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The Influence of CASE on Agriculture Teachers' Use of Inquiry-Based Methods

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Abstract

The Curriculum for Agricultural Science Education (CASE) is a national curriculum model used to promote inquiry-based learning, with a focus on facilitating student development of critical thinking skills through hands-on application. However, limited research has been conducted on how agriculture teachers are using the curriculum after completing the required professional development training and its impact on their future classroom instruction. The central research question that guided this study was: how does completion of the Southwestern Land Grant University CASE professional development institute influence behavior patterns of agriculture teachers for incorporating inquiry-based learning through science integration? This research was conducted utilizing a multi-case study design. Nine certified CASE teachers who completed a summer 2018 institute were interviewed, observed, and had lesson plans analyzed. Five major themes emerged from the data: 1) barriers to CASE implementation exist that impacted teacher behavior, 2) experience in industry leads to increased teacher efficacy for inquiry-based strategies, 3) traditionally certified teachers are more likely to fall back on didactic teaching orientations, 4) a disconnect exists between student capacity and CASE expectations of inquiry-based methods, and 5) in state training and networking plays a vital role in teachers' perceptions of CASE. Further research recommendations include expanding the scope of this study to provide insight on how lead teachers, regions, and/or curriculum pathways affect implementation of inquiry-based learning and purposeful science integration. Recommendations for practice include increased collaboration among CASE certified teachers, development of a state-wide online platform, and additional funding opportunities for teachers.

Keywords: CASE; inquiry-based learning; science integration; teacher behavior

Introduction

After the reauthorization of the Carl D. Perkins Career and Technical Education (CTE) Act of 2006, there was a call to administrators and teachers to identify, support, and rigorously evaluate evidence-based, innovative strategies and activities to improve and modernize CTE programs and align workforce skills to the labor market. Employers nationwide are seeking employees who demonstrate professional and people skills along with technical skills within their discipline (Casner-Lotto & Barrington, 2006). Specifically, the ability to contribute problem-solving, critical thinking, and planning initiatives in a team-based environment (Taylor, 2005), which can be achieved through involvement in secondary level CTE programs.

Pedagogical research supports the need for teachers to shift their instructional methodology from passive, teacher-centered instruction to active, student-centered instruction (Smith et al., 2005). Student-centered methods encourage students to reach higher levels of critical thinking needed in professional settings. In science education, one pedagogical method available to meet this need is inquiry-based learning, which is defined as students learning and/or applying material to meet a challenge or solve a problem (Nilson, 2010). This method can include questioning, experimentation, and interpretation of data. When used effectively, inquiry-based learning is focused on students utilizing their prior knowledge and experiences, with the assistance of instructor support, through

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engagement in higher-order thinking and problem-solving skills combined with reflection (National Research Council, 2000).

Historically, school based agricultural education (SBAE) programs across the United States have been at the forefront of integrating science techniques, including inquiry, in agriculture curriculum (Conroy et al., 2000). Specifically, the Curriculum for Agricultural Science Education (CASE) is a national curriculum model created to enhance delivery of agriculture content using student-centered methods and provides a structured course sequence validated through alignment of lessons with national standards for agriculture, science, mathematics, and English. The mission and vision of CASE (2020) requires teachers to attend a CASE institute, which is an extensive professional development experience complete with hands-on lab instruction delivered through inquiry-based methods, to achieve certification.

While CASE professional development institutes are designed to promote inquiry-based learning and science integration, little research has been completed on current certified CASE teachers to determine the impact within their local programs. Currently, there are only a few empirical studies within agricultural education that directly address the CASE curriculum. Lambert et al. (2014) explored practicing teachers' experiences when implementing CASE. Five themes emerged from this study: adaptability towards the curriculum being student-centered, teachers enjoyed the content, materials and equipment were vital for successful implementation, and attending the institute, especially with other peers and colleagues, was extremely important to their future success. Carraway (2015) investigated preservice agriculture teachers who received CASE training and found participants had positive views of science integration through use of the CASE curriculum. However, participants also identified barriers to incorporating CASE, including the expense of supplies and equipment needed. CASE is promoted to agriculture teachers nationwide, but with little research exploring the curriculum and its implementation, it is unknown what behaviors patterns are being exhibited by teachers after completing certification.

Literature Review

Inquiry-Based Learning Through Science Integration

There are countless definitions for inquiry-based learning and what it looks like in the classroom; however, for the sake of this research, the definition of inquiry-based learning utilized was a student-centered approach that involves formulating questions, investigating to find answers, and building new knowledge that students communicate to others (Stephenson, 2015 as cited in Carraway, 2015). The National Research Council (2000) identified the major features of the inquiry-based learning process to be very similar to steps within the scientific method, which allows this process to promote strong scientific reasoning and critical thinking skills in students.

