PRESERVICE AGRICULTURE TEACHERS DEVELOPMENT OF KNOWLEDGE OF CONTENT AND STUDENTS DURING THEIR STUDENT TEACHING EXPERIENCE

by

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Table of Contents

Abstract

The central research question that guided this study was: how does PCK develop in the area of KCS within the unit of plant growth and development among Arizona agriculture preservice teachers? This research was conducted using a multi-case study design where each preservice teacher served as an individual case. Five preservice teachers were interviewed, observed teaching a lesson and had lesson plans analyzed throughout the student teaching experience. There were 6 major themes that emerged from the data: evolving beliefs of agricultural education, underutilization of lesson plans, emphasis on hands-on "learning", student motivation is primarily external, instruction shifts from teacher preferences to student needs, and college classes as the dominate source of content knowledge. These themes support future research on KCS development over the course of a teachers' career including experienced teacher KCS development. Additionally, further exploration into the influence of hands-on education in agricultural education is needed. Recommendations for practice include: increased focus on knowledge of students in preservice education, clear instruction on how to break down content for high school students, and deep, consistent reflections to encourage belief development over the student teaching experience.

Keywords: Pedagogical Content Knowledge, Knowledge of Content and Students, Preservice Agriculture Teachers

Introduction

In 2016, 721 agriculture teachers that taught the previous year were not going to return (Smith, Lawver, & Foster, 2017). According to agriculture teacher preparation programs only 508 graduates were planning to enter school based agricultural education (SBAE), leaving 30% unfilled (Smith, Lawver, & Foster, 2017). Additionally, 175 of the agriculture teacher positions posted were newly created positions, with 149 schools opening a school-based agricultural education program for the first time (Smith et al., 2017). These employment opportunities demonstrate a strong desire within school districts for both qualified agriculture teachers and high quality SBAE programs across the United States. However, despite demand for these positions and programs, 26% of agricultural education majors that graduated from an accredited teacher preparation program did not pursue a career in SBAE (other paths include: graduate school, teaching another subject, production agriculture etc.) (Smith et al., 2017). This study intends to improve teacher preparation programs execution of the student teaching experiences to increase retention rates in SBAE.

Among the numerous responsibilities of post-secondary agricultural education departments, there remains a strong pressure to meet the demand for agriculture teachers through comprehensive preservice teacher education and preparation (Myers & Dyer, 2004). The goal is for these graduates to enter the classroom as agriculture teachers after completing their degree. This is achieved through instruction in content knowledge and pedagogy cumulating in the student teaching experience. Specifically, novice teachers in various academic disciplines purport student teaching was the most significant and impactful component of their teacher preparation programs that led to them pursuing a career in education (Levine, 2006). In agricultural education specifically, novice teachers claimed student teaching was the most

influential experience in developing their content knowledge and pedagogy (McKim & Velez, 2017), increasing their likelihood to enter and remain in the profession.

There are strategies teacher preparation programs can use to enhance the student teaching experience. Teacher preparation programs that provided more oversight during the student teaching process supplied significantly more effective teachers in a variety of disciplines to first year schools in New York (Boyd, Grossman, Lankford, Loeb, & Wyckoff, 2009). Teachers who engaged in real-world teaching practices, such as listening to students read aloud for assessment, facilitated greater student achievement in their first year (Boyd et al., 2009). This combination of content knowledge and pedagogical knowledge utilized by the teachers in these studies contributed greatly to their effectiveness in the classroom (National Research Council, 2010). Shulman (1986) described this knowledge base specifically for teaching as pedagogical content knowledge (PCK). PCK is defined as the knowledge of, reasoning behind, and enactment of the teaching of certain topics in a particular way, with particular students, for certain reasons, for enhanced student outcomes (Berry, Fredrichsen, & Loughran, 2015). Student teaching is an opportunity provided to preservice teachers to integrate content knowledge and pedagogical knowledge and develop PCK in a capstone field experience. Because of its documented impact, student teaching and the quality of that experience is important to examine when addressing the preparation of teachers, their knowledge development, and their decision to pursue a career as an agriculture teacher upon graduation (McKim & Velez, 2017).

While PCK is developed over time due to experience (Hashweh, 2005), preservice teachers can begin their development of PCK during their teacher preparation programs (Magnusson, Krajcik, & Borko, 1999). Agriculture education has had little research conducted on preservice teacher PCK as compared to other education disciplines. Rice and Kitchel (2015a)

explored teaching knowledge in preservice teachers, but primarily focused on content knowledge acquisition. If teacher preparation programs facilitate the beginning stages of PCK at the preservice level, they could produce more prepared teachers that are twice as likely to remain in the profession (Gardner, 2006). While PCK has been studied for practicing agriculture teachers (Rice & Kitchel 2015b; 2016a; 2016b; Stewart, 2017; Rice, 2015), there is a need to study preservice agriculture teacher development. At the 2012 PCK Summit, (a conference held for science PCK experts to reach a consensus on defining, measuring, and researching PCK) one of the proposed areas for future research was PCK development during teacher preparation (Berry et al., 2015). Finally, the American Association for Agricultural Education Research Agenda includes research aimed at the clarification of the purpose and activities involved in field based experiences, under research priority 5: efficient and effective agricultural education programs (Roberts, Harder, & Brashears, 2016). It is recommended preservice teachers engage in additional opportunities to develop PCK to become more effective teachers (Magnusson et al., 1999).

Review of Literature

Shulman (1986) described the history of teacher preparation and evaluation as being too focused on either content knowledge or pedagogical knowledge as separate entities. Shulman (1986) suggested knowledge for teaching included understanding content knowledge for the purposes of teaching. Shulman described three categories of content knowledge: subject matter content knowledge, PCK, and curricular knowledge. Of these three categories, PCK is arguably the important knowledge base for quality teachers to possess (Mishra & Koehler, 2006).

The most current and widely accepted definition of PCK was created at the 2012 science PCK summit (Berry et al., 2015). It is important to note agriculture teachers perceive agricultural

education as an applied science making it most relatable to science education (Warnick, Thompson, & Gummer, 2004). PCK is also topic specific, which means a teacher's PCK can vary from topic to topic (Loughran, Berry, & Mulhall, 2012). Despite Shulman (1986) coining the term PCK over thirty years ago, Abell (2008) theorized that PCK is still very relevant and practical for describing teacher knowledge and preparing quality future teachers.

