

Exploring the Connections Between Pedagogical Content Knowledge and Experiential Learning

Josh Stewart¹
Misty D. Lambert²
Kellie Claflin³

Abstract

This study sought to explore the connections between experiential learning and pedagogical content knowledge (PCK) in agriculture teacher candidates. Guided by Kolb's Experiential Learning Cycle and the 2015 PCK model, we utilized a phenomenological approach to examine how agriculture teacher candidates construct their own knowledge, then amplify and/or filter personal knowledge to support students' understanding of content. The purposefully selected population for this study included all agriculture teacher candidates at Oregon State University (N = 10). Three sources of qualitative data were collected and triangulated: field notes, lesson plans, and interviews. Context was found to be an important theme for describing the lived experiences of these participants. The context in which they learned content and the context in which they planned for and taught content for student understanding were both evident, and quite different. The felt need to learn was a decisive component of the context for learning. Context for teaching was shaped by the subject area being taught, by the teacher applying amplifiers and filters, and by the classroom environment. We recommend teacher preparation programs foster thinking about how personal and educational experiences can be used for developing PCK and continue to identify learning experiences to help teacher candidates develop PCK.

Introduction

“What we know about how students learn ought to influence teaching practices, and what we know about effective teaching practices, as well as teacher learning, should influence teacher education” (Bransford et al., 2005, p. 23). For teachers to be effective they need to be both competent in the subject matter they teach and understand how students might struggle to learn the content (Grossman et al., 2005). Shulman (1986) identified this important intersection of teaching and content knowledge as pedagogical content knowledge (PCK) and highlighted the need to combine these two critical aspects of teacher knowledge within the context of teaching and learning. For example, one may be an expert at welding or building cabinets yet know little about instilling the culture of a safe work environment for students or understand how to scaffold information for student learning. On the other hand, one may be passionate about student learning, critical thinking, and developing rapport, but lack any practical experience or knowledge about tool safety, welding technique, or cabinet construction. “Mere content knowledge is likely to be as useless pedagogically as content-free skill” (Shulman, 1986, p. 8). As such, teacher educators are faced with the task of creating experiences that initiate the understanding and development of the knowledge bases needed for teaching agriculture (Terry, Jr., & Briers, 2010).

¹ Josh Stewart is an Associate Professor of Agricultural Education in the Department of Agricultural Education and Agricultural Sciences at Oregon State University, 108 Strand Hall Corvallis, OR 97331. Josh.stewart@oregonstate.edu. ORCID# 0000-0003-1863-6288

² Misty D. Lambert is an Associate Professor of Agricultural Education in the Department of Agricultural and Human Sciences at North Carolina State University, NCSU Box 7607, Raleigh, NC 27695-2707, mdlamber@ncsu.edu. ORCID##0000-0001-8880-385X

³ Kellie Claflin is an Assistant Professor of Agricultural Education in the Department of Agricultural Communication, Education, and Leadership at The Ohio State University, 2120 Fyffe Rd. Columbus, OH 43210, claflin.11@osu.edu. ORCID# 0000-0001-8499-1742

While both content and pedagogical expertise can be developed through a “progressive and continuous cycle of professional development, growth, reflection, and refinement” (Edwards & Thompson, 2010, p. 118), the diversity of secondary agricultural curriculum is unique and requires a wide array of content knowledge (Terry, Jr. & Briers, 2010). For example, Rice and Kitchel (2015a, 2015b) found teacher candidates gained content knowledge from a variety of sources prior to their teacher preparation programs but felt largely disappointed by their agricultural content knowledge preparation as they began teaching. In addition, Rice and Kitchel (2017b, 2018) also found that teachers’ integrated belief systems (defined as a combination of beliefs about the purpose of agricultural education, beliefs about the specific content area, and beliefs about teaching and learning in agricultural education) had a direct influence on shaping their PCK in plant sciences. Likewise, we know the connection between effective pedagogy and student achievement has been well-documented in educational literature, but teacher candidates come into a teacher preparation program with vastly different understandings of effective pedagogy based on their own experiences as students, which they often rely on as models for their own teaching (Kennedy, 1999). Previous research in agricultural education has only begun to explore PCK and recommendations have continued to call for more studies exploring lessons taught by agriculture teachers (Rice & Kitchel, 2015b), observations and interviews of beginning agriculture teachers (Rice & Kitchel, 2016a), exploration of content facilitation in the classroom (Rice & Kitchel, 2015a), and research investigating how teacher candidates develop PCK (Rice & Kitchel, 2017b). We sought to understand how agriculture teacher candidates in one preparation program were drawing on their own learning experiences through the recurring cycle of practice (i.e., student teaching) to construct new knowledge and skills related to PCK.

Purpose and Research Questions

The purpose of this study was to explore the connections between experiential learning and pedagogical content knowledge (PCK) in agriculture teacher candidates. The following research questions were developed to guide the study: How do agriculture teacher candidates use past experiences to inform the knowledge bases needed for teaching agriculture? How do agriculture teacher candidates understand and break down content for student understanding? How do agriculture teacher candidates utilize reflection and abstract conceptualization in their thinking about pedagogical content knowledge?