Inquiry-based learning is best described through a spectrum (see Figure 1) between teacher-centered and student-centered methods. From the far-left side beginning with a more teacher-centered approach, inquiry can be the teacher posing a question but *knowing* exactly what outcome the students should come up with. An example of this kind of lesson would be a lab where students take the pH of different substances (e.g. Coca-Cola in which the teacher knows the pH will be acidic). Moving along the middle of the spectrum to a more student-centered approach, inquiry can be the teacher posing a question *not knowing* the results of the students' findings before-hand. An example of this would be a lab where students test the "5-second rule" of dropping food on the ground to observe what bacteria colonies might grow. Students may have some autonomy in the experimental design by choosing the location in which to drop the food; therefore, the teacher does not know the exact outcome of each experiment. Finally, on the far-right side of the spectrum with increased student-centered learning, the students pose their own question and design their experiment. Agriscience Fair, a National FFA Organization program designed to recognize research conducted by students in the application of agricultural scientific principles (National FFA Organization, 2020), is an example of this type of inquiry-based learning that falls on the far-right side of the inquiry-based learning spectrum.

Figure 1

Inquiry-based Learning Spectrum (National Research Council, 2000).

Less --------------------------------------Learner Self Direction---More

More---------------------------------- Direction from Teacher or Material---Less

When teaching within the inquiry-based learning spectrum, there are five major science features to consider for any content area. These features include: 1) students' engagement with scientifically oriented questions, 2) collection and analysis of evidence (i.e. data), 3) formulation of explanations based on scientific evidence, 4) connection between scientific concepts and collected evidence, and 5) communication and justification of outcomes (National Research Council, 2000). Each of these five main features can also span the student and teacher-centered spectrum, depending on the approach chosen by the teacher. For example, in a lesson on soil porosity, the teacher could choose from a variety of pedagogical approaches along the inquiry-based spectrum for feature four alone, which describes the connection between scientific concepts and collected evidence. The teacher may approach the lesson from the far-left side of the spectrum (i.e. more teacher centered) by providing the students with all connections to scientific concepts of soil porosity through a lecture following an in-class lab. Alternatively, the teacher could have the student independently examine other credible resources to form connections between the lab and the current scientific body of knowledge on their own, approaching the lesson from the far-right side of the spectrum (i.e. more student/learner centered). These pedagogical decisions are highly dependent on students' cognitive levels, skills, desired outcomes, and teacher choice of how to best structure the content for the students and their learning needs.

Inquiry-based learning is an effective tool that benefits students' retention of content more than traditional teacher-centered methods, and it is a highly recommended method for science and applied science teachers to include in their classrooms (Skelton et al., 2018). It is common for teachers who do not receive explicit training as preservice or practicing teachers to be responsible for integrating science and inquiry-based learning methods into their classrooms (Skelton et al., 2018; Thoron & Myers, 2011). However, this method can be difficult for teachers to implement successfully. Past research indicates inquiry-based learning methods are most commonly conducted in the middle of the teacher and student/learner-centered spectrum (see Figure 1), and often the focus is still predominately teacher-centered (Washburn & Myers, 2010). To be effective, the structure of the inquiry needs to be a "knowledge-in-action" approach where students are challenged to think on their own and problem solve to construct an answer that may or may not be correct, while teachers facilitate the learning process (Blythe et al., 2015).

CASE Curriculum

The CASE curriculum is designed to promote common understanding of agricultural concepts by aligning the lessons to the national Agriculture, Food, and Natural Resources (AFNR) Standards and Next Generation Science Standards. The curriculum is delivered through a structured sequence of courses to enhance the total program of SBAE. The pathways of courses are structured upon 10 CASE course curriculums: Introduction to AFNR, Agricultural Science- Animal, Agricultural Science- Plant, Agricultural Power and Technology, Natural Resources and Ecology, Animal and Plant Biotechnology, Food Science and Safety, Mechanical Systems in Agriculture, Environmental Science Issues, and a capstone of Agricultural Research and Development. To complete a pathway, teachers must get certified in all the relevant curriculums. For the sake of this research, the focus was on the Introduction to AFNR curriculum, which is typically the first CASE curriculum in which teachers become certified.

CASE is currently on its 13th year of implementation after the National Council for Agricultural Education launched the curriculum in 2007. CASE claims to enhance the rigor and relevance of the agricultural curriculum by highlighting science, mathematics, and English language arts concepts throughout the curriculum. This rigor stems from the utilization of inquiry-based learning taught through activity-, project-, and problem-(APP) based instructional strategies (CASE, 2020). The use of these activities is what staggers the curriculum across the spectrum of inquiry-based learning of the instructor knowing, or not knowing, the input (i.e. what information the student has to work with when completing the lesson) and output (i.e. the results the students will come up with at the end of the lesson) (see Figure 2).

Figure 2

CASE Activity, Project, and Problem-based Format (CASE, 2020).

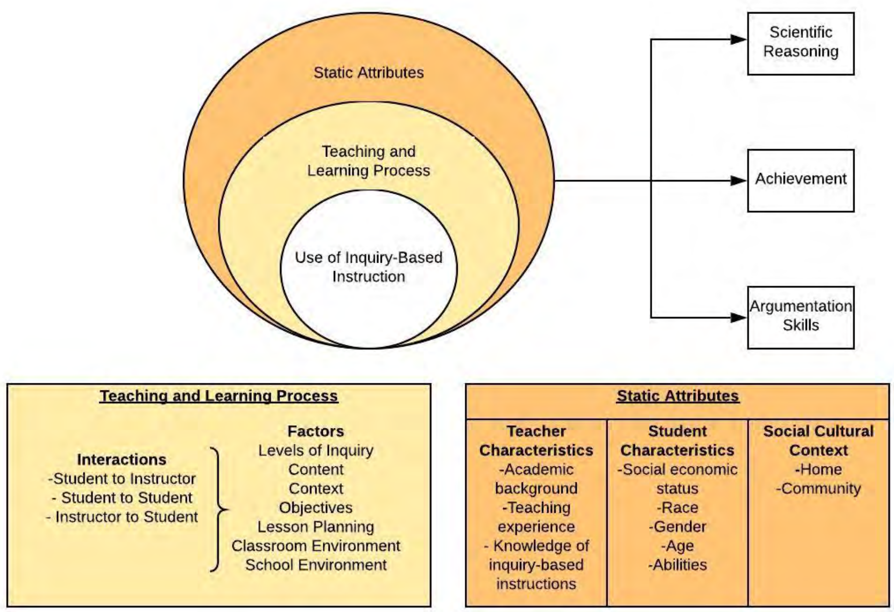
	Input	Output
Activity	Known input	Known output
Project	Known input	Unknown output
Problem	Unknown input	Unknown output