Novice agriculture teachers described themselves as deficient in regard to content knowledge in agriculture (Rice & Kitchel, 2016b). While research shows that quality, experienced teachers possess knowledge at the intersection of content knowledge and pedagogical knowledge, there is still a need to develop novice and student teacher's PCK (Berry et al., 2015). Chemistry student teachers displayed strong content knowledge in the macro and micro meanings of chemistry concepts but struggled to present it to students without making mental jumps the students couldn't follow (De Jong & Van Driel, 2004). These challenges only appeared after the act of teaching; during the lesson planning stages the preservice teachers did not report difficulties (De Jong & Van Driel, 2004). To address this problem, De Jong and Van Driel (2004) recommended student teachers engage in microteaching prior to the student teaching experience. Additionally, they suggested student teachers receive more general information on the prior knowledge of their students.

Content Representations (CoRes) have also been a useful tool for developing PCK during preservice teacher education (Hume & Berry, 2011). CoRes are written representations of how a community of teachers thinks about the knowledge needed to teach a particular topic (Berry et al., 2015; Loughran, Mulhall, & Berry, 2004). Some aspects captured in a CoRe template are: what the teacher intends the student to learn, what about the content is important, what the teacher knows about the content but does not what to teach yet, and potential difficulties with

teaching the content (Loughran et al., 2004). If CoRes are utilized in conjunction with scaffolding techniques, there is great potential for this tool to aid in PCK development in preservice teachers (Hume & Berry, 2011). As additional research emerges on PCK at the preservice level, teacher educators can adjust their curriculum to develop PCK earlier in their teacher preparation programs leading to more prepared teachers (Ballantyne & Packer, 2004).

Theoretical Framework

The most current and widely accepted framework for PCK within science education comes from the 2012 PCK summit (figure 1) (Berry et al., 2015). It is important to note that this framework draws thin lines between concepts and many examples can fall into one or more categories. The framework begins with five overarching teacher professional knowledge bases (TPKB): assessment knowledge, pedagogical knowledge, content knowledge, knowledge of students, and curricular knowledge (Berry et al., 2015). The summit recognized other categories of knowledge could be included (e.g. industry knowledge) (Berry et al., 2015). Knowledge in the TPKBs category is not discipline specific. Particularly, knowledge of students, a knowledge base that guides this study, was described as understanding students as individuals and tailoring education for each student (Berry et al., 2015). Although TPKBs identify knowledge of students as a knowledge base, due to the interconnectedness within PCK, the framework in its entirety was needed to understand KCS development.

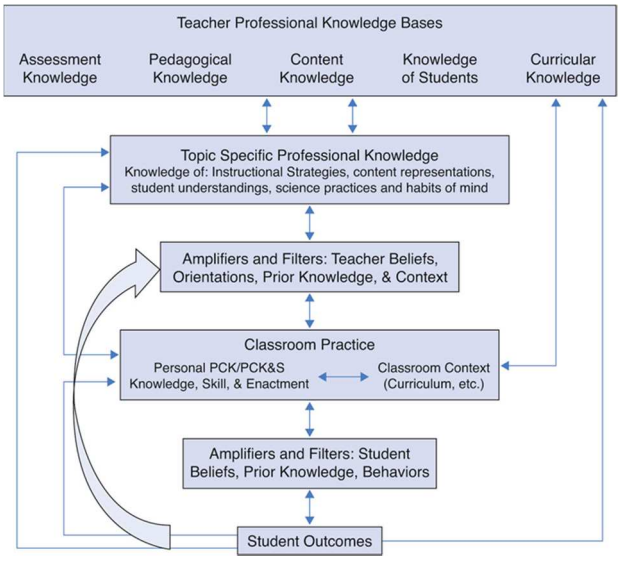

Figure 1. Framework of teacher professional knowledge and skill including PCK and influences on classroom practice and student outcomes (Berry et al., 2015).

Teacher professional knowledge bases influenced topic specific professional knowledge and vice versa. For example, within the topic of forces and motions for a third-grade classroom, a teacher would use their content knowledge and knowledge of students to create a content representation of pushing a student on a swing, utilizing their teacher professional knowledge and topic specific professional knowledge (Berry et al., 2015). In topic specific professional knowledge, the content is broken down to a topic level. An example of topic level content in agricultural education, and the one selected for this study, is plant growth and development. This section is where subject matter, pedagogy, and context begin to coalesce. This knowledge is still part of the public body of knowledge created by experts in the field. This knowledge is used to determine effective instructional strategies such as which representation to use for teaching a particular topic. Currently, topic specific professional knowledge is one of the most defined knowledge bases through CoRe (Berry et al., 2015).

The arrows between teacher professional knowledge bases and topic specific knowledge bases are bi-directional because growth in one can lead to growth in another. To describe this

Berry et al. (2015) uses deductive and inductive models. In a deductive model, the scope would move from the general (teacher professional knowledge bases) and use the specific (topic specific professional knowledge) to test it. An example of this is all men are mortal, Daniel is a man, and therefore Daniel is mortal. In an inductive model, the scope would be viewed in the opposite manner. For example, if Daniel is a grandfather, and Daniel is bald, then all grandfathers are bald. Either way, one can influence growth or understanding of another.

These two knowledge bases, teacher professional knowledge and topic specific professional knowledge, are then filtered through the lens of teacher's beliefs, orientation toward specific instructional strategies, prior knowledge, and the current context of the teacher. This is where the individual teacher chooses to embrace, reject, or modify discipline knowledge. This decision varies depending on the teacher's beliefs, preferred instructional strategies, and how they organize their curriculum. The prevalent arrow on the left of teacher's beliefs that stems from student outcomes indicates student outcomes are the primary driver of changing a teacher's amplifier or belief. The difference between an amplifier and a belief is an amplifier will enhance change already in practice while a belief would oppose a change. An example of an amplifier is the release of a new set of curriculum standards that emphasizes what you already believe is important. A teacher's commitment to teaching, what they believe is important, would be considered an amplifier for the change in practice (Berry et al., 2015). An example of a filter would be if a teacher believed teaching is didactic in nature and is then presented with student centered learning strategies and methods. If the teacher rejected or opposed these strategies due to their belief, then their belief is acting as a filter to the knowledge base presented to them (Berry et al., 2015).

