ajzen's (1991) Theory of Planned Behavior Model



Effective PD enables teachers to become more confident in modifying curriculum as they gain a better understanding of their content, evaluate their performance, and identify their student needs (Patton et al., 2015). Desimone's (2009) suggested components of a PD were used to enhance the TPB variables including behavioral control, attitude, and subjective norms. *Content focus* is a prominent factor when improving teacher knowledge and skills (Desimone, 2009). The Science and Agricultural Academy is a multi-part PD consisting of targeting behavioral control factors by increasing teacher knowledge on creating and teaching IBL science content (Ferand et al., 2020) through an animal science perspective and providing materials needed to facilitate the lessons. *Active learning* components of a successful PD enable teachers to engage in experiential learning of lessons and activities (Desimone, 2009; Patton et al., 2015) that increases teachers' ability to facilitate the content on their own (Garet et al., 2001). In this specific PD, teachers were given the opportunity to be active learners where they participated as students and in collaboration with peers to broaden their perspectives and enhance their behavioral control. Additionally, c*oherence* enabled teachers to form their attitudes and discuss the importance of addressing science and agricultural literacy efforts using IBL. Furthermore, the recommended *duration* of a PD is 20 or more hours contact time (Desimone, 2009). The PD for this study was held eight hours daily over a period of five days, giving the teachers prolonged time to engage in material and increase their skills and self-efficacy in facilitating IBL animal science concepts. The PD also allowed teachers to engage in *collective participation* as they participated in science and agriscience teacher pairs from their own school to create IBL animal science lessons from both a science and agricultural perspective that satisfies their school and student needs.

Teachers' intent to integrate IBL into their classrooms is influenced by attitudes, subjective norms, and perceived behavioral control (Conner et al., 2021). However, barriers that affect teachers' intent to use IBL consist of lack of resources and support from school administration, high student-to-teacher ratios, and state-level expectations (DiBiase & McDonald, 2015;

Ramnarain, 2014). This PD attempted to address and provide solutions to some of those barriers through the activities previously described. There is an increasing need to explore the impact that PD has on teachers' intent in using IBL animal science concepts as a context for teaching science.

Purpose

The purpose of this research was to describe the impact that a professional development about integrating inquiry-based learning into curricula had on science and agriscience teachers' intent to use IBL. The following objectives guided this study:

1. Determine Science and Agricultural Academy participants' change in confidence in integrating inquiry-based learning animal science concepts into their curriculum before and after and inquiry-based learning professional development.
2. Describe Science and Agricultural Academy participants' perceived behavioral control, attitude, subjective norms, and intent toward integrating inquiry-based learning animal science concepts into their curriculum.
3. Determine how attitude, behavioral control, and subjective norms influence the behavioral intent that the Science and Agricultural Academy participants have toward utilizing the activities and integrating inquiry-based learning animal science concepts into their curriculum.

Methods

To fulfill the purpose of this study, a paper survey with nine questions was distributed to the Science and Agricultural Academy participants in Tennessee and Nebraska immediately following an in-person PD. There were 32 respondents who participated in the study (n = 32, 97% participation rate), and they had been teaching for a range of years (M = 9.75, SD = 8.32). Subjects that the teachers taught were: agriscience (65.63%), biology (18.75%), chemistry (9.38%), and other agricultural and science areas (62.5%). Six questions from the survey were reported for this study: perceived behavioral control, attitude, subjective norms, intent, and respondents' pre and post confidence in using IBL.

Confidence was measured using two, 6-item, 5-point Likert-type scale ranging from 1 = *strongly disagree* to 5 = *strongly agree.* Respondents indicated their pre-PD and post-PD confidence in teaching the six animal science concepts covered in the PD. The averages for the pre-confidence items (Cronbach's α = .78) and the post-confidence items (Cronbach's α = .83) were used to create the constructs. To ensure consistent interpretation of the findings, real limits were created (Sheskin, 2004). The real limits for confidence were 1.00 - 1.49 = *strongly disagree,* 1.50 - 2.49 = *disagree*, 2.50 - 3.49 = *neither agree nor disagree*, 3.50 - 4.49 = *agree,* 4.50 - 5.00 = *strongly agree*.

