*Journal of Agricultural Education, 57(4), 86-100.*
*https://doi.org/10.5032/jae.2016.04086*

# Influence of Knowledge of Content and Students on Beginning Agriculture Teachers' Approaches to Teaching Content

Amber H. Rice[1] and Tracy Kitchel[2]

**Abstract**

*This study explored experiences of beginning agriculture teachers' approaches to teaching content. The research question guiding the study was: how does agriculture teachers' knowledge of content and students influence their process of breaking down content knowledge for teaching? The researchers employed a grounded theory approach in which five beginning teachers were interviewed and observed teaching a lesson. The researchers found beginning teachers' knowledge of content and students greatly influenced how they broke down content knowledge for student understanding. Five major themes emerged: students' prior knowledge and enrollment in sequences of courses influenced content covered, student engagement methods were not primarily driven by content, differing perceptions of content difficulty for students shaped teaching decisions, deconstructing content for students was deemed important by teachers, and teachers engaged in a form of learning egocentrism. These findings support further research on teachers' development of pedagogical content knowledge, including knowledge of content and students overtime as it was found to be an influential knowledge base. Recommendations include providing teachers with more opportunities to explore integrating student's prior knowledge into the curriculum and incorporating student thinking about agriculture content more specifically in teacher preparation.*

**Keywords:** Pedagogical Content Knowledge; Knowledge of Content and Students; Beginning Agriculture Teachers; Content Knowledge

## Introduction

Pedagogical content knowledge (PCK), is a knowledge base for teaching that exists at the juncture of content knowledge and pedagogical knowledge (Shulman, 1986). Teachers who possess PCK can effectively create representations for concepts, recognize student preconceptions and misconceptions of content, and sequence curriculum to enhance student learning (Shulman, 1986). Effective preparation of teachers includes a focus on PCK development. In fact, CAEP (2013) standards for accreditation of teacher preparation list possession of PCK as their first standard. Teacher candidates are expected to develop foundational content knowledge in their particular discipline and to cultivate ways to best present that knowledge to their students, which includes knowledge of instructional strategies, learner development, learner differences, assessment, and application of content, among others (CAEP, 2013).

Teacher and teaching quality, including teacher knowledge about content and pedagogy, can greatly impact student achievement (Kaplan & Owings, 2002). In a quantitative study of elementary teachers, teachers' mathematical content knowledge positively predicted student achievement in mathematics (Hill, Rowan, & Ball, 2005), demonstrating the importance of a strong content knowledge base for mathematics teachers. However, content knowledge alone, while

[1] Amber H. Rice is an Assistant Professor in the Department of Agricultural Education in the College of Agriculture and Life Sciences at the University of Arizona, 1110 E. South Campus Drive, Tucson, AZ, 85721, amrice@email.arizona.edu

[2] Tracy Kitchel is a Professor and Chair in the Department of Agricultural Communication, Education, and Leadership in the College of Food, Agricultural, and Environmental Sciences at The Ohio State University, 208 Ag Admin Building, 2120 Fyffe Road, Columbus, OH, 43210, kitchel.2@osu.edu

recognized as an imperative knowledge base by researchers, is not the only type of knowledge teachers need to be effective (Baumert et al., 2010). Transforming content knowledge for student understanding requires teachers to use their PCK (Halim & Meerah, 2002), indicating PCK is the greatest single contributor to explaining student progress (Baumert et al., 2010).

An important component of PCK is knowledge of content and students. A framework of mathematical knowledge for teaching developed by Hill, Ball, and Schilling (2008), sought to delineate and elaborate upon individual components of PCK. Their framework was divided into six domains and two groups. The first group was subject matter knowledge. The second group was specifically PCK which included three domains: knowledge of content and students, knowledge of content and teaching, and knowledge of content and curriculum. Teachers' knowledge of content and students was described as the combination of knowledge of how students think and learn content with content knowledge in a particular subject matter area (Hill et al., 2008). Components of knowledge of content and students as discovered by Hill et al. (2008) included: common student errors, student understanding of content, student developmental sequences, and common student computational strategies.

Investigation into the impact of knowledge of content and students is crucial for future PCK research. In a study of novice mathematics teachers, knowledge of content and students was a pivotal point for PCK development for the majority of beginning teachers (Lannin et al., 2013). Recent calls for empirical research in PCK include further establishing the connection between PCK and its effect on student learning (Gess-Newsome, 2015). Examining this knowledge base specifically in agriculture teachers could provide information to teacher educators on how to train preservice teachers and develop professional development initiatives for inservice teachers (Rice & Kitchel, 2015), with the end goal of increasing student understanding and retention of agriculture knowledge.

## Review of Literature

Since its conception as a construct, research has been conducted within various education disciplines and numerous frameworks have been developed in an attempt to elucidate the complex nature of PCK (Chick, Baker, Pham, & Chang, 2006; Gess-Newsome, 2015; Hill et al., 2008; Hashweh, 2005; Lee, 2011; Loughran, Berry, & Mulhall, 2012; Magnusson, Karjcik, & Borko, 1999). Recently at an international summit on science PCK, a consensual definition for PCK was established and elaborated on by experts in the field. PCK was defined as the knowledge of, rationale behind, planning for, and act of teaching a specific piece of subject matter, in a specific context, to support student learning of the material (Gess-Newsome, 2015). This definition focused on the topic specific nature of PCK (Darling-Hammond & Bransford, 2005; Etkina, 2010; Van Driel & Berry, 2012), further necessitating research specifically for agricultural education, which may be unique to core content area disciplines such as mathematics or English due to the breadth and depth of content that can be covered in an agriculture classroom (Barrick & Garton, 2010).