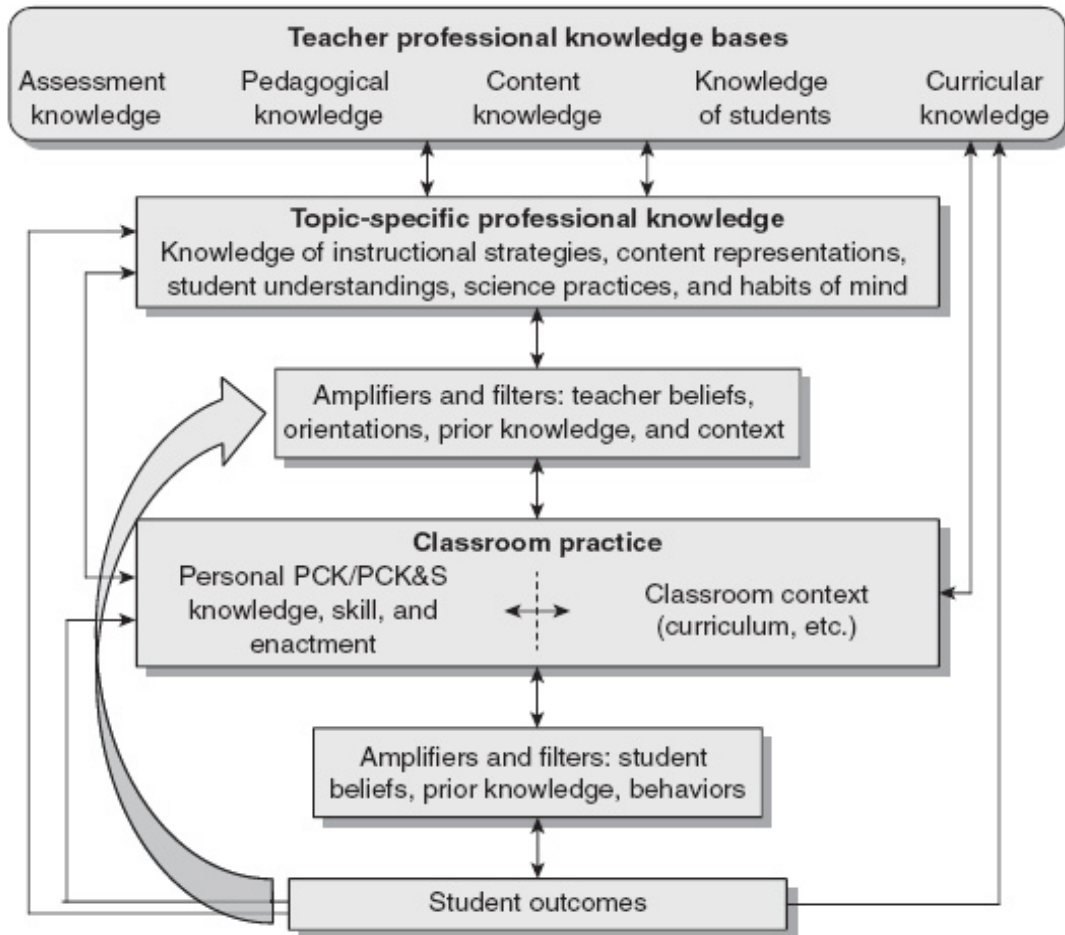
Literature Review

Pedagogical Content Knowledge

The PCK construct has provided a useful way to explore the connections between content and pedagogical knowledge, and student learning. More specifically, the model of teacher professional knowledge and skill (TPK&S, Gess-Newsome, 2015, see Figure 1) was a major advancement in the understanding of the PCK construct.

Figure 1

Model of teacher professional knowledge and skill



Note. From “A model of teacher professional knowledge and skill including PCK,” by J. Gess-Newsome, 2015, In A. Berry, P. Friedrichsen, & J. Loughran (Eds.), *Re-examining Pedagogical Content Knowledge in Science Education*, (pp. 28-42). Copyright 2015 by Routledge.

The TPK&S model helped re-establish and define the knowledge bases involved in the planning for and teaching of particular content for a particular purpose, to particular students (Gess-Newsome, 2015). A distinguishing component of the TPK&S framework is the recognition of teachers’ ability to apply amplifiers and filters (likely motivated by teacher beliefs, orientations, contextual variables, and depth of content knowledge) to current knowledge bases, (Gess-Newsome, 2015). Essentially, these amplifiers and filters are used to enhance or break down content knowledge for student understanding. For example, Rice and Kitchel (2017b, 2018) found experienced agriculture teachers’ beliefs about the content area and about teaching and learning in agricultural education, experiences before and during teaching, and external influencers like the school and community (i.e., amplifiers and filters) had the greatest influence on shaping their PCK related to teaching specific agricultural content in plant science.

Experiential Learning

While it takes many years of experience to develop expertise, teachers need to be able “to reflect on, evaluate, and learn from their teaching so that it continually improves” (Bransford et al., 2005, p. 3). Loughran (2010) indicated teachers’ learning through experience is critical to the act of teaching, as teaching and student learning is reflected on, deconstructed, and then reconstructed again to learn from each teaching episode. Kolb (2015) posited all learning is essentially relearning, developed through a continuous process of testing and refining personal beliefs and theories, and grounded in experience.

Educators should concern themselves with how students interact with and interpret experiences, as well as their own interaction with prior experiences which foster understanding and mastery of content for teaching. The job of an educator is to establish new ideas as well as dispose of or modify old ones (Kolb, 2015). Likewise, Schön (1983) believed in the need for the framing and re-framing of problems in order to modify and implement actions as a result of tested interpretations. Educators should know how to employ prior experiences and current surroundings to develop new learning experiences that are beneficial for students’ construction of knowledge (Dewey, 1938/1997), an idea we argue also applies to teacher preparation programs. Teacher educators should encourage and facilitate teacher candidates’ reflection on and development of conceptualizations from prior learning experiences so they may situate their new beliefs and theories in the context of student understanding (Nilsson, 2008).