Conceptual and Theoretical Frameworks

The conceptual framework for inquiry-based learning utilized within this research was adapted from an empirical study on the effects of inquiry-based agriscience instruction on student achievement (Thoron & Myers, 2011). Effective inquiry-based instruction lies within a teaching and learning process that involves interactions between students and teachers and other factors including levels of inquiry, content, context, lesson planning, and classroom and school environments (see Figure 3). This process is then affected by static attributes of the teachers, students, and social-cultural context. If all these components align, students are expected to develop scientific reasoning skills, argumentation skills, and academic achievement as outcomes.

Figure 3

Conceptual Model for the Effects of Inquiry-based Instruction (Adapted from Thoron & Myers, 2011).



Within the teaching and learning process, inquiry-based learning promotes three types of interactions including: student to instructor, instructor to student, and student to student. These interactions are fluid and depend on a variety of factors. Student to instructor and instructor to student interactions deal specifically with the instructor acting as a facilitator of learning. These are two-way interactions and can be differentiated by who is initiating the interaction. The interactions between students and teachers can be observed through a variety of exchanges including the amount and level of questions students are asking the teacher, how well the students understand the content, and students' understanding of how this information can be applied in the real world. Teacher to student interaction can also be present during the teacher's preparation of the lesson or lab and the creation of learning objectives. Within inquiry-based learning, there is also a strong focus on student-to-student interaction built upon social-cultural contexts. These interactions help students work together in a constructive manner by developing their communication skills with diverse peers (Thoron & Myers, 2011). Both classroom and school environments can affect the interactions between students and teachers.

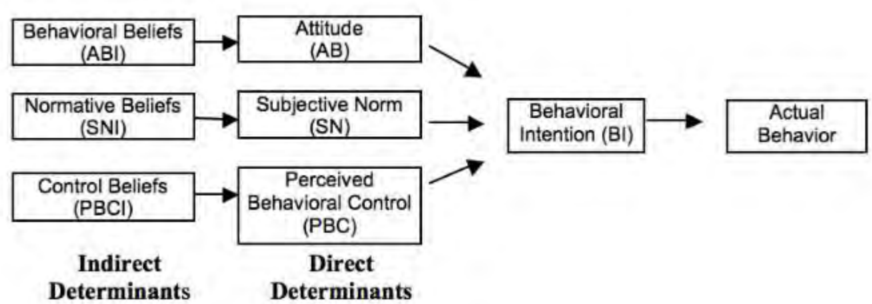
The outermost circle of Figure 3 represents the static attributes that exist regardless of individual teacher or student action. These attributes can impede on every part of the teaching and learning process which affects the implementation of inquiry-based methods. These static attributes include those of the teacher, student, and social-cultural context. For the teacher implementing inquiry-based learning, their effectiveness is dependent on their academic background, teaching experience, and knowledge of inquiry-based instruction. Teachers need to have knowledge in the subject and content being taught as well as appropriate ways to breakdown and relay the information to students (Rice & Kitchel, 2015). The teaching experience of a teacher, both years taught and quality of experiences, can affect their ability to implement inquiry-based methods along with their knowledge of inquiry-based methodology.

Static student attributes that can affect inquiry-based learning include socio-economic status, age, gender identity, race, ethnicity, and abilities. The environment students are within, including their school, home, and local community, can also play a role in the students' learning process. Inquiry-based learning is derived from a constructivist lens of learning where students can be affected by individual, interpersonal, and communal factors when constructing knowledge (Schunk, 2008). These individual static factors, such as age and maturity, can affect how students take responsibility for their own learning, including self-regulation strategies and metacognitive approaches to learning. Although some of these static attributes of the teacher and student can change over time, this framework captures a moment in time of incorporating inquiry-based learning into the classroom.

The theoretical framework used to guide this study was the Theory of Planned Behavior (Ajzen, 1985), which seeks to explain behavioral intentions of people (see Figure 4). For there to be a change in someone's behavior there is a behavioral intention (BI) as a precursor. The intent of changing behavior stems from both indirect and direct determinants. The direct determinants, factors that most directly affect behavioral intention, include attitude toward the behavior (AB), subjective norm (SN), and perceived behavioral control (PBC). The indirect determinants, factors that prelude the direct determinants, include behavioral belief (ABI), normative beliefs (SNI), and control beliefs (PCBI) (Ajzen, 1985).

