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Teachers' Confidence to Integrate Biology in Agriscience Courses

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Abstract

The primary purpose of this study was to determine the confidence levels of School-based Agricultural Education (SBAE) teachers to integrate biology concepts in plant and animal science courses. The researchers also sought to describe the demographic characteristics of New Mexico SBAE teachers. This study used a descriptive-correlational research design. Teachers were asked to identify their confidence levels to teach the state standards of the animal science and plant science course that matched course objectives in biology and life science. The teachers had an average age of 39 and reported having an average of 13 years of teaching experience. The majority of New Mexico SBAE teachers received secondary science teacher certification and over 70% had obtained a master's degree. Teachers felt the least confident to teach the processes of cell division, including binary fission, mitosis, and meiosis. Teachers felt the most confident integrating biology concepts within lessons dealing with the nutrients required by plants, how they obtain and transport those nutrients, as well as teaching the evolution of plants from green algae. The findings suggest that there are some relationships between years of teaching experience, school size, and teachers receiving the science certification.

Keywords: agricultural education; biology; SBAE teachers; confidence

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Introduction

The establishment of agricultural experiment stations with the Hatch Act (1887) occurred not only to disseminate agricultural principles, but also to utilize basic science to improve agricultural techniques, thereby broadening the scope of agriculture education (Hillison, 1996). In fact, Dewey (1944) posited the separation of core curriculum concepts from vocational programs would hinder student success. This sentiment has been expressed by organizations (National Research Council (NRC, 1988) and in state (Thompson & Schumacher, 1998) and federal (Carl D. Perkins Vocational and Technology Act, 2006) legislation. In the context of agricultural education programs, the integration of science concepts occurs in laboratory and classroom instruction and Supervised Agricultural Experience (SAE) programs (Ramsey & Edwards, 2004).

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Previous literature has indicated that the integration of science in SBAE programs assist students in meeting state standards (Thompson, 2001; Warnick, Thompson, & Gummer, 2004) and increasing administrator and parental support (Newman & Johnson, 1993; Thompson & Balschweid, 1999). Moreover, other general program benefits, such as the increase of enrollment of high ability students (Thompson & Balschweid, 1999), have been attributed to the heightened focus on science in SBAE courses. Aside from SBAE program benefits, previous studies have highlighted the benefits of students engaged in SBAE courses which have a strong science focus. Specifically, the integration of science in SBAE courses have been reported to increase secondary science achievement (Baker, Bunch, & Kelsey, 2015; Chaisson & Burnett 2001; Dormody, 1992; Newman & Johnson, 1993; Thompson, 2001), boost students' motivation to learn (Newman & Johnson, 1993; Roegge & Russell, 1990; Stubbs & Myers, 2016), prepare students for careers (Stubbs & Myers, 2016), provide applications for problem solving (Newman & Johnson, 1993), and enhance students awareness of connections between science and agriculture (Thompson, 2001; Warnick et al., 2004).

Previous literature in agricultural education supports the sentiment that SBAE teachers, in general, are fairly confident in their ability to integrate science concepts in SBAE courses **(**Balschweid & Thompson, 2002; Scales, Terry, & Torres, 2009; Smith, Rayfield, & McKim, 2015; Thompson & Balschweid, 1999). Scales et al., (2009) posited that although the SBAE teachers might have the confidence to teach these concepts, they lack the competence to teach them. Former researchers have noted the need for the enhancement of SBAE teachers' science content knowledge and have recommended teacher preparation programs provide science integration instruction, and place student teachers in programs with strong science integration (Baker et al., 2015; Scales et al., 2009; Thompson, 2001; Warnick, et al., 2004). Furthermore, Baker et al. (2015) and Warnick and Thompson (2007) recommended SBAE teachers should collaborate with science teachers in the school science department to enhance science integration in their SBAE programs.

As with most educational movements, barriers associated with science integration have been reported. Issues such as the lack of appropriate equipment, funding, time and workshops have been identified as barriers to integrating science concepts and curriculums into SBAE courses **(**Balschweid & Thompson, 2002; Stubbs & Myers, 2016; Thompson, 2001; Thompson & Balschweid, 1999; Warnick & Thompson, 2007; Warnick et al., 2004).