Specifically in agricultural education, scholars have linked experiential and authentic learning (Knobloch, 2003), aligned Kolb’s model to a comprehensive agricultural education model (Baker et al., 2012), proposed new experiential learning models (Roberts, 2006), and most recently suggested a holistic model of experiential learning (Coleman et al., 2024).

Conceptual Framework

While PCK has been investigated across several educational disciplines, there is only a small body of literature dedicated to exploring PCK in agriculture teachers (Ball et al., 2008; Rice & Kitchel, 2015a, 2015b, 2016a, 2016b, 2017a, 2017b, 2018; Wooditch et al., 2018). Furthermore, the explicit connections between experiential learning and pedagogical content knowledge development have not yet been explored in agricultural education.

We contend teachers develop expertise in teaching through the utilization of both teaching and learning knowledge and through content or subject knowledge (which Gess-Newsome termed teacher professional knowledge bases (TPKB) and topic-specific professional knowledge (TSPK), respectively) and transform those learnings through their own progress through the experiential learning cycle.

Shulman’s (1987) early work on PCK emphasized the transformation of knowledge for instruction, as well as evaluation and reflection to develop new comprehensions of knowledge. This point of view directly parallels the main tenet of experiential learning, the construction of knowledge by grasping and transforming information through experiences in a cyclical model (Kolb, 1984) and in specific contexts (Coleman et al., 2024; Roberts, 2006).

Methods

This study was a phenomenological inquiry into agriculture teacher candidates’ lived experiences (van Manen, 1990) to explore the connections between experiential learning and PCK. Phenomenology is a practical approach to describe how individuals orient themselves to lived experiences and fosters a focused description on what all participants have in common (Creswell, 2013; van Manen, 1990). Specifically, hermeneutic phenomenology is used to explore the human experience as it is lived (Laverty,

2003) and develop understanding about a phenomenon through interpretation of the participants' lived experiences in the context of the phenomenon (Dowling & Cooney, 2012). Participants included 10 agriculture teacher candidates enrolled in a teacher education program at Oregon State University. Semi-structured one-on-one interviews were used as the primary data source for this study. However, the fact that teachers can exhibit PCK in different settings (Rice & Kitchel, 2016a) created the need to consider other data sources as well. Each source of data has strengths and weaknesses, making triangulation important in qualitative research (Patton, 2002). Classroom observations and field notes, in addition to lesson plans for the observed lessons, were triangulated with the interview data (Creswell, 2013).

The interview protocol was derived primarily from the Content Representation (CoRe) template, an analytical tool developed by Cooper et al. (2015) for PCK research on science teachers. Questions from the CoRe template have been used previously to guide other studies on PCK in agricultural education (Rice & Kitchel, 2015b; Wooditch, et al., 2018). Interview protocol questions for this study included:

1. What prepared you to know the content for this lesson?
2. What are the most important concepts in this lesson?
3. What strategies or methods did you use to teach this lesson? Why?
4. Did your students meet the objectives? What evidence do you have to support this?
5. What else do you know about the content that you did not share with students as part of the lesson? Why?
6. What experiences have you had that prepared you to teach this lesson?
7. When you have the opportunity to teach the lesson again, what will you do differently?

Interviews were transcribed verbatim, and transcripts were read through by the lead researcher who applied provisional codes developed according to the conceptual framework. Miles and Huberman (1994) and Saldaña (2009) recommended the use of a conceptual framework and what initial investigation suggests could be found in the data, to create provisional codes prior to fieldwork.

These provisional codes were useful to begin understanding the participants' lived experiences of teaching, as well as their reflections on how they learned the particular content they were teaching or learned to teach the content in the manner in which they planned for teaching. Throughout the initial coding of the interview transcripts, meaningful and relevant text was marked (Auerbach & Silverstein, 2003), synthesized, and compiled into research memos (Creswell, 2013) by the lead researcher. Field notes taken by the lead researcher were also coded using the same codebook and compared to highlighted text in the transcripts, and we independently analyzed lesson plans for evidence of PCK, providing a glimpse at another aspect of teaching: the forethought and planning that went into teaching the lesson.

During coding and analysis we began to see similar themes emerging across participants, suggesting data saturation. Consequently, data reported in the findings and conclusions presented here will be taken from six of the participants. Specifically, during analysis and for triangulation purposes, we made the decision to reduce the data for reporting from 10 participants, to six (Patton, 2002). Data reduction can be an important part of the data analysis process (Miles & Huberman, 1994). According to Patton (2002) and Yin (2009), two methods of triangulation to test for consistency include triangulation of different data sources and among different evaluators. We based the data reduction on descriptions of the participants formulated from questions asked during the interview about agricultural production and education background, and 4-H/FFA participation. The six purposefully selected participants whose data will be reported here, exhibited a diversity of agricultural and educational experiences that were representative of the whole group. To be clear, data from all participants were analyzed and used in understanding and describing the phenomenon. Participant quotes presented here are characteristic of quotes from the whole group. As part of initial coding and for triangulation purposes, the remaining four transcripts were distributed to the other two researchers, who individually began reading through and marking relevant text

without the use of the codebook (Auerbach & Silverstein, 2003; Moustakas, 1994). The three of us then met to determine what about the structures of experiences were similar among the participants (van Manen, 1990). We used these researcher conversations to triangulate among the data sources and among the research team. We felt we had met data saturation through initial coding, triangulating the six selected participants' data with relevant text marked in the remaining four transcripts, discussions among the research team, and thorough review of field notes and lesson plans.