The next section of the framework is classroom practice, where teacher professional knowledge, topic specific knowledge, and amplifiers and filters are combined into actions. This knowledge can emerge due to the realities of the classroom environment and events, such as a student asking a clarifying question. It is best described as the act of teaching. This knowledge is always fluctuating and is very topic specific due to the fact that it is an in-action component of the overall framework.

Following classroom practice in the framework are student amplifiers and filters. This section acknowledges how students' background and beliefs affect the learning process. This is similar to the teacher's amplifiers and filters, but it is focused on the lens of the student. This lens could include students' social-economic status, background knowledge of the subject, or parental involvement. The last section of this framework is student outcomes. This section highlights the performance of the student and is the end goal for education. It is also the only portion of the framework that influences the framework as a whole. For example, if student performance is low on a state standardized test, this could influence research, a teacher's belief, how a teacher chooses to present content or how the student feels towards school.

Knowledge of Content and Students

This study will utilize the 2012 PCK summit framework as a guide for exploring Knowledge of Content and Students (KCS) in both the phases of preparation and practice. KCS is a subset of PCK, which is why the PCK framework is useful for this study (see Figure 2). Hill, Ball, and Schilling (2008) defined KCS as, "content knowledge intertwined with knowledge of how students think about, know, or learn this particular content." (p. 375). An example of KCS could include addressing the misconception that the main job for plant leaves is to capture water. Using this knowledge, a teacher could generate interest by beginning a lesson with asking

students where they believe plants receive their oxygen (Köse 2008). In the PCK summit framework, KCS is a form of a topic specific professional knowledge and it takes into consideration student understandings to adjust how content knowledge is utilized and presented (Hill et al., 2008). KCS could be used by the teacher when selecting an image or theme to address a student misconception or deciphering the thought process used by a student when they answer a question incorrectly.

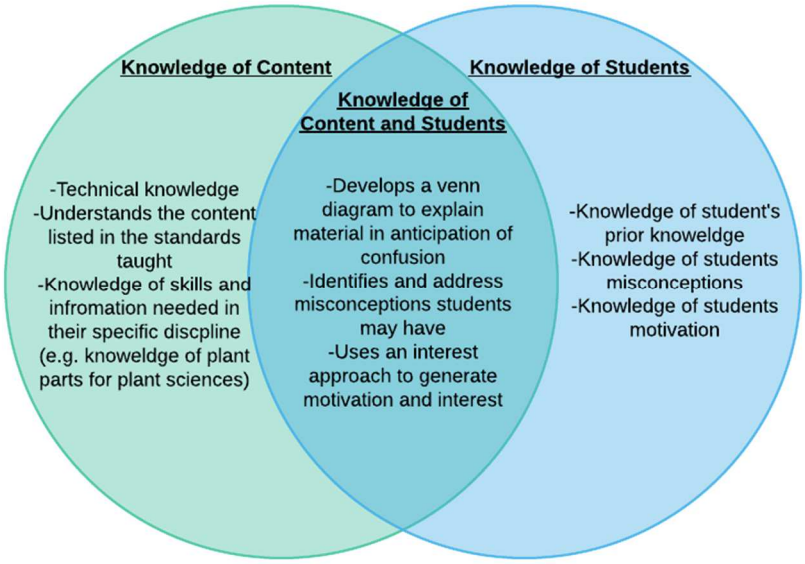

Figure 2. Diagram depicting the combination of content knowledge and knowledge of students to create KCS

The National Board for Professional Teaching Standards (NBPST) (2016) specifies Career and Technical Education (CTE) (the umbrella that agricultural education falls under) educators must be dedicated to meeting the needs of a diverse body of students, which is an important component of KCS. Even experts in content areas often struggle to remain aware of novices' misconceptions when explaining an idea (De Jong & Van Driel, 2004). As with PCK in

general, studies have been conducted to operationalize KCS. In mathematics, KCS was utilized through the examination of: common student errors, students understanding of content, student developmental sequences, and common student computational strategies (Hill et al., 2008). Additional areas influenced by KCS include misconceptions, learning difficulties, students' motivation and interests, and the felt need to learn by students (Berry et al., 2015).

Even though there is no single definition for KCS across education disciplines, many researchers have explored KCS or related concepts. Preliminary KCS research suggests a need to develop this knowledge within teachers (Hill et al., 2008; Ball et al., 2008). For example, a common component of KCS is being aware of student misconceptions. One misconception identified for students in plant growth and development, the topic utilized in this study, is plants get their food from the soil through their roots (Köse, 2008). A teacher could use their KCS to address this misconception and ensure students understand plants receive their food through the process of photosynthesis. This research will aim to identify KCS and describe how preservice teachers develop KCS during the student teaching experience.

Purpose of the Study and Central Research Question

The purpose of this study was to describe how Arizona agriculture preservice teachers develop their KCS within the topic of plant growth and development. Berry et al.'s (2015) research focused on modernizing and unifying PCK was a driving force in developing our central research question: how does PCK develop in the area of KCS within the unit of plant growth and development among Arizona agriculture preservice teachers? This study provides guidance to agriculture teacher preparation programs by tracking the current development of KCS in preservice teachers throughout their student teaching experience.