Figure 4

Theory of Planned Behavior (Adapted from Ajzen, 1985 as cited in Lee et al., 2010).



Attitude refers to how the individual views the behavior. For behavioral intention to happen, the individual's attitude towards behavior change needs to be positive. Subject norm contributes to the way individuals perceive that other significant people want them to engage in the behavior. When important people in an individual's life view this behavior change as something positive or necessary, it becomes important to the individual to have the intent to change their behavior. Finally, perceived behavioral control is when the individual believes they can perform the behavior successfully. If the individual does not believe they will be successful when exhibiting a behavior, it will not to be a behavior they will pursue (Lee et al., 2010).

All these direct determinants have specific influential indirect determinants. Behavioral beliefs (ABI) link the behavior of interest to expected outcomes. An individual must be interested in the behavior and believe it is going to have a positive outcome. Normative beliefs (SNI) refer to the way the individual perceives behavioral expectations of important individuals which could include teachers, doctors, administrators, supervisors, and/or coworkers. These normative beliefs, when combined with an individual's motivation, determine the prevalent subjective norm. Finally, control beliefs (PBCI) relate the perceived presence of factors that may facilitate or impede performance of a behavior. If an individual believes there is going to be some impeding factor to carrying out the behavior successfully, then they are less likely to pursue the intention of changing the behavior (Ajzen, 1985). This theory was utilized in this study to consider the change that has, or has not, been implemented by CASE certified teachers. Although the institutes for CASE are more rigorous than many professional development workshops, teachers will not change their methodology if they are not completely "bought-into" the idea. Professional development can only go so far, if teachers do not value inquiry-based learning and science integration in their teaching, they will not incorporate it into their classroom.

Purpose of the Study and Central Question

The purpose of this study was to determine the influence of CASE AFNR certification on the behavior patterns of high school agricultural education teachers in one Southwestern state for implementing inquiry-based methods. The American Association for Agricultural Education National Research Agenda (2016-2020) calls for meaningful learning within SBAE programs to engage students and the need for motivated teachers to facilitate engagement (Edgar et al., 2016), which fits with the purpose of this study. The central question was: How does completion of the Southwestern Land Grant University (SWLGU) CASE AFNR professional development institute influence behavior patterns of agriculture teachers for incorporating inquiry-based learning through science integration?

Methods

A multi-case study research design was employed where each CASE certified teacher served as an individual case (Yin, 2014). Case studies can be used to observe a process, which will allow the complex dynamics of the CASE curriculum in the classroom to be analyzed (Yin, 2014). In line with Yin (2014), a pragmatic approach was used as the epistemological lens. Pragmatism is the uncritical exploration of the practical applications of an idea or value (Crotty, 2012). When looking through a pragmatic lens, the view of the world can change depending on the person experiencing it (Yazan, 2015). It is also important that positionality is disclosed to avoid any biases in the research (Creswell, 2013). The researcher was provisionally certified in the CASE AFNR curriculum in the Fall of 2017 as a preservice teacher and integrated CASE lessons into the curriculum during student teaching. The researcher also served as a teaching assistant for an integrated CASE course at the university level.

Description of the Case

The CASE curriculum is designed to promote common understanding of agricultural concepts by aligning the lessons to the National AFNR Standards and Next Generation Science Standards. The curriculum is delivered through a structured sequence of courses to enhance the total program of SBAE. For this study, the focus was on the Introduction to AFNR curriculum, which is typically the first CASE curriculum in which teachers become certified. Additionally, this study only focused on CASE certified teachers currently in the chosen Southwestern state to be congruent with in-state standards. To become certified in CASE AFNR, teachers attended a 10- day institute at SWLGU during the summer of 2018. This specific institute was chosen because numerous in-state teachers attended and experienced the same professional development. The final requirement to participate was the teachers had to be actively implementing CASE AFNR in at least one course during the 2018-2019 school year.

Nine agriculture teachers agreed to participate in this study. Of the original 20 participants at the SWLGU institute, only thirteen were agriculture teachers in the chosen Southwestern state. One individual taught at the collegiate level making them ineligible for the study and three individuals opted out of the study. For eight of the participants, this institute was their first CASE curriculum certification. Participating teachers had a variety of teaching experience ranging from 1-38 years and obtained certification through various avenues. Teaching certifications included traditional certification (i.e. goes through a college or university teacher preparation program) or alternative certification (i.e. teacher who did not go through a teacher preparation program, but instead met requirements through work in the agriculture industry) (Arizona Department of Education, 2018). Four of the teachers taught in rural SBAE programs and five taught in suburban/urban programs. Pseudonyms were assigned to each of the nine participants to protect their identity and any personal information disclosed within the research.

Data Sources and Collection

Multiple data sources were collected to achieve triangulation including a pre-interview, classroom observation with field notes, post-interview, and a textual analysis of lesson plan documents. All protocols were derived from the theoretical and conceptual frameworks and data were collected during the 2019 Spring semester. The semi-structured pre-interview was conducted over a Zoom video call prior to the observation of a CASE lesson to illicit perceptions of the CASE curriculum, understanding of inquiry-based learning, and their process of incorporating inquiry-based learning into their instruction. An example pre-interview question was, "How do you expect your students to interact with each other during these inquiry-based lessons?"