To provide transparency and ensure trustworthiness, member checking was employed on three different occasions during the study (Creswell, 2013). Two participants were provided with a synthesis of their interview, to confirm accurate interpretation of the data (Maxwell, 2013). In two other instances, feedback was solicited from participants about emerging conclusions (Maxwell, 2013). Additionally, as researchers and agriculture teacher educators, we attempted to acknowledge our own positions within the study and maintain reflexivity throughout data collection and analysis by recognizing and acknowledging that our own experiences, perspectives, and biases would directly influence the analysis and interpretation of findings (Creswell, 2013; Patton, 2002).

Findings

In the study of how to promote excellence through education, an on-going debate is whether “excellence is something fostered in individuals – by enhancing their inherent mental abilities, their knowledge, or their personal efforts to excel – or whether excellence is a product of particular institutional practices” (Ferrari, 2002, p. vii). Conversations prompting this study began with questions about the courses of action our agriculture teacher education program should take to help teacher candidates develop pedagogical content knowledge (PCK) through experiential learning opportunities, to develop their expertise in teaching. To reach this goal, we began with an exploration of the connections between experiential learning and PCK in agriculture teacher candidates.

We discovered *context* as an important theme which we used for describing the lived experiences of these agriculture teacher candidates. However, it became apparent an important delineation was needed to further explain context as a theme. In this study, the context in which participants learned content (i.e., context for learning) and the context in which they planned for and taught content for student understanding (i.e., context for teaching) were both evident, and quite distinct. We found the *felt need to learn* was an important component within the *context for learning*. Through the participants, we also learned how the *context for teaching* was shaped using context as a *filter* or *amplifier*, and the *learning environment*.

Context for Learning

In general, the experience learning content was equally as important as the content itself. Participants who had learning experiences that were interactive, commented on remembering and valuing those the most. Beth said, “I guess my memories of those classes that had those interactive components probably helped prepare me for what we’re doing now, because I know those were the classes I enjoyed most.” Rebekah, who purposely took a welding course at a community college before student teaching acknowledged the influence her learning experience had on her own teaching:

I took the welding class at Linn Benton fall term and that was super helpful and I think it was particularly helpful, not only for my own understanding of skill development, but I think it was also helpful that the welding teacher at LB was a former high school welding teacher...so he was kind of able to help develop the content a little differently for me, so that I could apply it in the classroom.

In some instances, participants compared various learning experiences related to content they were teaching. Morgan commented on her animal science knowledge which she developed through personal experiences and courses at a community college. She stated, "...it was easier to, it seems, looking back, it seemed like Linn Benton was easier to connect the curriculum that I was learning in class to the previous experience. Was that called 'schema'?" She continued comparing her experiences learning animal and plant science content:

...it seemed easier to be able to do that because I had a deeper experience of raising animals...at OSU when I took all my plant classes...because of the caliber, and the rigor of academic, choice of academics is, is higher... is more extreme... a lot of it was retained to pass an exam and I couldn't tell you where it went.

Cole remarked about the fact he had a variety of experiences related to plant science and hydroponics that made him confident to teach the lesson:

I kind of knew just the basics of plant growth and what they need as far as nutrients, just from my experiences on the farm and my experiences growing plants and some of my classes at Oregon State, I took a couple of classes where we talked about electrical conductivity and basically growing plants in a greenhouse system. So, I guess it was a combination of areas that I got that background knowledge from.

It was also evident when there had not been a prior learning experience in the specific content area, or when learning experiences in the content area had not made an impression that might have affected participants' teaching. Faith taught an agricultural leadership lesson on commitment. When asked about prior leadership experience, Faith responded:

No, I haven't taken any leadership classes. I think the closest thing is I was really involved with leadership in 4-H. Well, I guess I have taken a couple of leadership classes. I don't remember what class it was, though.

Rachel taught an agricultural science lesson on mitosis and meiosis. When asked about learning the content she answered,

I think I was taught it in high school, but my clearest memory is college...So, it was, I think, my junior year when I finally took those biology series. So only two years ago, but I didn't remember a lot.

The context in which previous learning experiences occurred contributed to how the participants thought about and planned for teaching. In some instances, it was evident the context for learning content was the only point of reference in their thinking about the content or planning to teach. In other cases, the immediacy in which the content needed to be learned in order to teach became altogether a different learning experience.

Felt Need to Learn.

The felt need to learn changed the dynamic of the learning experience. Depending on the particular content area, the teacher candidates often relied on direct instruction from the cooperating teacher, learned the content through planning to teach, or some combination of rapidly gathering content knowledge to be able to teach. Morgan indicated she felt fairly comfortable with the general content in the lesson, but had to re-learn the specific academic language to communicate with students. Faith stated:

Well, there was a teaching, like a teacher book for that curriculum...I read that and then I read the student's version also. And, [cooperating teacher] kind of walked me through what she does with that or what she planned to do with it. I don't know if she has ever used it. I think they're brand new books.