Methods

This research was conducted using a multi-case study design where each preservice teacher served as an individual case. This allows the researcher to examine a specific moment of time (in this case the student teaching experience during spring of 2018) and locate trends that could apply to similar cases (Yin, 2014). A quality case study consists of multiple data sources such as interviews, observations with field notes, and a written document analysis (Creswell, 2013). This allows the researcher to examine the phenomena from multiple angles and determine if the trends are present throughout the case or cases. This project used a collective case study, which means there were multiple cases examined for the same issue or phenomena (Creswell, 2013). This method was chosen to examine KCS in depth from multiple perspectives to identify trends. Case studies also focus on answering how or why questions (Yin, 2014), which fits with the primary research question. The case study method is used when observing a real-life, bounded system over time through multiple data points in great detail (Creswell, 2013; Yin, 2014)

Description of the Case

Since PCK is topic specific (Loughran et al., 2012), this study only focused on agriculture preservice teachers teaching topic specific knowledge in the area of plant growth and development (Loughran et al., 2012). This topic is congruent with Arizona CTE standard 5.0, which states the student will be able to describe plants growth and development (Arizona Department of Education, 2016). This standard includes indicators such as identifying plant parts and function and exploring methods of classifying plants. This particular standard was chosen because the majority of the preservice teachers were teaching it within one of their classes, as it is a common standard in Arizona. Additionally, the researcher had the expertise in this area to

accurately identify KCS and PCK. The unit of analysis in this case study was the individual preservice teacher, who each taught plant growth and development in the spring of 2018 at their cooperating school. To be selected in this study, the preservice teachers had completed a curriculum development course, a teaching methods course, and were enrolled in the student teaching internship for the spring 2018 semester. Additionally, all participants must have taught Arizona CTE standard 5.0, describing growth and development (Arizona Department of Education, 2016).

Participants

Participants in this study consisted of a purposive sample of five UA preservice teachers that were completing their student teaching internship in the spring of 2018. Of the eleven original preservice teachers, four UA preservice teachers were not chosen since they were not teaching plant growth and development and two opted out of the study. Preservice teachers were chosen to determine how KCS is developed in the area of plant growth and development over the course of the student teaching experience. Preservice teachers consisted of two undergraduate seniors and three graduate students all achieving certification. Background knowledge and experiences varied among the preservice teachers and are outlined in tables 1 and 2. Table 1 includes the participants: year in school (i.e. undergraduate senior or graduate student), previous work experience in plant science (e.g. working on a farm or in a nursery), previous plant science courses at UA (e.g. plant genetics), whether or not they were enrolled in high school agriculture, and any other previous teaching the participant experienced. The purpose of this table was to describe the background knowledge or development a preservice teacher may have had in plant science prior to this unit. Table 2 includes a description of the cooperating sites including: number of agriculture teachers, agriculture program focus, facilities available, the classes where

the unit was taught, and the number of students in each class. The purpose of this table was to describe the facilities and situation a preservice teacher is in to provide context that could influence the findings. One class was chosen to observe at each site and was the 9th grade class if available. The tables below provided a clear picture of the backgrounds and resources each preservice teacher had.

Table 1
Preservice Teachers' Background and Prior Knowledge in Plant Science

Pseudonym	Year in School	Previous Work Experience in the Plant Sciences	Previous Plant Science Courses at the UA	Previous High School Agriculture Enrollment	Other Teaching Experience
Josh	Graduate Student	None	Crop Science, Plant Genetics	No	TA at UA
Spencer	Graduate Student	USDA-plant research	Plant Genetics, Field Botany	No	Preceptor at UA
Maddie	Undergraduate Senior	None	Plant Genetics, Plants and our World	Yes	State FFA Officer
Lilly	Undergraduate Senior	None	None	Yes	State FFA Officer
Kelly	Graduate Student	Department of Game and Fish	Rangeland, Intro to Plant Science, Forestry	No	TA at UA

Table 2
Preservice Teacher Cooperating Site Descriptions

Pseudonym	Single or Multi-teacher	School Program	Facilities Available	Classes where unit was taught (Grade Level)	Number of students in class
Josh	Single	Plant	Land lab, Greenhouse	Freshmen Agriculture	22
Spencer	Single	Plant	Farm, Greenhouse	PALS	16
Maddie	Multi	Business	Greenhouse	PALS	24
Lilly	Single	Animal	Greenhouse	Intro to Agriculture (9^{th})	32
Kelly	Multi	Agribusiness	Greenhouse	8^{th} grade	26

*PALS is Plants Animals Leadership and Scholarship intended for 1^{st} year agriculture students

Epistemology

This case study research was grounded in Yin's (2014) case study design and approached through a pragmatic lens. Yin (2014) views case studies as being able to observe a process, which is in line with pragmatism. Pragmatism can be described as worldviews changing as they are experienced through people (Yazan, 2015). For example, how I see one event happening can vary if looked through the lens of another person viewing the same event. Additionally, pragmatists believe that reality cannot be separated from the researcher due to the belief that reality varies as experienced by people. Other researchers who utilize Stake as their primary guide for case study research view the case as an object and not a process (Yazan, 2015); further substantiating my choice to use Yin (2014). My investigation was one of inquiry because I attempt to answer the "how" and "why" questions pertaining to my area of focus (Yin, 2014; Goldkuhl, 2012). Finally, due to my pragmatist view, I will evaluate knowledge in terms of how it useful or used in action specific to each participant (Goldkuhl, 2012).

Positionality Statement

It is important that I address my positionality to discuss my expertise and address any possible biases that may become evident in this study (Creswell, 2013). I student taught for a semester, which provided experiences that have shaped my view of teaching. In student teaching, there is a steep learning curve in the first few weeks. One of the most difficult components of student teaching for me, as well as for others in my cohort, was tailoring and changing the curriculum based off of students' experiences, questions, and interests. This struggle led to my interest in KCS and how it develops over the course of the student teaching experience.

Additionally, I was a product of a high school agriculture program; which had a strong focus in the plant sciences, specifically nursery and greenhouse management. My high school agriculture program was tailored towards students without any prior agriculture experience or knowledge, which helped me feel comfortable immersing myself into the program. I was able to take this content knowledge gained and transfer it to employment at my landscaping business. I also worked in a nursery to financially support myself throughout my undergraduate degree. When I was a senior in college and began developing my own curriculum, I noticed despite my plant science knowledge, it was not easy to tailor that knowledge to teaching. I had to consider various other factors that affected the students, such as how much do I want them to know, what are they interested in, and what can help them obtain future employment in the community. In meeting with other members of my student teaching cohort, I found I was not the only one experiencing similar struggles. In fact, each preservice teacher in my cohort reported issues with adapting content knowledge. My hope is this research will help preservice teachers from all backgrounds utilize their strengths in curriculum development more effectively.