Following the pre-interview, each teacher was visited to observe one CASE lesson lasting between 45-90 minutes, which allowed the researcher to see their inquiry and science integration in action. Due to the timing of visiting each teacher, it could not be guaranteed that all participants would be teaching the same CASE lesson; however, all teachers were at least in unit three of AFNR, which is the beginning of the science content. During the observation, the lesson was video recorded to refer to during analysis and field notes were taken on the various interactions within the classroom. Teachers also self-identified utilization of the CASE curriculum within this first year of teaching the curriculum. Minimal utilization was defined as less than 25% use of the curriculum, moderate utilization was defined as 25%-50% use of curriculum, and heavy utilization was defined as more than 50% use of the curriculum. It is important to note that one participant, Theodore, was unable to be observed due to school restrictions, but participated in the pre- and post- interviews. In addition, teachers provided any documents they disseminated to their students for document analysis to observe if anything was changed from the original CASE materials.

Immediately after the in-class observation, the researcher conducted a post-observation interview with the teacher. This interview allowed the teachers to reflect on the lesson they just taught and explain their thoughts on the amount of inquiry they included within the lesson. An example post-interview question was, "Has your teaching style changed since getting certified in CASE?" This question delved deeper into behavioral changes of teachers that were potentially impacted by CASE certification and institute participation.

Data Analysis and Trustworthiness

All data sources were analyzed using deductive and inductive analytical approaches and the researcher engaged in open, axial, and selective coding to let findings emerge from the data and to establish relationships across concepts (Creswell, 2013). After the first round of inductive coding, there was 220 individual open codes. Pattern matching was implemented following open coding, attending to the multiple sources of data within individual cases and across multiple cases to examine similar issues or trends (Yin, 2014), which yielded twenty-five emergent categories across all cases. Deductive analysis was also conducted by matching initial open codes with a structured coding framework derived from the theoretical and conceptual frameworks. Finally, categories from inductive and deductive analytic processes were collapsed into five overall themes that served as the basis for the findings.

To ensure the trustworthiness of the study, triangulation was utilized through collecting different data sources: pre- and post-interviews, classroom observations with field notes, and textual document analysis of curriculum materials (Creswell, 2013). To ensure opportunity for participant input in the analysis process, the researcher engaged in member checking of the findings. Researcher bias was addressed by disclosing positionality (Creswell, 2013). Finally, thick and rich descriptions of the participant's experiences were provided through the inclusion of quotes from the direct data sources (Tracy, 2010).

Findings

Barriers to CASE Implementation that Impacted Teacher Behavior

There were varying amounts of CASE AFNR curriculum utilization within the classroom for each participant during the 2018-2019 school year. James identified he had only utilized three lessons from the CASE curriculum during the fall 2018 semester, while in contrast Gretchen utilized CASE for the majority of her lessons. Reasons for this variance among participants directly related to real and perceived barriers within the planning process for lessons and access to materials needed for conducting labs and activities. Each participant was asked, "When teaching an inquiry-based lesson, what are some of the things you have to plan for?" The purpose of this question was to highlight the process of implementing an inquiry-based lesson to identify the components of the teaching and learning process outlined in the conceptual framework. Gretchen said, "It is a very difficult and very different way of teaching, so I am glad that it [CASE] is kind of planned for me because I don't think I would know how to do that." This was echoed by numerous participants in the study. The CASE curriculum is inclusive of all instructional materials including PowerPoints, worksheets, and assessments. All documents are provided in both pdf and editable formats; however, none of the teachers used this editable version for the student activity worksheet during classroom observations. Despite a lack of alterations for those observed lessons, numerous participants discussed ways that they have adjusted previously taught CASE lessons or plans for altering future CASE lessons.

Following any CASE institute, teachers have the responsibility to figure out how the curriculum is going to fit into their individual courses and classrooms. Gretchen and Michael took a proactive approach to integration by incorporating CASE into their curriculum maps in August and regularly collaborated during the school year. Gretchen and Michael were two of four participants with heavy utilization and integration of the CASE curriculum. James, a participant with minimal utilization, suggested in his post-interview, "We needed time in the institute or after to be like here is what you need to do next." James had difficulty implementing CASE in his school, but also did not identify time set aside for curriculum planning. It is also important to note that teachers in multi-teacher departments, or in more urban areas with easier access to other teachers using CASE, were more likely to engage in proactive planning.

The second barrier to CASE implementation that emerged among multiple participants was acquiring the consumable materials and capital supplies needed to execute labs and activities. CASE provides a purchasing manual for all courses including AFNR; however, it can be expensive to purchase in entirety and targets specific vendors for specialized equipment. James surfaced his hesitation in purchasing materials for his rural program. "The only thing I didn't like…I really haven't done a lot with CASE this year because I don't have a lot of this stuff that I said I wouldn't be able to afford myself or from the school." The participants who struggled with obtaining the materials were mostly from rural schools. This is a static attribute of the school environment with a lower budget and lack of funding to go towards materials for CASE. Barbara explained, "funding for the equipment is very limited at my school so I am trying to piecemeal [supplies and equipment]." During James' classroom observation, he taught a CASE lesson that required no major supplies from the CASE purchasing manual. However, this did not negatively impact James' ability to incorporate inquiry-based approaches, utilize effective questioning strategies, probe students to think deeply about the content, and connect to their lives beyond the classroom. All participants in this study acknowledged that the materials are a vital part of the success of the CASE curriculum, even if materials are purchased from vendors not recommended through the CASE purchasing manual.