Rachel felt she possessed limited, surface-level content knowledge due to inadequate previous learning experiences and indicated her felt need to learn as well. She commented, "It did come back to me and I feel like I learned it better having taught it now than when I was trying to learn it in college because it was... just for the test...in college." The felt need to learn also emerged when talking about teaching shop-related agricultural mechanics courses with Rebekah, an area of content preparation in which the teacher candidates in this particular program often lack experience. She said:

I think that when I found out that I was teaching four shop classes, I kind of went into a panic mode and started talking to everyone I know about how I was going to be teaching four shop classes and that I was going to be lucky if none of my students blew anything up or lost any body parts.

Additionally, Beth reflected on her preparation for the reproductive systems animal science unit she was teaching and said, "When I started the repro unit for animal science, I mean, I spent a lot of hours just refreshing my memory on the content," another indication of the felt need to learn, or re-learn, content for teaching.

Context for Teaching

Whether or not participants were able to reflect on prior learning experiences to plan for teaching made a difference as to how they thought about the content. For instance, Faith referenced her lack of experience with the content to be able to deepen student thinking through sharing her own personal experiences. However, several of the participants were able to break down content for student understanding, based on their own learning experiences. Rachel said, "I had to review it and then I also had to read... I had to simplify it and modify it for my students." For Rebekah, learning how to weld helped develop the context for how she thought about teaching, "...because it was something that I was super invested in being good at and learning more about because it's not my skill set, and I wanted to be confident." When talking about how she plans for teaching, Beth stated:

But for me, I know learning these kinds of things, I always struggled with not being able to see it and I know a lot of kids struggle with that, so incorporating some kind of activity where they can see it always helps.

Cole utilized his personal experiences to break down the important concepts in the lesson for student understanding:

...most people, especially if they don't have any experience in hydroponics, they don't realize that you can grow plants without soil...so I think that was the most important thing: just for them to realize that there's another way to do it and, I guess some of the important things were realizing why you would want to grow it in water, just plain water, as opposed to having dirt medium.

He went on to say, "I think I spent a lot of time on those concepts just so the kids could understand why you would even want to grow something in a hydroponic system".

Evidence of the participants' thinking about the content was also found in their lesson plans. For instance, Rebekah's lesson plan was nothing more than a few jotted notes about the class opener and closer,

which is certainly not causal, but does potentially indicate some comfort facilitating students working in the shop and managing the time and activities. Rachel's lesson plan was also concise, although 50 minutes of the scheduled 75 minutes was to be used for watching a video, followed by a PowerPoint lecture with guided notes. The remainder of the time was allotted for an interest approach and review activity, likely an indication of her admitted surface-level understanding of the content.

Cole placed components of a hydroponics system on the tables in the classroom before students arrived. As an interest approach, he asked the students to work together and attempt to identify the individual components, then speculate about their purpose in a hydroponics system. This was an unscripted discussion, but highlighted Cole's personal knowledge of the components and willingness to use the context of the learning environment to guide students' thinking.

Context as a Filter or Amplifier

At times, participants were able to filter or amplify their own knowledge bases, based on the context for teaching. During the interview, Rachel, Beth, and Cole each identified the age, maturity, and abilities of their students, which contributed to how they thought about the planning for the lesson. In discussing her animal reproduction lesson, Beth said, "...reproduction was a hard concept for me to understand in high school until I got into college...I think by being in those classes it helped me understand how to kind of tailor that more to high school students...". Referring to her mitosis and meiosis lesson, Rachel said, "I had to simplify it and modify it for my students, so having to rewrite everything, um, that also helped me." She continued:

I didn't use the PowerPoint that I found...the bullet points were really long sentences...they used pretty big words. Some of them I even had to look up. And, it's a very, as we discussed earlier, a very content heavy subject. So, I didn't want them to sit there and stare at the screen.

Participants also selectively filtered content based on their own limited understanding, which likely influenced the delivery of the lesson. Morgan admitted not feeling confident with any content beyond what she taught in her animal science lesson, and Cole said:

There's times where I won't include something...because I don't feel super comfortable about all the material in it and so...if I tell them that and they ask me a question, a clarifying question, I might not be able to answer it real [*sic*] well.

The context for teaching was also evident in the way participants began to conceptualize teaching the lesson again and was generally based on the classroom environment in which they taught the lesson. Faith described having students who knew each other really well and had the tendency to be really talkative, which resulted in spending too much time on the front end of the lesson and not reaching the intended outcome because of lack of time, which she would manage differently next time. Related to her leadership lesson, she said, "We spent, like, almost twenty minutes talking about, um, or just brainstorming how a hundred percent effort must be made. And, I think it was way too much time." Participants also believed students preferred interactive and engaged learning, largely because those were the learning experiences that were more in-line with their own preferences for learning. For example, Beth stated:

...our labs were always pretty neat and interactive, like...the classes that I felt like I got the most from, you know, like our reproductive physiology class with [professor] I really liked because we had some really neat hands-on lab activities to do. Microbiology was another really cool one because we did a lot of things...

Morgan was the only participant in this group who had the opportunity to teach the same course at different times during the day, and used the time between the two class periods to filter or amplify her knowledge bases depending on her perception of the effectiveness of the first lesson, to prepare for the next class period:

I would test things in first period and I would make adjustments...if I needed to add any more detailed instructions; or if I needed...built in more time; if I could incorporate groups differently; I would adjust throughout the day.

While it was an unrelated content area, Rebekah also provided an example of a learning experience that directly informed that way she thinks about teaching. She said:

I was feeling really challenged in feed rations and so, [my high school agriculture teacher] had me sit down and plan out my feeding schedule from that day to fair and rate of gain and different fat contents and all that kind of stuff to figure out feed ratios... and so that was the way that she, kind of, adapted lessons to my needs.