The remaining questions were based on Theory of Planned Behavior (Ajzen, 1991) variables, and the constructs were adapted from prior literature and research (Ajzen, 2002; Rogers-Randolph et al., 2021) to align with the context of this study. Perceived behavioral control was

measured with a 4-item, 5-point Likert-type scale. The labels for the scale ranged from 1= *strongly disagree* to 5 = *strongly agree.* The average for the items was calculated and the original reliability was a Cronbach's alpha of .62. This reliability fell below .70, which is the acceptable threshold for reliability (Field, 2013). Removal of an item did not improve the reliability of the construct; however, Nunnally (1978) has suggested a reliability above a .50 is acceptable when in the beginning phases of research. Because this survey instrument was adapted for a new context of the PD program, it was deemed acceptable for this research and the instrument was not edited. Real limits for perceived behavioral control were the same as confidence.

Attitude was measured using a bipolar semantic differential 8-item, 5-point scale attaching the idea of integrating IBL animal science concepts to a set of adjectives that were antonyms. Items were coded so that a positive adjective was a five and a negative adjective was a one. The construct was created using the average for the items (Cronbach's α = .86). The real limits for attitude were 1.00 - 1.49 = *extremely negative*, 1.50 - 2.49 = *negative*, 2.50 - 3.49 = *neutral*, 3.50 - 4.49 = *positive*, 4.50 - 5.00 = *extremely positive*. Subjective norms were measured with seven items on a 5-point Likert-type scale with the same labels as perceived behavioral control. The initial reliability of the scale was below the acceptable value of Cronbach's alpha of .70 or higher (Cronbach's α = .55), but increased to a Cronbach's alpha of .80 after two items were deleted. The average for the remaining five items was used to create the construct. Real limits for subjective norms were the same confidence. Intent was measured with a 2-item, 5-point Likert-type scale. The following labels for the scale ranged from 1 = *extremely unlikely* to 5 = *extremely unlikely.* The average for the items were used to create the construct (Cronbach's α = .92). Real limits for intent were 1.00 - 1.49 = *extremely unlikely,* 1.50 - 2.49 = *somewhat unlikely*, 2.50 - 3.49 = *neither likely nor unlikely*, 3.50 - 4.49 = *somewhat likely,* 4.50 - 5.00 = *extremely likely*. To address concerns of validity, the instrument was reviewed by a panel of experts with expertise in survey design, IBL, and animal sciences.

Responses from the paper surveys were entered electronically to a replicated Qualtrics survey, and data were exported to SPSS version 26 for analysis. Paired samples *t*-tests were used to determine objective one. Descriptive statistics were reported for objective two. A multiple linear regression analysis was used for objective three. Assumptions for normality was not an issue because the variables' skewness or kurtosis fell within +/-2. Assumptions for this multiple linear regression were met as well. Multicollinearity diagnostics were run, and no issues were identified as the tolerance and variance inflation factors (VIF) fell within the acceptable thresholds (Field, 2013).

Findings

Objective One

Respondents' confidence in teaching inquiry-based animal science concepts related to facility management, genetics, health, meat science, nutrition, and reproduction before and after the PD can be found in Table 1. Respondents' confidence was on average 3.36 (*SD* = 0.66) prior to the PD and 4.28 (*SD* = 0.50) after participation in the PD. To determine if there was a significant

change in confidence, a paired samples t-test was conducted and a statistically significant difference was detected (t = 9.012, p < .01), thus indicating that confidence in teaching animal science concepts increased after completing the PD. The effect size, using Cohen's d, indicated a large effect (d = 1.62).

Table 1

Confidence in teaching the following concepts before and after PD (n = 32)

	Pre PD confidence	Post PD confidence
Genetics	3.94 (0.88)	4.48 (0.63)
Reproduction	3.81 (1.03)	4.42 (0.81)
Health	3.56 (0.88)	4.42 (0.62)
Nutrition	3.47 (1.02)	4.35 (0.55)
Facility Management	2.94 (0.98)	4.03 (0.75)
Meat Science	2.47 (0.95)	4.00 (0.68)
Total Average	3.36 (0.66)	4.28 (0.50)

Objective Two

Respondents indicated they had behavioral control after completing the PD with a mean of 3.91 (SD = .71). Majority of the respondents agreed or strongly agreed to feeling equipped with the knowledge and skills necessary to successfully integrate animal science concepts into their classroom (87.60%; Table 2) and indicated that finding the resources to integrate the concepts would not be challenging (75.0%). Additionally, some respondents agreed or strongly agreed that integrating the animal science concepts into their classroom would not inhibit their teaching of state standards (65.70%) and expressed that they will have enough time to utilize the IBL animal science lessons (62.50%).