Experience in Industry Leads to Increased Teacher Efficacy for Inquiry-Based Strategies

All participants identified that the purpose of agricultural education, at least in part, was for students to develop technical skills in the agricultural classroom that were transferable to their future careers. This belief was amplified during classroom observations and interviews for participants who possessed personal experience working in the agriculture industry. Six of the nine participants were employed in other careers within the agriculture industry prior to entering the classroom. This career experience ranged from government employment, to business ownership, to Cooperative Extension agent roles. Just because the participant had experience in industry prior to teaching, does not automatically mean they were alternatively certified.

Each of these six participants with real-world industry experience exhibited more student-centered inquiry-based approaches during classroom observations, were able to reach deeper levels of inquiry through a strong connection to science utilized within industry, and reported feeling more comfortable with inquiry-based methods. When asked about her beliefs surrounding inquiry-based learning, Jessica, who had over ten years of previous industry experienced responded, "Well I've always been all about that [inquiry]. So, CASE aligns with the practices I already like to do." Overall, this industry background influenced the following behaviors in teachers related to implementing inquiry-based methods: a stronger felt need to learn when introducing content, emphasis on problem-solving approaches, development of employability skills, and higher expectations for critical thinking and real-world connections.

Teachers with industry experience consistently taught using interest approaches that connected closely to real world industry applications as evidenced through observations. Moreover, interviews with teachers also surfaced overt attention to bridging the gap between scientific content and industry applications. During Barbara's observation, she included personal stories during her interest approach on animal systems and made connections to industry competencies and skills. This impacted the classroom environment as students reciprocated by posing new questions related to their current jobs, all within the context of animal systems.

During observations careful attention was paid to teacher questioning strategies, noting the types of questions asked (e.g. open ended vs. directed), use of probes when necessary, frequency of questioning overall, and depth of questions (e.g. what vs. why). James, who had industry experience, spent almost 1/3 of his class time questioning students, and often began questions with "why". In his post interview James said, "My personal experience helps when students ask why do we need to learn this? And I've seen a lot of the application of what we teach in real life and bring those points up to my students." When observing Jessica, she was reluctant to simply answer a student question posed to her, but instead posed new questions to help students consider the content from a different perspective. Teachers with industry experience asked more questions total during observations regardless of content context and challenged students to reach higher cognitive levels of thinking.

Other participants took their industry experiences as opportunities to teach their students problem-solving and critical thinking skills through inquiry-based methods. Elyse said, "I will go to my grave saying the most important skill you can learn whether it's through jobs or school or whatever is problem-solving." Jessica exemplified similar values about the importance of critical thinking and problem-solving skills. She pushed students to take ownership of their learning by solving issues on their own prior to interacting with her. James took this a step further by expecting students to not only be able to answer the reflection questions provided by CASE, but to verbally articulate the *why* behind their answers. He engaged in a class wide question and answer session *after* collecting student worksheets, to reduce student reliance on their written answers. Forcing students to verbally articulate the science behind the process lends itself to argumentation skills and scientific reasoning, important outcomes in the conceptual framework.

Traditionally Certified Teachers More Likely to Fall Back on Didactic Teaching

Teachers who have been traditionally certified in a teacher preparation program were more likely to deviate from the student-centered inquiry-based approaches and instead, fell back on didactic teaching orientations. A teacher with a didactic orientation to teaching would view the teacher as a distributor of knowledge in a predominately one-way exchange between teacher and student. Two participants, both traditionally certified, noted it was difficult to not rely on traditional pedagogical strategies that more closely align with didactic teaching orientations. This stemmed from a desire to be in control of the classroom, which is easier to maintain with traditional lecture or discussion-based approaches. Michael described his experience before utilizing CASE, "I used to give directions in incredible detail to put a lot more of the responsibility in my hands." Although classroom management is important, the nature of inquiry-based learning is to have the students *inquire* into a subject, which requires teacher to transfer some control to students. During Tommy's observation, he shifted from student-centered to teacher-centered approaches during a single lab session. For the first half of the class, he responded to student questions that could be easily answered by the lab protocol with, "what do your instructions say?" However, as the class period progressed, Tommy fell back into the didactic orientation by simply answering the questions students posed.

Scarlett showcased similar difficulties to Tommy during her lesson on electrical power. She told one group while walking around the classroom, "Do not do it that way… You will set it up wrong and it will not work correctly." Students getting the correct answers was a concern of most of the traditionally certified teachers. With standardized testing initiatives and expectations of high student achievement on these exams, teachers are commonly expected to have students test their content knowledge through traditional exam questions that yield one correct answer. Inquiry-based learning challenges that expectation by allowing students to problem-solve with critical thinking skills, a greater focus on the process versus product of learning. Michael, who was alternatively certified after working in industry, said, "I mean, just the structure of going through the process is more important to me than did I get the correct answer" and explained most of his grading is based off of completion of the process rather than accuracy of the product. In reverse, Gretchen expressed frustration towards CASE's assessments because, "they are so vague, the students do not know what to put, and then it is very difficult to grade."