Context was distinctly described in two ways, and it was evident that the context for learning and the context for teaching informed one another. Context proved to be an interesting point of reference as observers. Participants discussed the differences between teacher centered instruction and learner centered instruction and mostly indicated wanting to provide learner centered instruction, however, many of the observed lessons were quite teacher centered. When prompted about how the lesson could have been more learner centered or what could be done differently, participants began reflecting on and conceptualizing how they would prepare differently, amplify or filter the content for student understanding differently, or facilitate student learning differently.

Conclusions/Recommendations/Implications

According to Kolb (2015), the learner is responsible for their own learning, and while learning involves repeated practice, time spent practicing does not always equate to improved performance. Kruger and Dunning (1999) argued those who are incompetent (e.g., untrained, inexperienced) often reach incorrect conclusions and make poor choices, then fail to notice they have done so. We are fascinated with the manner in which teacher candidates manage to develop and transform their thinking about teaching and learning in such a short amount of time (during the student teaching internship) but still curious about how that development and transformation happens and how we can further encourage and foster growth through our teacher preparation programs. At the outset of this study, we were attempting to understand whether or not agriculture teacher candidates could learn all they need to know about becoming a teacher through their own experience, whether life experiences, educational experiences, or experiences in their teacher education program. But what if they lacked experiences related to the content area they were expected to teach? How would their limited classroom teaching experience influence their planning and execution of that plan? What do agriculture teacher candidates need to know or have the opportunity to do, to become effective agriculture teachers; we believed from both personal experiences and anecdotally, an understanding of agricultural content was simply not enough.

Conceptual Model for Teacher Development

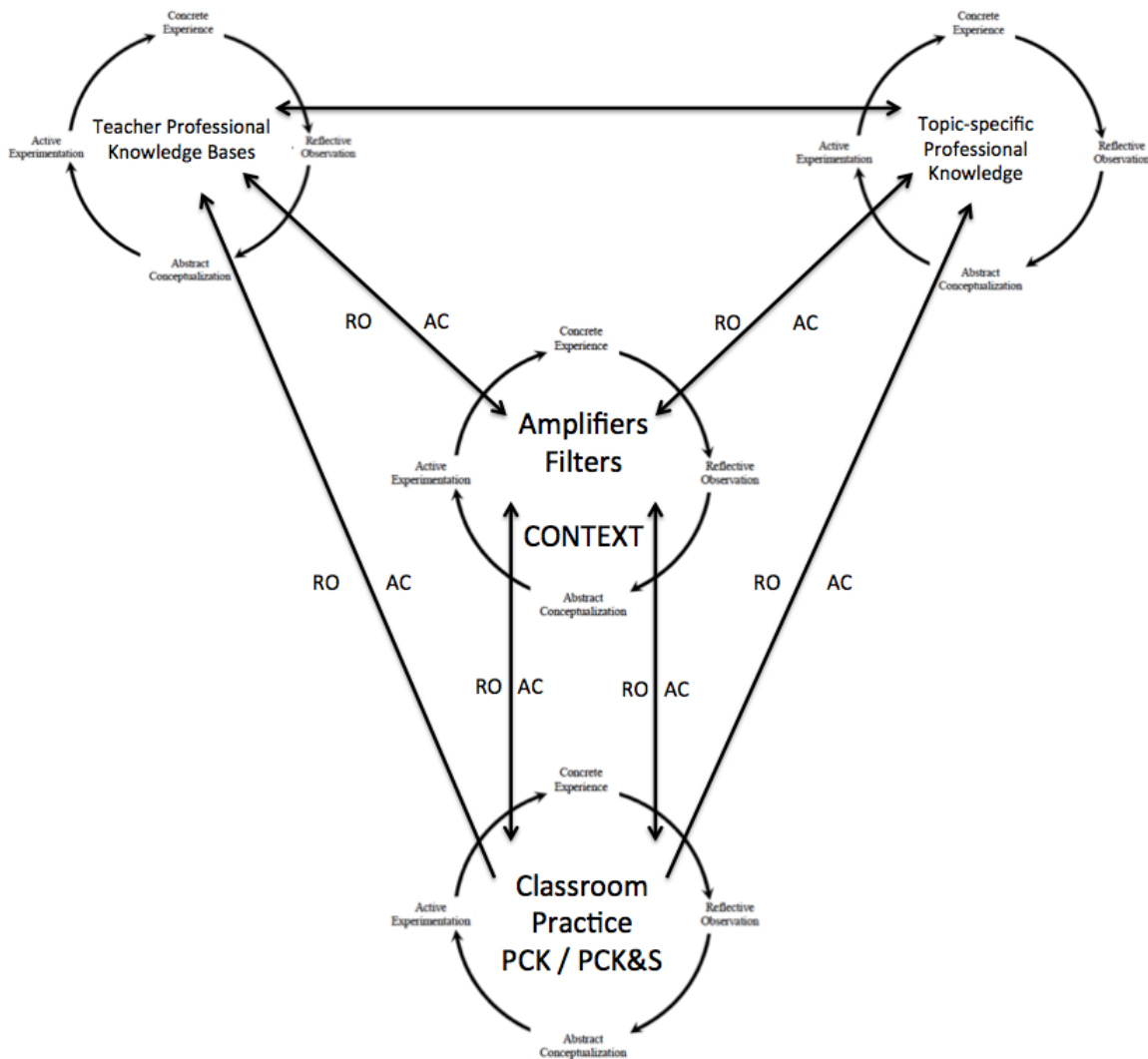
We developed a conceptual framework (see Figure 2) to help us synthesize relevant literature and think about how teacher candidates develop professionally. Our model represents and encourages constant re-evaluation of the knowledge bases necessary for teaching agriculture (PCK), primarily through grasping and transforming (Kolb, 1984) experiences (reflection and abstract conceptualization). While there may have been some evidence these participants were developing PCK, it is unlikely they understood what that

meant or had the vocabulary to describe it (Cooper et al., 2015). With limited teaching experience and no knowledge or understanding of the conceptual framework or the PCK model, participants were unable to explain specifically how they were merging content knowledge and pedagogical practices. Additionally, it is reasonable to assume the participants were only engaging in reflective practice because they were prompted to do so through the interview protocol.