Data Sources and Collection

A quality case study analyzes the case(s) from multiple data sources such as interviews, observations and analysis of written documents (Creswell, 2013). PCK, and specifically KCS is best captured through a combination of tools and data sources (Morrison & Luttenegger, 2015). I collected the following data sources for each preservice teacher: pre-observation interview, post-observation interview, observation with field notes, and lesson plan analysis. A timeline of these data sources are shown in figure 3. A pre-interview was conducted prior to the preservice teacher beginning the unit and a post interview was conducted after the completion of the unit. Pre-interviews were used to evaluate the knowledge a preservice teacher used to create and prepare for the unit. Post-interviews were used to have the preservice teacher reflect on how their knowledge was used and what they would change when re-teaching the unit. Additionally, I observed each preservice teacher during one lesson of the unit. Observations allowed me to see PCK and KCS in action. I was able to view how KCS was enacted in teaching, not just how it used in the planning or reasoning of teaching. Lastly, the lesson plans for the unit were examined for KCS. Examining lesson plans allowed for document analysis on each case. The use of these four different sources of data provided multiple angles and increased depth of information over the course of the single unit (Yin, 2014).

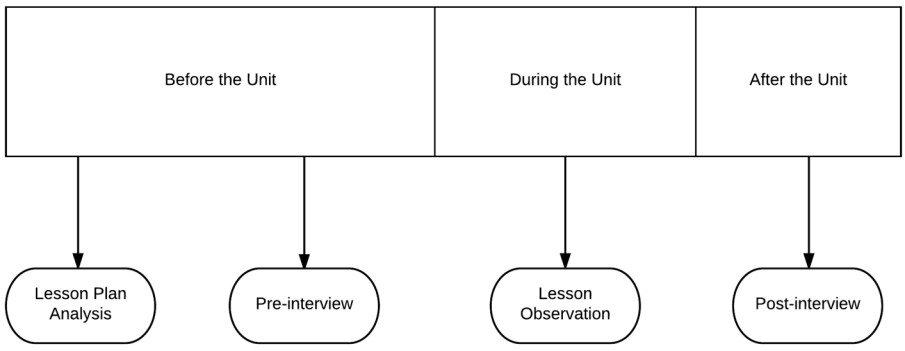

Figure 3. Data Collection Timeline

Each method of data collection was chosen to surface internal knowledge the preservice teacher possessed. The first data collection point was a semi-structured pre-interview lasting 30-60 minutes. The purpose of this interview was to explore whether or not the preservice teachers were connecting content to students before the unit was taught. This was intended to help the preservice teacher articulate their knowledge and thoughts. Questions were modified from Rice and Kitchel (2016b) who conducted a similar study on KCS with early career agriculture teachers. A sample question was: what specific teaching strategies do you plan to use when teaching plant growth and development?

The 30-60 minute post-interview was conducted after the unit was taught. This data source was chosen to explore if the preservice teacher felt they incorporated KCS into their unit during their teaching. Interviews have been found to be a useful in surfacing PCK and KCS as well as recommended for PCK studies (Hill et al., 2008; Magnusson et al., 1999; Park & Oliver, 2008). Similar to the pre-interview, this provided an opportunity for the preservice teacher to articulate their knowledge and also reflect on the unit. An example question was: what aspects of this unit (if any) contributed to your understanding of student learning for teaching this unit in the future?

One lesson was observed during the teaching of the unit. The first lesson and last lesson in the unit were avoided to ensure the lesson was not a review or introduction. Observations with field notes were chosen to see the translation of lesson plans into action (Grossman, 1990). This is important because PCK is not just the knowledge of, and reasoning behind teaching but also the enactment of teaching (Berry et al., 2015). This allowed me to explore whether or not the preservice teacher incorporated KCS in the act of teaching, not just the planning of teaching. I took field notes while observing the preservice teachers. A list of criteria was used to maintain

focus on KCS. An example criterion was: does the teacher change or modify instruction based off of student inquiry into knowledge?

Lesson plans were obtained prior to the beginning of the unit for evaluation of written documents. Documentation analysis has been found as an effective way to capture PCK (Loughran et al., 2004). Each lesson plan was analyzed for the unit. This allowed me to determine whether or not the preservice teacher had students in mind when designing the curriculum. Additionally, the document analysis led to additional pre-interview questions, such as: how did you adapt lesson plans when referencing another lesson plan? An example criterion for the document analysis was: does the method and content include an example, representation or a metaphor?

Trustworthiness

Creswell (2013) proposed a quality qualitative study must possess 3 of 8 strategies to improve trustworthiness including: prolonged engagement and consistent observation, triangulation, peer review and debriefing, negative case analysis, clarifying research bias, member checking, rich, thick description, and external audits. I employed data triangulation, which is the use of multiple data sources to describe a phenomenon (Creswell, 2013). I used a pre and post-interview, an observation with field notes, and lesson plan analysis to capture the development of KCS in preservice teachers. Triangulation assisted with the identification of trends present through multiple data sources. I also clarified the researcher's bias by outlining my beliefs and positionality to make transparent the lens of the researcher when analyzing data (Creswell, 2013). I also reached out to participants through member checking to present findings and ensure the findings were representative of their experiences. I used rich, thick description through the use of quotes and examples from the data to provide further trustworthiness to the

study. Additionally, a pilot pre-interview and lesson plan analysis was conducted to ensure the criterion and questions used were surfacing the intended knowledge bases.

Data Analysis

Data in this study was analyzed through pattern matching (Yin, 2014). Data was analyzed for trends that aligned with the various aspects of KCS as defined through the PCK framework and Hill et al.'s (2008) research on operationalizing KCS. Specifically, I looked for trends in regard to common student errors, students understanding of content, analyzing misconceptions, learning difficulties, students' motivation and interests, and the felt need to learn (Berry et al., 2015; Hill et al., 2008). This study also utilized constant comparative analysis, which is analyzing the data as it is gathered and comparing data against data (Yin, 2014). This allowed me to modify or change the research based on the findings as they are analyzed. Additionally, I compared across multiple documents in each case. The codes created were used across the lesson plan analysis, interviews and observation notes. The same codes were used to compare and identify trends across the cases. The initial codes used came from Hill et al. (2008) and Berry et al. (2015) who outlined components of KCS. Specifically, the initial codes were: common student errors, students understanding of content, misconceptions, learning difficulties, students' motivation and interests, and the felt need to learn by students. In addition to theoretical coding, I inductively coded the data and created open codes in line with the theoretical framework used for this study. Some examples of open codes include: teacher belief of agricultural education, curricular knowledge, teaching strategies, and emphasis on hands-on learning.