Table 2

*Behavioral Control (*n*=32)*

	Strongly Disagree *% (f)*	Disagree *% (f)*	Neither Agree or Disagree *% (f)*	Agree *% (f)*	Strongly Agree *% (f)*
I feel equipped with the knowledge and skills necessary to successfully integrate animal science concepts into my classroom.	3.1 (1)	3.1 (1)	6.3 (2)	56.3 (18)	31.3 (10)
I will have enough time in the semester to teach animal science concepts to students.	3.1 (1)	18.8 (6)	15.6 (5)	25.0 (8)	37.5 (12)
It would be challenging to find the resources to integrate agriscience into my classroom.[a]	0 (0)	9.4 (3)	15.6 (5)	43.8 (14)	31.3 (10)
Integrating animal science concepts into my classroom will inhibit my teaching of state standards.[a]	3.1 (1)	6.3 (2)	25.0 (8)	34.4 (11)	31.3 (10)

[a] Items were reverse coded so that strongly disagree was a 5 and strongly agree was a 1.

Respondents had extremely positive attitudes toward integrating IBL animal science concepts (*M* = 4.68; *SD* = 0.45). Overall, respondents' attitudes toward integrating IBL animal science concepts into their classrooms were more *positive* than *negative* (*M* = 4.84; *SD* = 0.37) and more *good* than *bad* (*M* = 4.81; *SD* = 0.40). The item with the lowest mean was *essential/not essential* (*M* = 4.50; *SD* = 0.84). Table 3 shows respondents' response means for items in the attitude scale.

Table 3

*Respondents Attitudes (*n*=32)*

	M (*SD*)
Good: Bad	4.81 (0.40)
Positive: Negative	4.84 (0.37)
Beneficial: Not Beneficial	4.69 (0.78)
Acceptable: Unacceptable	4.81 (0.59)
Necessary: Unnecessary	4.59 (0.62)
Important: Unimportant	4.69 (0.54)
Essential: Not Essential	4.50 (0.84)
Crucial: Trivial	4.53 (0.72)
Scale Average	4.68 (0.45)

Respondents indicated they felt subjective norms associated with IBL animal science concepts (*M* = 3.70; *SD* = .80). Most respondents agreed or strongly agreed that they did not feel pressure to focus only on standardized testing and nothing else (78.20%; Table 4). Some respondents also agreed or strongly agreed that people who are important to them want them to integrate animal science concepts into their classroom (64.50%). Respondents also expressed that their school administration encourages them to increase their knowledge and confidence in teaching animal science concepts (62.50%), as they are expected to possess the necessary confidence in teaching the concepts (53.20%). Furthermore, the majority of respondents agreed or strongly agreed that they did not feel pressure to focus only on standardized testing and nothing else (78.20%). Approximately one-third of respondents indicated they do feel social pressure from their communities to increase their confidence in teaching animal science concepts (34.40%), while others neither agreed nor disagreed (34.40%).

Table 4

*Subjective Norms (*n=*32)*

	Strongly Disagree *% (f)*	Disagree *% (f)*	Neither Agree nor Disagree *% (f)*	Agree *% (f)*	Strongly Agree *% (f)*
I feel pressure to focus only on standardized testing and nothing else.[a]	0 (0)	6.3 (2)	15.6 (5)	31.3 (10)	46.9 (15)
People who are important to me want me to integrate animal science concepts into my classroom.	0 (0)	12.9 (4)	22.6 (7)	35.5 (11)	29.0 (9)
My school administration encourages me to increase my knowledge and confidence in teaching animal science concepts.	3.1 (1)	6.3 (2)	28.1 (9)	21.9 (7)	40.6 (13)
It is expected of me to have great confidence in teaching animal science concepts before I integrate it into my classroom.	3.1 (1)	6.3 (2)	37.5 (12)	34.4 (11)	18.8 (6)
I feel social pressure from my community to increase my confidence in teaching animal science concepts	12.5 (4)	18.8 (6)	34.4(11)	15.6 (5)	18.8 (6)

[a] Items were reverse coded to that strongly disagree was a 5 and strongly agree was a 1.

Table 5 shows respondents' intent to use the IBL animal science curriculum learned during the PD (*M* = 4.75; *SD* = .42). The majority of respondents were extremely likely to utilize the hands-on activities (78.10%) and integrate the animal concepts (71.90%). However, a minority of the

respondents indicated they were only somewhat likely (21.90%; 28.10%). Furthermore, nobody said they were unlikely utilize the activities from the PD (0%).