Teacher candidates need to be given the tools to move beyond simply reflecting, to conceptualizing how experiences can be used for teaching. Zeichner and Liston (2014) posited, “Viewing teachers as reflective practitioners assumes that teachers can both pose and solve problems related to their educational practices.” (p. 5). Given the broad range of lesson topics that were observed for this study, using the conceptual framework to make sense of teacher candidates’ preparedness seems more effective than attempting to measure teacher candidate’s PCK for every subject area, which is consistent with previous work on reflective practice.

Figure 2

Conceptual Model for Teacher Development



Note. Reflective Observation (RO), Abstract Conceptualization (AC)

Dewey (1938/1997) believed all learning happens as the result of experience and both Kolb (2015) and Shulman (1987) posited expertise and knowledge are constructed through the transformation of experience. Because knowledge is constructed through the transformation of experience, we argue the development of teacher knowledge bases happens as a result of the experiential learning cycle (i.e., experience, reflective observation, abstract conceptualization, active experimentation), seen in the model surrounding the four main PCK components. The repetitive nature of experiential learning affords constant construction and re-construction of knowledge needed for teaching, assisting in the progression from novice to expert (Darling-Hammond & Bransford, 2005). The bi-directional arrow between the two knowledge bases indicates how they inform one another throughout preservice and inservice teacher development. Important to note is the fact that teacher professional knowledge bases (TPKB) and topic specific professional knowledge (TSPK) will always be filtered or amplified based on teacher beliefs, orientations, prior knowledge, and context (Gess-Newsome, 2015). Amplifiers and filters afford teachers the ability to accept, reject, or change new knowledge during teacher education, inservice training, or classroom practice. Any effect new knowledge, policy, administration, teaching method, or content, may have on students' learning "will be filtered through teachers, mediated by what teachers believe and know and are able to do" (Thompson & Zeuli, 1999, p. 349).

Kolb (2015) expressed the need for individuals to develop topic-specific knowledge, and called for a conceptual framework to explain how knowledge is retrieved and then transferred to other contexts, arguing iterations of the experiential learning cycle foster the deliberate practice needed to develop expertise in teaching. Within our conceptual model for teacher development, the bi-directional arrows between the knowledge bases, and amplifiers, filters, and context, represent how teachers utilize amplifiers, filters, and context to adapt knowledge bases for teaching, which is then realized in classroom practice. The experiential learning cycle surrounding each section of the model represents the recursive and deliberate practice needed to develop these items. "In a certain sense every experience should do something to prepare a person for later experiences of a deeper and more expansive quality" (Dewey, 1938/1997, p. 47). As such, we argue the power of Kolb's (1984) experiential learning cycle is in the reflective observation and abstract conceptualization steps, which are critical for directly informing how knowledge bases are developed, amplified or filtered, and utilized in classroom practice. Accomplished teachers assess their own effectiveness through reflection and modification (Bransford et al., 2000). Reflection-on-action and reflection-in-action (Schön, 1983) each plays a significant role in experiential learning and the development of PCK.

We consider this conceptual framework to be an analytical tool used to explore the development of the knowledge bases needed for effectively teaching agriculture. We have also begun incorporating the framework into the lead researcher's teacher preparation program to help teacher candidates understand their own reflection-on-action and reflection-in-action (Schön, 1983) and the benefits of reflective teaching, which aligns with recommendations from Rice and Kitchel (2017a) to introduce teacher candidates to a framework for PCK that can be utilized for shaping their PCK and embedding reflective practice into teacher preparation programming. It may also be helpful for teacher candidates to use this framework to visualize how they implement amplifiers and filters in their own pedagogical practices. As previously stated, teacher belief systems directly influence the development of agriculture teachers' development of PCK (Rice & Kitchel, 2017a, 2017b, 2018), and utilizing this framework could help teacher candidates illuminate their own beliefs and experiences (i.e., amplifiers and filters) to explore how they shape their PCK in particular content areas. Perhaps a future study could ask teacher candidates to identify specific amplifiers and filters related to teaching specific content to specific students.