Findings

There were 6 major themes that emerged from the data when tracking preservice teachers' development of KCS. The themes included: evolving beliefs of agricultural education,

underutilization of lesson plans, emphasis on hands-on "learning", student motivation is primarily external, instruction shifts from teacher preferences to student needs, and college classes as the dominate source of content knowledge. Some themes developed naturally throughout the process of student teaching, while some were hindered and stayed at the same development stage. It is worth noting that while a specific standard was chosen for this study (plant growth and development) the way the preservice teachers chose to teach it made it difficult to capture topic specific data. For example, some preservice teachers taught this standard through forestry, while others focused on greenhouse crops. The six themes that emerged showcased how some areas of KCS developed throughout the student teaching experience, while some KCS themes did not develop overtime.

Evolving Beliefs of Agricultural Education

One of the most emergent themes of KCS development for the preservice teachers was their change in perspectives regarding the purpose of agricultural education from the pre-interview to the post interview. I asked the preservice teachers, "What do you believe is the purpose of agricultural education?" The intent of this question was to encourage the preservice teacher to disclose why they are teaching agricultural education, and what lens they are using in the classroom. As demonstrated in the PCK framework, a teacher's belief can act as an amplifier or filter to knowledge utilized when teaching. All of the preservice teachers interviewed moved from a very specific purpose of agricultural education as career preparation or agricultural literacy to a much broader purpose of developing thinkers or developing people.

Josh exemplified a change in his belief over the course of the semester between his pre and post-interviews. When asked about the purpose of agricultural education in his pre-interview, Josh answered, "to not only prepare the next future farmer or rancher but also the next

agriculture businessman or woman, the next teacher teaching agriculture, but also to continue to grow agriculturalists to feed the overwhelming demand." When asked the same question in his post interview he replied, "…to hopefully educate our youth on agriculture, and agricultural practices and usages and maybe look at public perception or what they thought agriculture was and disprove any negative perceptions."

The other preservice teachers also had a change in their beliefs, as evident by Spencer's evolving answers. Although Spencer began with a broader belief stating in her pre-interview that the purpose of agricultural education was to have students, "…become stewards to both our cultivated natural lands so that way we can live and benefit with our land and feed and clothe ourselves in perpetuity." She still took a broader approach in her post-interview claiming the purpose of agricultural education is, "…a way to teach people how to be people…" Josh and Spencer clearly demonstrated a change in beliefs of the purpose of agricultural education and the catalyst for this development was learning about their students. This is evident in Josh's post interview, "I thought everybody was going to college and everybody is going to change the world in a positive manner, but they're not." As he learned about his students and worked with them, his expectations changed his beliefs and developed his understanding of KCS. This was confirmed in my classroom observation, as he would capitalize on opportunities to teach or emphasize soft skills even during a very technical lesson. The preservice teachers showed that they found more realistic ways that they can reach their students. In this area, the student teaching experience aided in the development of KCS, as it influenced their philosophy on why agricultural education is important, which in turn influences all other components of the framework.

Underutilization of Lesson Plans

When analyzing lesson plans that were created the fall prior to the student teaching experience, two major behaviors became apparent. First, many preservice teachers relied heavily on other lesson planning resources. Secondly, some lessons were copied and pasted from existing lesson plans (e.g. peers, internet sources, or cooperating teachers). In the resources section of the lesson plan template, there was almost always another individual's lesson plan listed. In Spencer's post interview when asked if she "stole" lesson plans her reply was, "Yes, I did, thank you, Dr. Smith." Additionally, this year at the University of Arizona, preservice teachers were taught how to lesson plan through a new template. Since I was taught on the old template, it was obvious to me when someone would copy and paste from an older template to the new one. Lilly had the most noticeably copied lesson plans, as the felt need to learn was copied for the entire unit. One lesson plan I obtained was completely unfilled, but the preservice teacher, Kelly, believed it was complete when she emailed it to me. Additionally, there was a lack of KCS evident within the lessons themselves when analyzed. Kelly mentioned in her pre-interview that, "she did what she could" on her lesson plans, but she wouldn't know how effective she was until she entered the classroom.

This lack of KCS during the development of lesson plans led to many preservice teachers not referencing their lesson plans while student teaching, as the teachers did not have the students in mind during the lesson planning process. This surfaced in both interviews and observations. Lilly mentions in her pre-interview, "To be honest this week, I haven't used a single one of my lesson plans that I wrote last semester." This was in reference to all of her classes and not plant science specifically, as she had not started that unit yet. Lilly even expressed regret claiming the time spent on lesson plans in the fall was "not worth it" due to the lack of use in the classroom. When asked why she doesn't use the lesson plans she made Lilly

claimed, “When I got to know my students and I figured out what they needed rather than what I thought they needed last semester, I was able to plan better.” During my observation of Kelly, I was handed the lesson plans for the day and told that although that was her formal plan, she was not intending to follow it. The preservice teachers in this study did not have the TPKB related to students when developing their lesson plans. Due to the lack of knowledge of students as a TPKB most elected to not use their lesson plans as they felt it was not applicable to their students. This models the PCK framework, as the lack of knowledge of students influences all other areas of PCK, included KCS.

Emphasis on Hands-on “Learning”

It quickly became apparent that hands-on learning had been over emphasized prior to the student teaching experience. This was most noticeable in the preservice teachers’ classroom practice during my observations. When observing Maddie, the entire lesson was hand-on focused. Students brainstormed words associated with forests by writing them on a shaving cream topped table, went outside to observe trees, and concluded by making a tree out of clay. While on the surface it seemed to be an engaging lesson, upon reflection there was not much learning demonstrated by the students. Maddie’s primary objective was for the students to be able to distinguish between different trees; however, when questioned during her post-interview, the purpose of the activities was to have a hands-on activity, not to distinguish between trees. When asked about the purpose of the clay activity, Maddie responded, “I'm utilizing the clay in order to build either a tree that they saw or a tree that they liked. This gave them creativity and kind of a hands-on perspective of trees.” Maddie ended the clay activity by asking students to share why they built their tree the way they did. Because of the emphasis on hands-on “learning”, students’ answers that described their tree as a “good” tree or referenced a tree that

belonged to George Washington were accepted. The overarching goal of the preservice teacher was to be hands-on not necessarily connect to content or standard.