The importance of science integration in SBAE programs is also highlighted in Research Priority Five of the American Association for Agricultural Education (AAAE) National Research Agenda—Efficient and Effective Agricultural Education Programs (Thoron, Myers, & Barrick, 2016). Thoron et al. (2016) posited SBAE teachers should be "able to discuss the application of principles from all aspects" (p. 42), specifically concepts related to science and math, due to their direct ties to agriculture. Israel, Myers, Lamm, and Galindo-Gonzalez (2012) recommended these connections (between concepts of science and agricultural subjects) should be emphasized in pre-service programs. According to Scales et al. (2009), SBAE teachers' confidence and "ability to teach science concepts should be used as a foundation to create professional development programs to increase their effectiveness in teaching this content" (p. 110). Therefore, as a precursor to determining the appropriate structure and content for professional development and pre-service events related to the integration of science in SBAE programs, it is important to determine New Mexico SBAE teachers' confidence in teaching science concepts.

Conceptual Framework

This study, which focused on the perceptions of SBAE teachers regarding the integration of biology in SBAE courses (i.e., plant and animal science), was guided by the theoretical foundation of the Theory of Planned Behavior (TPB), an extension of the Theory of Reasoned Action (TRA). The TRA hypothesized psychological processes linking attitude and behavior (Azjen & Fishbein, 1980; Fishbein, 1967; Fishbein & Azjen, 1975). The TPB suggested attitude, intention and behavior result from value and beliefs, which are themselves informed by individual knowledge, experience and demographic setting (Azjen, 1985; Connor & Armitage, 1998). The TPB represents behavior as a function of behavioral intentions and perceived behavioral control (PBC) (Azjen, 1991).

Along with the conceptual framework of the TPB, teachers' confidence is routinely linked to Bandura's (1984, 1997) concept of self-efficacy. According to Bandura (1997), self-efficacy is an individual's self-held belief in their capability to execute and organize a given task. In the context of education, Gavora (2010) defined teacher self-efficacy as a "teacher's personal (i.e., self-perceived) belief in ability to plan instruction and accomplish instructional objectives" (p. 2). Previous research indicated there are four main sources of teacher self-efficacy: (1) mastery learning experiences, (2) vicarious experiences, (3) physiological and emotional states, and (4) social persuasion (Bandura, 1997; Gavora, 2010). Self-efficacy has the propensity to enhance or impair an individual's performance: if the individual has low efficacy or confidence in a task, then their performance in that task is expected to be low (Bandura, 1997). Conversely, higher confidence correlates positively with performance (Bandura, 1997). Although, it is important to note that a person's beliefs about their capabilities are not the same as actual ability, but they are closely related.

As adapted for this study, these aforementioned frameworks suggest that SBAE teachers' beliefs (attitude, perceived subjective norm and behavioral control) and self-efficacy towards science integration have the propensity to influence their decisions to integrate biology concepts into their plant and animal science courses. In essence, developing a better understanding of SBAE teachers' perceptions and confidence in integrating science into SBAE courses will shed light on their intentions to do so.

Purpose and Objectives

The purpose of this study was to determine the confidence level of New Mexico SBAE to integrate biology into their animal and plant science courses and provide supporting demographic and institutional information. The following objectives served to guide this study:

1. Describe the characteristics of the SBAE programs.
2. Describe SBAE teachers' confidence levels associated with teaching biology concepts in plant and animal science courses.
3. Describe relationships between SBAE teachers' confidence levels and demographic characteristics.
4. Describe relationships between SABE teachers' confidence levels and program characteristics.

Methods

Research Design

This study utilized a descriptive-correlational research design. According to Gall et al. (2007), correlational research is defined as "A type of investigation that seeks to discover the direction and magnitude of the relationship among variables through the use of correlational statistics". This study is descriptive as it also employs a methodology that allowed secondary SBAE teachers to describe the characteristics of their SBAE program and gauge preparedness.

Population

Secondary SBAE teachers teaching at least one SBAE course in New Mexico ($n = 84$; New Mexico Public Education Department) were targets (Dillman, 2009) of this study. A total of 58 responses were received, yielding a response rate of 69%. Participants were mostly male (74%) and reported an average age of 39.5 ($SD = 11.1$). The SBAE teachers had an average of 13.1 ($SD = 13.1$) years of teaching experience and reported teaching core science courses for an average of 4.6 years. Most teachers reported receiving their initial degree in agricultural education ($n = 50$, 86.2%); other teachers indicated receiving a degree in agricultural business ($n = 4$, 6.9%), animal science ($n = 2$, 3.4%), horticulture ($n = 1$, 1.7%), and agricultural communication ($n = 1$, 1.7%). Forty-one (70.7%) of the SBAE teachers reported earning a master's degree and three (5%) had received their doctorate in either agricultural education or educational administration. A majority of teachers ($n = 41$, 70.7%) indicated they had received their science endorsement.