Knowledge Bases and Amplifiers/Filters

In relation to the conceptual framework, these participants generally exhibited underdeveloped knowledge bases for teaching. Perhaps that is to be expected, given their limited time spent preparing

content for teaching and being directly involved in teaching practice. Rice and Kitchel (2015a) and Wooditch et al. (2018) also found inadequate content knowledge foundations in teacher candidates and early career teachers, which limited PCK development in their study participants. In addition, for the teacher candidates in our study (with the exception of one or two), amplifiers and filters they might apply to these knowledge bases were also mostly limited by their lack of experience. In both of their 2017 papers, Rice and Kitchel (2017a, 2017b) found participants' integrated beliefs (i.e., amplifiers and filters) had a direct influence on shaping their PCK. However, these were veteran teachers with a minimum of eight years of teaching experience (Rice & Kitchel, 2017a, 2017b). The participants in our study were teacher candidates with somewhat limited content and very limited teaching experience to inform their amplifiers and filters. Expertise in teaching, developed over time, directly affects how knowledge is organized and explained, what the teacher notices, how problems are solved, and how adaptive the teacher is able to be (Bransford et al., 2005). According to Hammerness et al. (2005), teachers understand and process new information based on their prior experiences and beliefs. Additionally, they may be unable to apply new understanding or ideas that are not directly connected to their prior experiences or developed schemas (Hammerness et al., 2005). A teacher education program is limited by time spent with teacher candidates. In fact, according to Zeichner and Liston (2014), "...no matter how good a teacher education program is, at best it can only prepare teachers to begin teaching." (p. 6). However, perhaps utilizing the conceptual framework to foster the ability for teacher candidates to not only reflect on their prior learning experiences, but also move beyond reflection to conceptualizing practical applications of their learning experiences in their planning and teaching, is an important step in teacher candidates learning how to develop their own PCK during the novice stage of their teaching career. Future research could explore learning transfer and investigate whether or not, or how teacher candidates transfer learning from past experiences to current teaching experiences.

The Importance of Context

We found context to be relevant to participants' PCK, which aligns with models of experiential learning contexts proposed in agricultural education (Coleman et al., 2024; Roberts, 2006). Rice and Kitchel (2017b) also reported that context had an influence on teachers' PCK. They found the local community, intra-curricular programming, and the school environment (e.g., program structure and available resources), all functioned as contextual influencers. In our study, participants may very well have been constructing their own knowledge in attempting to learn content for teaching agriculture, although the contexts in which they were constructing this new knowledge was critical to their own learning or re-learning in order to teach. In addition, the contexts in which our participants were teaching the content shaped their thinking about PCK, whether they identified their classroom practice as PCK or not. "Abstract representations are meaningless unless they can be made specific to the situation at hand" (Lave & Wenger, 1991, p. 33). This is the case with Kolb's (1984) learning cycle where abstract conceptualizations are contextualized through active experimentation, and also evident in the newest published holistic model of experiential learning (Coleman et al., 2024). An observation of one lesson might be enough for researchers (or the teacher) to begin to identify developing PCK and possibly even reflection-in-action, but the opportunity to see evidence of how reflection-on-action informs knowledge bases and how amplifiers and filters are implemented into the re-planning of the same content could be a valuable investigation to highlight how knowledge bases develop over time and through repetitive practice (Dewey, 1938; Edwards & Thompson, 2010). "Growth is continuous and coherent, achieved in an incremental sequence moving from novice to expert performance" (Schneider, 2015, p. 163); perhaps a teach and re-teach model within teacher preparation programs as suggested by Henderson and Stewart (2017) would be useful for both PCK development and future data collection.

Participants in this study provided evidence of the context-specific nature in which they had learned content for teaching. This context-specific, situated learning (Lave & Wenger, 1991) provides confirmation for our conceptual model for teacher development in which teacher professional knowledge bases and topic-specific professional knowledge are developed through the reflection on and application of specific

experiences (i.e., the experiential learning cycle). For these participants, the learning of these knowledge bases needed for teaching was situated in practice, presumably the reason they felt they had learned more from preparing to teach the content than learning the content in the context of a college classroom. Rice and Kitchel (2015a, 2016a) also found evidence that teacher candidates were largely unsatisfied with their content knowledge preparation which resulted in coping strategies enacted during planning for teaching, as well as in-the-moment reactions during teaching to overcome or cope with content knowledge deficiencies. Future studies could seek to measure and document reflection-in-action (Schön, 1983) practices of teacher candidates during teaching observations.

PCK is the merging of knowledge bases needed for teaching (Shulman, 1986), and because the knowledge bases inform each other (Gess-Newsome, 2015), a deficiency in one knowledge base often results in a change in the other. Because the context in which participants learned the content varied from the context in which they were preparing to teach the content, the result was often to fall back on a teacher-centered lesson design and delivery. The *felt need to learn* offers an interesting perspective on how teachers develop the knowledge bases needed for teaching (e.g., learning or re-learning content solely for the purpose of being able to teach it), and for these participants, lessened their effectiveness at teaching the content. In some cases, we saw evidence of this in the lack of depth of critical thinking, both in planning and in student performance, and in the lack of ability to extend questioning, connect the content to personal anecdotes, or make the content relevant for students. This deficit in content knowledge was even more exposed when the participant had not had any prior learning experiences related to the content. This is presumably the case among many teacher candidates and early career teachers. “For beginning teachers, the narratives and metaphors [used in teaching] are constructed from their lives as students and initial understandings and practices of teaching and schooling. More years in the classroom provide additional material from which to draw upon.” (Zeichner & Liston, 2014, p. 37). How can we further leverage opportunities in teacher preparation programs to have all candidates work with lessons for which they have no background experiences?

When prompted, the participants began to reflect on their own teaching, and perhaps prior learning experiences, to conceptualize how or what they would change about the lesson given the opportunity to teach it again. Arguably, if teacher candidates are to be expected to reflect and conceptualize, perhaps this re-teaching opportunity should be an important component of teacher preparation programs as this engagement with the same content across multiple levels and in multiple opportunities may be key to reaching another level in their understanding of how students learn content.

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