Josh, Lilly, and Spencer all had a lecture portion of their lesson that I observed. All three were very rushed, as the goal was to get through the slides to engage in the activity that followed the lecture. Many preservice teachers had to repeat direction sets for the activity again to each individual student as the emphasis was to move forward to the activity not to listen during the lecture. Kelly even worried how students would do without hands-on in her pre-interview demonstrating that this is a belief that the preservice teacher had upon entering the student teaching experience. She said, "I think students may struggle with not having so much hands on-work and demonstration." Although KCS was apparent in preservice teachers' decisions to motivate students through hands-on activities; it hindered teacher effectiveness because of the unbalanced focus between hands-on "learning" and content acquisition. Maddie stated, "I have a lot of kids that are kind of a little rowdy, so they do like to get up and go and do things." While this is a common teaching context, for the preservice teachers keeping students busy with hands-on projects was driving the classroom instruction decisions, not necessarily the content being taught. Interestingly, when asked about how hands-on methods should be used, the preservice teachers all claimed their needs to be a balance between hands-on and lecture methods. Despite these claims, there was no evidence of this in observations of their teaching.

Student Motivation is Primarily External

Mirroring Hill et al.'s (2008) operationalized KCS components; student motivation was highlighted across the data. However, the preservice teachers kept the emphasis on external factors when it came to strategies for motivating students. In Lilly's pre-interview, she said students were motivated by music and choosing their own groups. Josh claimed being goofy or

embarrassing himself was a motivator for students. In lesson plans there was also evidence of student motivation being external, as Kelly used food as a motivator. What was often left out was a felt need to learn the content or an internal motivator for students. Also, in line with the previous theme, hands-on activities were frequently used as motivators. Maddie described a situation in which she used an activity as a motivator in her post interview as she addressed her students, "…if we don't get this done, if we don't lecture or we don't get the safety and actually understand it, then we're not going to be able to go out and do these fun things." In Josh's pre-interview, he claimed that a solid way to ensure he is doing a good job is whether or not students are smiling. This fits within the PCK framework as it looks at the students' beliefs as an amplifier for external motivation. An emphasis on external motivators stayed consistent throughout the student teaching experience. There was little evidence that motivation could be influenced by a felt need to learn the content. In this case, the KCS that was developed beforehand was reinforced during student teaching instead of challenged.

Instruction Shifts from Teacher Preferences to Student Needs

Preservice teachers were able to place themselves in the role of the student, but still struggled to see through the students' eyes. This is particularly interesting, as this is at the heart of KCS. At its core, KCS is an ability to see the content through a student's perspective and adjust the content accordingly. An illustration of this in Josh's pre-interview was, "So I've always wanted to do hands-on, real world applications because that reinforces the concept for me". He also said, "I bet you there's many students just like me". He is teaching the way he wants to be taught, not necessarily the most effective way for all students to learn.

This theme had the most evidence of KCS progression during the student teaching experience. In the majority of the post-interviews, there was a clear distinction between what the

preservice teacher needed as a learner and what they felt the students needed as learners. Josh demonstrated this in his post interview, “To me photosynthesis is a little easier or at least I know the concepts, but this might be the first time these [students] were introduced to this concept.” KCS is being highlighted here where it was absent before. Josh is now considering his students’ prior knowledge in content, not just assuming students are going to have similar knowledge to him. Lilly discovered that she had to accommodate for IEPs [individualized education plans], saying “…so then I discovered that some of these students have IEPs, that I need to slow down or give them more time.” Spencer illustrated her KCS claiming, “…they're coming from it in a little bit more of a production way. So the way they look at a flower is going to be different than the way I'm looking at a flower.” Although the preservice teachers began by highlighting portions of their instruction to accommodate for themselves, they clearly switched to understanding their students and adjusted their methods to reflect student prior knowledge and learning preferences.

College Classes Serve as Dominate Source of Content Knowledge

One concern for the development of KCS in preservice teachers is that their content knowledge is derived primarily from college content classes (e.g. crop sciences, plant genetics, field botany). Within the PCK framework, content knowledge serves as a TPKB, which influences KCS. There were many cases in which preservice teachers did not break down their content from their college class to adjust for high school students’ learning levels. Many lesson plans cited college notes and classes in their references. In an observation of Josh, he used a PowerPoint that appeared to be from a college level class, as it seemed to match college standards better than high school standards. For example, the PowerPoint began with the chemistry of phospholipids and how that affects photosynthesis, when this was Josh’s first

lecture about photosynthesis. When observing Spencer, there was a similar scenario, where the vocabulary being used was more college appropriate than high school. This ties into the lesson-planning theme when Spencer claimed she "stole" plans from Dr. Smith that was her college professor. There was no evidence of development throughout student teaching as even in Spencer's post interview she described herself as being, "…very lucky because I've gotten to take a couple of plant identification courses [in college]…" In traditional agriculture teacher preparation programs, content classes are taken within content specific departments (e.g. animal science is taken with an animal science professor and with other animal science majors). The preservice teachers in this study all took plant science courses with other plant science majors. This is the basis for PCK and KCS, as there was a disconnect between content knowledge and pedagogical knowledge and they did not adjust their content for their students.

Discussion

Overall, the student teaching experience appeared to aid in the development of KCS through broadening preservice teacher beliefs about the purpose of agricultural education and shifting instruction away from teacher learning preferences to focus on student learning needs. The student teaching experience impeded KCS development through the underutilization of lesson plans, the overemphasis of hands-on "learning", preservice teachers viewing student motivation as primarily external, and teachers not breaking down college level content for high school students.