Because the response rate was less than 80%, a random sample of 20 non-respondents was contacted (i.e., double-dipped) to control for non-response error (Gall et al., 1996). Responses from original respondents and non-respondents subsequently contacted were compared to evaluate the presence of non-response error. No statistically significant differences were observed on any item of the survey instrument (data not shown). Thus, inferential statistics were used to generalize findings to the population of New Mexico SBAE teachers. The absence of a probabilistic sample serves as a limitation for generalizability, therefore caution should be exercised when attempting to generalize the results to any other population of teachers.

Instrumentation

The survey instrument, sent to SBAE teachers, included a total of 36 rank-order questions based on a Likert-type scale (1 = *no confidence*, 2 = *very little confidence*, 3 = *moderately confident*, 4 = *confident* and 5 = *very confident*). Along with the items inquiring about the SBAE teachers' perceived confidence in integrating science concepts, the instrument included seven questions pertaining to demographic (i.e., biological sex and age) and background characteristics (i.e., years of teaching experience, initial certification, degree attainment, secondary science teacher certification, and years of teaching science-credited courses [e.g., biology, chemistry, physics, etc.]).

The content for this instrument was developed using referenced materials from previous studies (Dyer & Osborne, 1999; Scales, 2007) accepted scholarly publications in agricultural education and biology-based objectives found in New Mexico-mandated course objectives in animal science (see Table 1) and plant science (see Table 2).

Table 1

Biology Standards Related to Animal Science

Standard	Description
1.10	Know the many possible roles of proteins in cells.
1.12	Understand how fatty acids are classified (saturated, unsaturated), and the general structures and functions of triglycerides, phospholipids, and steroids.

3.02	Understand how genotype causes phenotype. Predict the probability of each possible genotype and phenotype in a genetic cross.
3.03	Understand exceptions to and extensions of Mendelian rules of inheritance, including incomplete dominance, co-dominance, epistasis, pleiotropic, and sex-linkage.
3.04	Construct and analyze pedigrees to determine the mode of inheritance.
3.05	Explain how to carry out genetic crosses to determine genetic linkage, and interpret genetic maps of chromosomes.
4.05	Explain the steps involved in transcription; identify the types of proteins required and the role of each.
4.06	Describe the steps involved in translation; explain the roles of mRNAs, tRNAs, ribosomes (RNA), and amino-acyl tRNA synthetases.
6.01	Describe the levels of organization, including cells, tissues, organs, organ systems, and the whole animal.

Table 2

Biology Course Standards Related to Plant Science

Standard	Description
1.08	Know the functions of cellulose, starch, glycogen, and chitin in cells.
2.02	Understand the distinctions between diffusion, facilitated diffusion, osmosis, and active transport in a cell system. Know the role of membranes in these functions (e.g., fluid mosaic model).
2.05	Know the basic functions of the light-dependent and light-independent reactions of photosynthesis, and their compartmentalization in a cell.
2.09	Understand the basic structures and functions of the following: nucleus, nucleolus, nuclear pore, cytoskeleton, cytoplasm (cytosol), mitochondrion, chloroplast, large central vacuole, contractile vacuole, peroxisome, ribosome, cell wall, cell (plasma) membrane, cilium and flagellum.
2.10	Describe the processes of cell division, including binary fission, mitosis and meiosis.
8.01	Describe the evolution of plants from green algae and discuss the adaptations that allowed plants to live on land while explaining the differences among gymnosperms, and angiosperms.
8.02	Describe the general structure of a flowering plant; explain the structure and function of plant organs and the major tissue types.
8.04	List the most important nutrients required by plants, and explain how they obtain and transport those nutrients. Discuss the relationship between Rhizobium and legumes.
8.07	Describe the reproductive structures in flowering plants, identify the parts of a seed and explain how seeds germinate.
8.08	Discuss asexual reproduction in plants; explain how it occurs in both nature and agriculture.
8.09	Discuss the role of plant hormones and their role in tropic responses and flowering during specific seasons (e.g. IAA, gibberellins, phytochrome, and ethylene).
8.10	Describe the cellular structure of a leaf, and discuss how this facilitates photosynthesis. Explain how transpiration occurs and how it is regulated.