Table 5

*Intent (*n*=32)*

	Extremely Unlikely *% (f)*	Somewhat Unlikely *% (f)*	Neither Likely nor Unlikely *% (f)*	Somewhat Likely *% (f)*	Extremely Likely *% (f)*
Please indicate how likely you are to utilize the hands-on activities related to animal science in your classroom	0 (0)	0 (0)	0 (0)	21.9 (7)	78.1 (25)
Please indicate how likely you are to integrate animal science concepts into your classroom	0 (0)	0 (0)	0 (0)	28.1 (9)	71.9 (23)

Objective Three

Attitude, subjective norms, and behavioral control were included in the regression model, shown in Table 6, to predict intent to use IBL animal science concepts in the future. This model was statistically significant (F (3, 30) = 10.33, $p < .001$) and could account for 53.4% of the total variance in intent to integrate IBL animal science concepts (r^2= .534). The only significant predictor in the model was attitude, and as it increased one point, intent increased by .49 points (b = .49, $p < .01$). Subjective norms (b = .14, p = .18) and behavioral control (b = .02, p = .81) were not statistically significant predictors of intent.

Table 6

Regression Model to Predict Intent to use IBL Animal Science Concepts in the Classroom

Predictor Variable	*B*	*SE B*	β	*t*	*p*
Constant	1.86	.603		3.074	.00*
Behavioral Control	.02	.10	.04	.25	.81
Attitude	.49	.17	.52	3.00	.00*
Subjective Norms	.14	.10	.25	1.40	.18

* $p < .01$

Conclusions, Discussion, and Recommendations

The purpose of this study was to describe the impact that professional development has on Science and Agricultural Academy participants' intent to integrate IBL in their classroom. This study was guided by the TPB to describe the teachers' attitudes, subjective norms, and perceived behavioral control, and the influence that those variables have on their intent to utilize IBL teaching strategies within the context of animal sciences (Ajzen, 1991).

After the PD, respondents showed an increased confidence in teaching the following animal science areas: genetics, reproduction, health, nutrition, facility management, and meat science. Possessing an increased confidence positively influences teachers' ability to use IBL in their classrooms which further supports prior research of PD boosting teacher confidence (Kreifels et al., 2021; Thoron et al., 2011; Thoron & Myers, 2011). Respondents reported feeling in control of perceived behavioral control factors that include finding time to teach the lessons and being able to locate the resources needed to facilitate the IBL lessons. Additionally, aligning with prior literature (Guskey, 2002), respondents possessed strongly positive attitudes after the PD. Respondents also indicated that they feel pressure from subjective norms, such as standardized testing and school administration, which aligns with previous studies that identify those as barriers that affect teachers' intent to use IBL (DiBiase & McDonald, 2015; Ramnarain, 2014). Barriers previously identified further demonstrates the need for teachers to engage in collective participation with other teachers during future PD programs to create potential solutions for subjective norms (Desimone, 2009).

The regression model could account for the large variance in intent to integrate IBL animal science concepts. Although perceived behavioral control and subjective norms are relevant, attitude was found to be the only significant predictor of intent. Replicating this research in other states could help better validate these findings and explore the relevancy and influences that attitude, subjective norms, and perceived behavioral control have on one another. Furthermore, when providing future PD, it would be beneficial to ensure that PD is enjoyable for teachers by including hands-on, active learning strategies that enable them to increase their positive attitudes (Desimone's 2009).

Our findings indicate that the PD was effective in increasing teacher intent to integrate IBL lessons in the context of animal science in their classrooms. The findings would also provide guidance to researchers and agricultural education faculty in planning future teacher PD and developing IBL curriculum. Additionally, as teachers continue to lack the knowledge and skills to use IBL in their classroom (DiBiase & McDonald, 2015), school administrations should encourage their teachers to seek inquiry-based learning PD.

To gain a broader understanding of the research problem, a qualitative study should be conducted exploring specific attitudes, subjective norms, perceived behavioral control that affect intent (Moustakas, 1994). Future research should also work to further refine the behavioral control measurement to increase the overall reliability of the study. Additionally, there could be value in exploring specific differences between science and agriscience teachers'

confidence and intent to use IBL. Since the findings from this study focus on animal science concepts, it would be beneficial to replicate other PD programs that address other agricultural topics such as agricultural mechanics or plant science. Also, because this study was only conducted in Tennessee and Nebraska, it should be conducted at other universities and states to better understand the impacts that an IBL PD program has on science and agricultural teachers across the United States. Furthermore, pursuing a follow-up with the teachers following implementation of the IBL lessons would contribute to a better understanding of the practicality of IBL in the classroom.

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