All the preservice teachers in this study broadened their beliefs about the purpose of agricultural education throughout the student teaching experience. This echoes previous research on beliefs of agricultural education in experienced teachers (Rice & Kitchel, 2017). In Rice and Kitchel's (2017) study, teachers possessed broad beliefs about the purpose of agricultural

education, with 6 of 8 teachers claiming life skill development as a primary or secondary belief, and 7 of 8 teachers claiming literacy as a primary or secondary belief. This highlights the importance of the student teaching experience, as it demonstrates that knowledge of students is developed overtime and shapes preservice teachers' core beliefs. Additionally, it became evident that it is difficult to simulate student behavior during preservice preparation curriculum. Subsequently, because teacher beliefs broaden with experience, this could potentially be used as an indicator of KCS in preservice teachers.

In regard to lesson planning, the findings of this study align with Ball, Knobloch, and Hoop (2007). Many novice and preservice teachers found the creation of a formal, detailed lesson plan to be a waste of time, as lesson planning was viewed as a mental process (Ball et al., 2007). If novice and preservice teachers continue to not use lesson plans, one must question the methods used and instruction time spent on them during the preservice preparation process. Preservice teachers do not seem to value or understand the importance of lesson planning (Ball et al., 2007). It is possible earlier KCS development could serve as a solution to this issue.

Hands-on learning literature, especially in agricultural education, focuses on the benefits of engagement. However, after reviewing agricultural education research, there were no studies connecting hands-on engagement to content knowledge acquisition. Instead, the measure for success was whether hands-on engagement techniques were present in the classroom. When examining the effectiveness of the Curriculum for Agriscience Education (CASE) (a popular, and growing curriculum used in Arizona and nationwide) for example, one study focused on length of time that students were engaged (Witt, Ulmer, Burris, Brashears, & Burley, 2014). Even though the CASE curriculum was found to be more engaging than traditional classrooms, the recommendation for agriculture teachers was still to provide even more engagement

opportunities for students (Witt et al., 2014). Perhaps the pendulum has swung away from lecture based learning to learning only happens through hands-on engagement. At the national FAST symposium, a conference for preservice agriculture teachers, most of the workshops were focused on the development of classroom activities. Even in the Teach Ag logo, there is a hand as the background (Smith et al., 2017). The hands-on activities observed lacked a strong content knowledge foundation, negatively affecting KCS development.

This emphasis on hands-on learning is also demonstrated through motivation being viewed as separate from content. In KCS research on beginning agriculture teachers, it was found that student engagement methods used were not driven by the nature of the content (Rice & Kitchel, 2016b). In support of the findings about the nature hands on learning and motivation as an external construct, Rice and Kitchel (2016b) summarized a theme saying, "… the focus was more on keeping the students entertained than how to best represent a particular piece of content for student understanding." (p. 91) The preservice teachers in this study believed student entertainment was the primary student motivator and a prerequisite for learning. This emphasis on extrinsic motivation also undermines the formation and utilization of intrinsic motivation (Deci, Koestner & Ryan, 1999).

Additionally, Rice & Kitchel (2016b) found that beginning agriculture teachers also engaged in a form of learning egocentrism when designing and executing their curriculum. This is particularly interesting, as the preservice teachers in this study showed development, but egocentrism was still found in beginning teachers. Previous research has discovered that teachers tend to teach how they preferred to be taught as students (Darling-Hammond & Bransford, 2005). While this is a reoccurring theme throughout the literature, this study illustrates that a KCS emphasis may lead to a path for developing away from an egocentric philosophy.

Additionally, many of the preservice teachers were using content knowledge derived from college courses and teaching high school students content at that same level. While college classes are an important source of content knowledge, teachers must be able to break down the content for student understanding. Preservice teachers have claimed a lack of application of courses to teaching existed in their preparation program (Rice & Kitchel, 2015a). Preservice teachers are commonly taught content in classes intended for majors in plant science, animal science, etc. and not intended for agriculture education majors (Rice & Kitchel, 2015a). Due to this separation of content and pedagogical instruction preservice teachers could gravitate towards teaching the content they were taught in college, as evident in this study. Overall, these themes contribute to the growing body of PCK and KCS knowledge in agricultural education as many of the themes support previous studies in the area.

Recommendations for Research and Practice

A longitudinal study of the participants could provide further insight into the development of KCS over time and through various career stages. This could provide a trajectory for KCS throughout teacher careers to establish a natural baseline for reference. More research on KCS is also needed with experienced teachers as the participants. Directions for KCS development could be achieved by studying experienced teachers and comparing and contrasting experienced and preservice teachers. Indicators of KCS from Hill et al. (2008) framework including: common student errors, students understanding of content, and student misconceptions were not found within the data. This is most likely due to the difficulty of selecting topic-specific concepts within agriculture because of the various approaches to standards. More research building on these themes using a different agriculture topic could strengthen our understanding of KCS development in early career and preservice teachers.

Finally, a separate research study could investigate the theme of hands-on learning and the impact these types of methods have on student learning at a deeper level than previous research.

Data from this study supports an increased focus on KCS before the student teaching experience for all post-secondary agricultural education departments. The more insight a preservice teacher has into student learning, cognitive development, and behavior, the faster KCS can develop. Increasing field experience opportunities and engaging in microteaching experiences can foster this development (Hashweh, 2005). When participating in an experience like microteaching, some of the time should be dedicated to inquiring about the students they are teaching not just exploring teaching strategies and effectiveness. Experience is an important factor to developing PCK and KCS, and can be difficult to replicate. A possible way to encourage development could be questioning preservice teachers on why they believe the students were interested or disinterested in their lesson. This could also help preservice teachers better utilize their lesson plans because of their richer understanding of students. In addition, clear and varied instruction on how to break down college content to the high school level could prove valuable during the preparation process. This could include requiring a pre and posttest for each unit during the student teaching experience to allow preservice teachers to adjust their content accordingly. To address the emphasis on hands-on learning, this study recommends having students spend a day microteaching a lecture and a lab on separate occasions to develop skills in both areas and not over-emphasize. Lastly, this study recommends a focus on deep consistent reflections during the entire student teaching experience. These reflections should be focused on development and defining the learning process, as it often felt during the interviews that preservice teachers were critically evaluating their own development for the first time.

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