Disconnect between Student Capacity and CASE Expectations of Inquiry-Based Methods

Inquiry-based methods inherently force the teacher into the mindset of a facilitator rather than the primary source of content knowledge for students. Eight participants identified that age affects inquiry-based learning, specifically discussing the maturity of the students to complete the labs and projects. Tommy explained, "You're trying to teach them something and at the same time you are trying to handle all of these students… The student maturity level actually makes it where I can't get through most of the curriculum." Multiple participants surfaced pushback from students on inquiry-based learning methods because they viewed it as more difficult when compared to their experiences in other classes. Scarlett elaborated on this idea, "when you do inquiry it is very kind of a high expectation for them to put in some effort to figure something out. A lot of them are not willing to do that at first and not comfortable doing that." The issue of students not liking the agriculture course they were enrolled in, or having difficulty understanding the learning that was occurring, surfaced in six of the participants' interviews. Most noted that it was due to lower expectations of students in their prior education experiences.

James pointed out a generational shift in students by saying, "Kids today don't think for themselves. We could teach it to them today and they wouldn't be able to do it tomorrow on their own." The prior expectation for these students before CASE was focused on learning information and being able to take a test on the concept. This school culture and the students' past experiences are static attributes of the environment that affected the incorporation of inquiry-based learning. James said in his post-interview, "You can't skim by with CASE, you have to do the work." This is the component that students struggled with the most, leading them to push back on inquiry-based learning and ask for easier tasks. Most of the participants tried to combat this push back from students with a heavier focus on group work and collaboration among students. Collaboration mirrors problem-solving skills that students would experience in the real world. When asked about expectations of student to student interactions within inquiry-based lessons, Scarlett said, "It [group work] helps the students. More minds are not a bad thing. If we are all looking at the same thing together, we might see different things." Students can experience frustration when working on problems alone; however, in real world situations, they would have access to other resources than just their own mind and experiences.

In-State Training and Networking Played a Vital Role in Teachers' Perceptions of CASE

All nine participants identified that having other teachers from the same state at their institute enhanced their overall experience. They surfaced strong collaboration with their colleagues and discussion about the curriculum in the context of their state and standards as particularly valuable. When asked about his institute experience, Theodore, an experienced teacher, described it as "Warm because of the relationships in there with my peers. Us older teachers, it's good for us to be with young teachers and frankly they helped build my confidence a little bit." Jessica explained, "The other great thing about the CASE institute is I initially didn't know everyone in that room, but I really bonded with them over the experience."

Four participants shared that the reason they chose to get CASE certified was from the testimonials of their colleagues in the same state who had previously gotten certified. This subjective norm is what led the teachers to begin their intent to change behavior for incorporating inquiry-based learning through the CASE curriculum. Theodore said, "CASE is the future and that is where the profession is headed." The collaboration and partnerships developed with other participants from the same state fostered the desire and drive to adopt the behavior of incorporating inquiry-based methods into their classrooms. These relationships and accountability could also lead to maintained behavior in the future.

Discussion

Barriers to CASE implementation ultimately affected the participants' behavior for incorporating inquiry-based methods. Equipment and supplies are vital for the successful implementation of CASE (Lambert et al., 2014; Carraway, 2015); however, it can be a costly investment for teachers. This is an essential control belief that can lead participants to believe they will not be successful in implementing the curriculum without all the supplies and equipment. The second major barrier to emerge from the data was lesson and course planning. Ball et al. (2007) outlined that the planning for a lesson can directly influence the delivery of content and student achievement outcomes. Although the CASE curriculum includes fully developed lessons and assignments (CASE, 2020), there are still aspects of the curriculum that must be set up or coordinated beforehand. Planning is a direct component of the teaching and learning process outlined in the conceptual framework. Course planning has been a known obstacle for agriculture teachers (Smalley & Smith, 2017) that can hinder their instructional preparation. The two participants who collaborated and outlined their curriculum maps for the entire year had the heaviest integration of the curriculum in their classrooms.

Duncan and Ricketts (2008) compared the efficacy of traditionally and alternatively certified agriculture teachers and concluded traditionally certified agriculture teachers had higher efficacy in the total program of agriculture and lower efficacy in technical agriculture content knowledge. Although not all the participants that supported this theme were alternatively certified, their experience in industry gave background and technical knowledge to help students understand the need to learn the concepts and their applicability to the real world. The value of this experience cannot be overlooked in terms of its impact on the delivery of CASE curriculum. Teachers with background knowledge of the industry explained the concepts included in the CASE curriculum with deeper science explanations. In addition, teachers with industry backgrounds understand employability skills that are vital for success including problem-solving skills, critical thinking, and teamwork (Casner-Lotto & Barrington, 2006). As the agricultural education profession continues to answer the call for career readiness from the Carl D. Perkins Act of 2006, teachers must develop pedagogical content knowledge for all content areas in relation to industry practices and critical thinking skills.