Pilot testing of the original instrument indicated a Cronbach alpha coefficient of 0.62. Augmentations were made to the instrument based on collected data and participant comments, resulting in a .86 reliability estimate for the final instrument. Such an alpha far exceeds the 0.5 - 0.6 suggested by Nunnally and Bernstein (1967) as acceptable in the early stages of research. To evaluate the content validity, the survey instrument was sent to a panel of experts comprised of two agricultural education faculty members, a faculty member in educational leadership, and two agricultural education graduate students. Upon receiving feedback from the panel of experts, changes were made to the design of the instrument to enhance readability.

Data Collection and Analysis

Using the Surveymonkey® Online Survey Software, a recruitment letter and a link to the instrument was sent to the population of New Mexico SBAE Teachers. Two reminder emails, containing the same contents of the initial instrument, were sent to the non-respondents in five-day increments, based on the distribution schedule of Yun and Trumbo (2000). At the conclusion of data collection, the participants (*n* = 58) were sent thank you notes via Surveymonkey®. Data were analyzed using IBM® SPSS Statistics® Software, version 20.

A t-test ($p = 0.05$) was applied to determine relative confidence level and variability in confidence level regarding teaching of basic biological concepts in plant versus animal science. Objectives three and four were facilitated by correlating nominal (demographic and institutional) data to confidence levels with a point-biserial coefficient, while ordinal data were correlated with a Pearson product correlational coefficient.

Findings

The first research objective sought to describe the characteristics of the SBAE programs. Responses were gathered from schools of all size classifications, with most respondents reporting affiliation with the smallest school classification (i.e., 1A). Overall, 24 (37.9%) schools represented in the study offered science credit (see Table 3).

Table 3

*School Size and Offering of Science Credit in SBAE Courses (*n *= 58)*

	f	%
School Classification/ Enrollment Size		
1A (≤ 199 students)	23	40.4
2A (200 – 449 students)	5	8.8
3A (450 – 1,004 students)	7	12.3
4A (1,005 – 2089 students)	13	22.8
5A (≥ 2,090 students)	9	15.8
Offering Science Credit		
Yes	22	37.9
No	36	62.1

Note. School classifications were derived from New Mexico Athletics Association.

Science credits were offered for animal science (*n* = 9, 37.5%), horticulture (*n* = 8, 33.3%), agricultural mechanics (*n* = 2, 8.3%), environmental science (*n* = 2, 8.3%), general agriculture (*n* = 2, 8.3%), and botany (*n* = 1, 4.2%). The average program had been offering science credit in their courses for 3.5 years (maximum = 25 years). Thirty-one percent (*n* = 18) of the programs were offering science credit for the first time. The programs were split with 43.9% (*n* = 25) indicating they would continue to offer science credit and 56.1% (*n* = 32) indicating they would not offer science credit in their agricultural courses the following year.

The second objective of the study was to describe SBAE teachers' confidence levels associated with teaching biology concepts in plant and animal science courses. SBAE teachers were poorly to moderately confident in their ability to integrate biology concepts into plant science and animal science course objectives, and overall confidence levels regarding inclusion of basic biological concepts in plant versus animal science were not significantly different ($p < 0.22$). However, there was a higher amount of variability in teachers' confidence to integrate biology in animal science than plant science ($p < 0.003$; see Table 4).

Table 4

*Overall Teachers Confidence Scores (*n *= 58)*

PLSC			ANSC		
Objectives	*M*	*SD*	Objectives	*M*	*SD*
1.08	2.45	0.94	1.10	2.33	1.06
2.02	2.47	0.98	1.12	2.95	1.04
2.05	2.69	0.91	3.02	2.63	1.06
2.09	2.60	1.03	3.03	2.56	1.05
2.10	2.26	1.08	3.04	2.84	1.07
8.01	3.17	0.96	3.05	2.40	1.05
8.02	3.02	0.87	4.05	2.61	1.04
8.04	3.23	0.80	4.06	2.40	1.02
8.07	2.94	0.94	6.01	2.37	1.20
8.08	2.36	1.06			
8.09	2.75	0.99			
8.10	2.73	0.96			
Average±SE	2.72±0.09	0.96±0.02a		2.57±0.07	1.07±0.02b