Traditionally trained and certified teachers were more likely to fall back into traditional, didactic orientations for teaching when attempting to integrate inquiry-based learning. Washburn and Myers (2010) found that inquiry-based learning methods can be difficult for agriculture teachers to implement and when implemented often focuses predominately on the teacher-centered side of the inquiry spectrum (National Research Council, 2000). Since the 1970s, there has been a push for teachers to move towards active, student-centered instruction within the classroom (Smith et al., 2005); however, professional development cannot force teachers to integrate inquiry-based methods. Teachers must value inquiry-based learning to effectively incorporate these pieces into the classroom (Lee et al., 2010). Traditionally certified teachers were trained in teacher preparation programs where the primary method of teaching often stemmed from didactic orientations. Teachers with didactic orientations toward instruction generally relay information through lecture and discussion where students are accountable for knowing facts in order to test (Gess-Newsome & Lederman, 1999). This directly correlates to both teacher to student and student to teacher interactions within the conceptual framework. In didactic approaches to instruction, the classroom environment promotes teacher to student interactions as the primary source of knowledge and information. Didactic orientations may limit student questioning to the teacher or reduce their likelihood of collaborating with their peers.

Many participants surfaced that the success of inquiry-based methods in the classroom is deeply affected by student maturity. The maturity of the student is an individual influencer on their learning according to Vygotsky's Sociocultural Theory (Schunk, 2008) and directly relates to age as a static attribute outlined in the conceptual framework. The CASE curriculum contains built-in expectations of students' abilities to follow directions, practice safety, and collaborate with peers. A lack of student maturity can hinder the teacher's ability to facilitate these activities and labs for the entire class. Additionally, some participants expressed difficulty implementing CASE curriculum because students pushed back on inquiry-based approaches. Students are often accustomed to receiving information from a lecture and memorizing that information for testing purposes, within the current school system structure. However, this does not match the assessments necessary for inquiry-based methods that focus on real world situations (Schwartz, 1991). This type of assessment is more elaborate and time consuming than sequestered problem-solving assessments because students are constructing and practicing learning through the test itself. Since the school environment has created a culture where students are not exposed to inquiry and discovery methods as much as traditional classroom methods, teachers are likely to experience pushback when attempting to deliver these types of strategies within the classroom (Corkin et al., 2016).

All participants genuinely enjoyed the in-state institute and discussed benefits related to this experience. In line with the theoretical framework, colleague support and endorsement served as a subjective norm and catalyst for behavioral change. There were numerous participants who chose to get CASE certified because of their other colleagues. With a state-wide endorsement for CASE certification, there is a normative belief that this behavioral change contains an expectation to incorporate inquiry-based methods. The subjective norm of having valued colleagues both encouraging and collaborating for the integration of inquiry-based methods is extremely vital (Ajzen, 1985). On a national scale, CASE has recognized the importance of collaboration and resource availability with the state leader model.

Recommendations for Further Research and Practice

As more teachers adopt CASE curriculum, the need for rigorous qualitative and quantitative research on how teachers are implementing this curriculum increases. Currently there is a paucity of research on CASE. This study was limited due to the time frame for data collection and investigation of a single institute and content area. It is recommended future research include an increased number of observations on CASE certified teachers to surface additional change and development for incorporating inquiry-based methods.

Additionally, this study focused on immediate behavior change and discovered that within a single year it was easy for teachers to fall back into didactic orientations for teaching. Therefore, a longitudinal study is recommended to observe if the behavior change for incorporating inquiry-based methods is maintained after years of implementation. Additionally, a longitudinal study would be beneficial to see if there is an increased efficacy in incorporating inquiry-based methods through science integration. Finally, it is recommended to broaden the scope of this study to observe behavior change over a variety of institute experiences, regions of the country, and other CASE curriculums outside of AFNR.

The major themes that emerged from this study highlight various opportunities for future practice. The first recommendation for practice is increased collaboration among CASE certified teachers within each state to foster the importance of alliance and teamwork between CASE teachers. This could be facilitated through collaboration sessions planned by CASE state leaders and integrated during summer teachers' conference (or a similar professional development experience depending on the state) or as a separate professional development event delivered in-person or over an online meeting platform. This would allow for CASE teachers to share ideas for curriculum integration, assessment, and alternative materials that can be used for each lesson, within the context of individual states.

Discussions can specifically target implementation of the curriculum according to state standards and regulations, as well as sharing new and innovative ideas for integrating the curriculum into the classroom. CASE state leaders can share ideas of integrating methods of preparing students for future content. These methods can include incorporating lab preparation days where students become familiar with the background information to prevent any delay of labs and exploring flipped-classroom methods where students are assigned background research of the lesson for homework the night before. This networking opportunity could also allow for teachers to share strategies for integrating inquiry-based methods into their teaching and how to establish expectations with students to increase their motivation to engage in inquiry-based lessons. Integrating a collaborative networking opportunity for CASE certified teachers could decrease potential barriers of implementation, as well as provide a support system that showed to be crucial within the fifth theme of the findings.

In addition to collaborative professional development sessions, it is recommended each state design and implement an online platform available to all teachers that is maintained by the CASE state leaders. Information on this platform could include contact information for CASE state leaders and their areas of expertise, opportunities for implementation grants, and a general page with frequently asked questions. This could also serve as a resource for teachers who are considering getting CASE certified to help them understand the process and financial implications when presenting the opportunity to school administrators to possibly diminish some barriers to implementation. Finally, it is recommended that increased opportunities for financial and resource support for currently certified CASE teachers and teachers who are interested in CASE certification be employed. This could include more grant opportunities for CASE institute attendance and implementation scholarships for supplies. Local, community, and industry sponsors should be sought out to provide financial support at the state level, in addition to current national level grants and scholarships, to minimize barriers to implementation.

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