Greatest confidence involved the identifying of nutrients required by plants, and explaining how they obtain and transport those nutrients (objective 8.04; see Table 2; see Table 5). Within animal science concepts, teachers were found to have the most confidence in teaching how fatty acids are classified (saturated, unsaturated), the general structures and functions of triglycerides, phospholipids, and steroids (objective 1.12; see Table 1; see Table 5) and constructing and analyzing pedigrees to determine the mode of inheritance (objective 3.04; see Table 1; see Table 5).

Teachers felt the least amount of confidence to teach the processes of cell division, including binary fission, mitosis, and meiosis within plant science (objective 2.10; see Table 2; see Table 5). Within the area of animal science, teachers felt the least amount of confidence in teaching the many possible roles of proteins in cells (objective 1.10; see Table 1; see Table 5) and the levels of organization, including cells, tissues, organs, and organ systems within the whole animal (objective 6.01; see Table 1; see Table 5).

The third objective sought to describe relationships between SBAE teachers' confidence levels and demographic characteristics. Correlations between teacher demographics and confidence were insignificant (i.e. $p > 0.05$) and correlations were low. The strongest correlations were achieved in relationships between teacher experience and confidence in plant science objectives 8.04: *nutrients required by plants, and explain how they obtain and transport those nutrients* (r = .326), and 8.08: *asexual reproduction in plants; explain how it occurs in both nature and agriculture* (r = .304).

The fourth objective was to describe relationships between SBAE teachers' confidence levels and Program characteristics. Correlation coefficients were computed among teacher's confidence levels in integrating plant science curriculum, school size affiliation, and science credit allocation. The Bonferroni approach was utilized to control for Type 1 errors, and the threshold for significance was set at .005, *a priori*.

A total of four, significant associations were observed between the school size and teachers' ability to integrate biology concepts into plant science. These associations had positive moderate (Davis, 1971) associations. Teachers from schools with larger student populations had more confidence integrating concepts of the basic functions of the light-dependent and light-independent reactions of photosynthesis, and identify the parts of a seed and explain how seeds germinate and the role of plant hormones and their role in tropic responses and flowering during specific seasons (e.g. IAA, gibberellins, photochromic, and ethylene).

Table 5

*Relationship between teacher confidence, school size and receiving science credit integrating biology in plant science (*n *= 58)*

Course Objective	School Size r_s	Science Credit r_s
PLSC (1)	.309	-.172
PLSC (2)	.319	-.310
PLSC (3)	.368*	-.233
PLSC (4)	.240	-.218
PLSC (5)	.031	-.145
PLSC (6)	.360*	-.382*
PLSC (7)	.267	-.303
PLSC (8)	.274	-.339
PLSC (9)	.385*	-.372*
PLSC (10)	.119	-.222
PLSC (11)	.432*	-.352*
PLSC (12)	.268	-.359*

Note. * $p < .005$

In contrast, low to moderate correlations (Davis, 1971) with a negative direction, were discovered regarding the relationship between the teachers' confidence levels and affiliation with schools who award science for plant science courses. The negative direction of these relationships indicate that teachers who teach science credited courses have lower confidence in integrating biology concepts in the plant science classes when compared to teachers of non-science credited courses.

Teachers who taught at schools with larger student populations were found to be more confident in integrating concepts of biology into their animal science courses. Some of the concepts they had the most confidence in include: the teaching of how genotype causes phenotype and exceptions to and extensions of Mendelian rules of inheritance; including incomplete dominance, co-dominance, epistasis, pleiotropic, and sex-linkage.

Table 6

*Relationship between teacher confidence, school size and receiving science credit integrating biology in animal science (*n *= 58)*

Course Objective	School Size	Science Credit
	r_s	r_s
ANSC (1)	.005	-.088
ANSC (2)	.252	-.304
ANSC (3)	.296	-.253
ANSC (4)	.295	-.241
ANSC (5)	.009	-.166
ANSC (6)	.026	-.154
ANSC (7)	.099	-.124
ANSC (8)	.061	-.123
ANSC (9)	.216	-.264

Teachers who were offering science credit in their classes were also found to be more confident in integrating biology concepts into their animal science curriculum. The concepts that their highest confidence levels surrounded topics involving understanding how fatty acids are classified (saturated, unsaturated), and the general structures and functions of triglycerides, phospholipids, and steroids.

Conclusions

Sixty-nine percent of the agriculture science teachers in the state responded to the survey instrument. The majority of participants were males in their late 40's with over ten years of teaching experience. Almost 90% of the teachers had received their initial teaching certification in agricultural education. Most of the teachers had received a master's degree with most of their advanced degrees being in agricultural education or educational administration. Contradicting previous findings (Thompson & Balshwied, 2000), many teachers (70%) had received their science endorsement.

Even with high rates of endorsement, less than 40% of respondents provided science credit in their agriculture courses. This could be because those teachers were already teaching a core science course or may occur because of other barriers. These barriers could include budget constraints, lack of appropriate training or community focus in traditional agriculture programs not focused on science integration. The majority of teachers offering science credit in agriculture classes, did so in animal science and plant science oriented classes, findings consistent with previous research (Balshwied & Thompson, 1999; Connors & Elliot, 1995; Newman & Johnson, 1993; Dormody, 1992). However, science credit was also offered in agricultural mechanics and "general agriculture", despite the lack of "general agriculture" as a state course heading. The average program had been offering science in agriculture courses for 3.5 years. Over half the participants offering science credit indicated that they would cease doing so the following year. At this time, the explanation for dropping science credit for agriculture-based courses is not known.

Confidence levels regarding integrating biology concepts into plant and animal science were low (Table 6), ranging from "very little confidence" to "moderately confident". Overall confidence levels regarding integration of biology concepts into plant and animal sciences were indistinguishable, though the variability associated with confidence level was consistently slightly higher for animal science than plant science (Table 5). As confidence levels grow, following our conceptual framework, the adoption of biology integration will increase.

In plant science, participants were most confident explaining acquisition and transport of plant nutrients. Lowest confidence accompanied discussion of cell division (objective 2.10) and asexual reproduction (objective 8.08). While cell division may be more esoteric, asexual reproduction, manifested in asexual plant propagation is a substantial component of horticulture course objectives and of business in the horticulture industry. Within animal science concepts, participants had most confidence regarding pedigrees and determination of mode of inheritance, important skills as students prepare for supervised agriculture experience (SAE) projects.
Highest correlations between confidence levels and teacher demographics occurred with teaching experience. Teachers with more experience were found to be more confident. Similar findings were put forth by Myers and Dyer (2004). While it is heartening that experience increases confidence, given the low confidence observed here, tactics should be identified to accelerate learning and confidence, since a lack of confidence increases the probability that the material will not be taught or will be taught poorly. It is helpful to note that faculty from larger schools had increased confidence when teaching biological concepts (Table 5; Table 6). This could occur because of ready access to subject-area-trained colleagues, access to improved equipment and instructional materials or related resources (greenhouse; livestock) allowing for greater hands-on experiences. An explanation of these higher confidence levels among faculty at larger institutions would facilitate tactics (e.g. peer-to-peer workshops in which biology faculty train agriculture education faculty) to overcome these challenges to confidence. While more research is clearly needed, programs nevertheless exist directly (e.g. the Curriculum for Agricultural Science Education, secondary science certification) or indirectly (e.g., animal project centers, learning labs, science fairs) to overcome the science-concept confidence-challenge. Aligning with recommendations from previous research (Baker et al., 2015; Warnick & Thompson, 2007), SBAE teachers should seek collaborations with teachers in their schools' science department. These members can serve as rich resources for science integration in the SBAE teachers' respective schools.

While the low confidence levels observed here should serve as a wake-up call to stakeholders in the educational community, it is important to remember that confidence should not be confused with competence. With improved training and commitment from all stakeholders', improvements in teacher confidence can be achieved. It is important to evaluate SBAE teachers' confidence in science integration as they go through the implementation process. Subsequent studies should evaluate the teachers' progress regarding implementation and assess the barriers teachers face regarding science integration in their SBAE programs. Future studies should re-validate the instrument due to the constantly changing nature of science curriculum and associated standards. Researchers should consider the addition of science content specialists (e.g., experts in biology) on the panel of experts to assess content validity. The lack of a biology-focused member on the panel of experts served as a limitation for this study.

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