Despite the espoused importance of PCK throughout the body of research in teaching and learning, various studies spanning education disciplines from mathematics to science to music have indicated that teachers are still grappling with development of this knowledge base and its applications in the classroom (Kind, 2009; Ball, Thames, & Phelps, 2008; Ballantyne & Packer, 2004). In particular, preservice and beginning teachers are routinely identified as lacking PCK (Borko et al., 1992; Diakidoy & Iordanou, 2003; Halim & Meerah, 2002; Van Driel, Verloop, & DeVos, 1998). Researchers investigating the PCK of preservice music education teachers found that despite having a strong background in music content, many of the preservice teachers were unable to apply that content knowledge and related skills to their classroom instruction (Ballantyne & Packer, 2004). Experience in the field is one of the most effective ways to develop PCK (Hashweh, 2005; Nilsson, 2008); however, without a framework to guide them beyond teacher

preparation, teachers may not be equipped to continually develop and refine this knowledge. Ballantyne and Packer (2004) recommended a more overt focus on the PCK development of preservice teachers during the teacher preparation phase.

In addition to research in the field of mathematics, science education has also contributed heavily to the current knowledge base on PCK (Berry, Friedrichsen, & Loughran, 2015; Kind, 2009). Pedagogical and Professional Experience Repertoires (PaPeRs) and Content Representations (CoRes) were developed by Mulhall, Berry, and Loughran (2003) to make explicit teachers thinking about content. An important component of both frameworks included information related to how knowledge about student thinking influences the teaching of an idea including: predicting students' difficulty with particular content, developing specific strategies to make sure students are understanding content, and withholding certain content for students developmental and contextual needs, among others (Loughran et al., 2012). A recent study with science preservice teachers documented use of the CoRe rubric tool and confirmed its value in raising awareness for and building inexperienced teachers' PCK (Hume & Berry, 2011). Using the contextual framework of PCK, teachers' skills can be thoroughly examined and understood (Abell, Park Rogers, Hanuscin, Lee, & Gagnon, 2009). Focusing on beginning agriculture teachers in the crucial stages of developing their PCK and describing their process of breaking down content knowledge could be an important starting point for PCK research in agricultural education.

## Central Research Question and Purpose

The central research question for this study was: How does agriculture teachers' knowledge of content and students influence their process of breaking down content knowledge for teaching? The purpose of this study was to explore the impact of teachers' knowledge of content and students on their process of breaking down agriculture content utilizing grounded theory methods. This research question aligns with the 2016-2020 National Research Agenda for agricultural education priority four, meaningful and engaged learning in all environments (Roberts, Harder, & Brashears, 2016).

## Methods

The data analyzed were part of a larger study that sought to examine the process beginning agriculture teachers engaged in when breaking down their content knowledge for student understanding in the classroom (Rice & Kitchel, 2016). Many of the methods will be consistent with or identical to the larger study. The findings in this manuscript focused on teachers' knowledge of content and students and its influence on their teaching. Grounded theory methodology was utilized for data collection and analysis because it is an appropriate method for investigating an undefined process (Corbin & Strauss, 2008). Other empirical studies have successfully used grounded theory methodology in their investigation of PCK (Van Driel et al., 1998). Additionally, research on agriculture teachers' deconstruction of content knowledge and specifically knowledge of content and students is limited in agricultural education. Specifically, my methodology was guided by the work of Corbin and Strauss (2008). Similarly, to Corbin, I identify as a pragmatist. My goal for this research is to investigate questions that have implications for practice, particularly for agriculture teacher preparation programs and inservice teacher professional development. Corbin and Strauss's (2008) guidelines for conducting grounded theory fit well with my theoretical lens and therefore were appropriate in guiding this research study. My personal bias influenced the lens in which I viewed the study and included my experience as a high school agriculture teacher who entered the field without a traditional agriculture production background. In my current position as a teacher educator, I witness firsthand the struggles that many preservice agriculture teachers face as they develop their content knowledge, pedagogical knowledge, and PCK for teaching agriculture.

## Site and Participants

Approximately five to seven years teaching experience in the field is when expertise begins to be achieved (Darling-Hammond & Bransford, 2005). With this in mind, Missouri agriculture teachers with a range of two to four years of classroom experience were chosen to keep the focus on beginning teachers. First year teachers were excluded from consideration of this study because they would not be able to compare their thoughts and strategies over the course of multiple years. All participants recruited were purposefully graduates of the University of Missouri and had similar teacher preparation courses and experiences. Thirteen teachers fit these criteria; in addition to being within a 180-mile radius of the university so fieldwork could be conducted. Out of these thirteen teachers, five agreed to participate in the study. Due to the variation in content that can be taught in an agricultural education program, the decision was made to focus on a lesson integrating science concepts, primarily plant or animal science. The participants consisted of two males and three females. Two of the participants were teachers in the same school district. One teacher had two years' experience, three teachers had three years' experience, and one teacher had four years' experience. One of the teachers was in a single teacher department and the rest were currently in a multi-teacher department but may have worked in a single teacher department in previous years. Four of the teachers were employed in schools in rural school districts and one of the teachers was employed in a suburban school district.

## Data Collection

Multiple forms of data were collected as this was part of a larger study. First, data were collected using video recorded classroom observations of one class period for each teacher lasting at least 45 minutes in length. Second, field notes were taken during the observation of the lesson to capture reactions of students and interactions between the teacher and students not captured on video. Observations were an important data collection point to create a comprehensive picture of the deconstructing phenomenon because often people are either not aware of what they are doing or are unable to accurately recall what happened (Corbin & Strauss, 2008). Third, one-on-one semi-structured interviews were conducted following the observation and were 30-45 minutes each. Preliminary interview questions included: what are the things that prepared you to know the content of this lesson well, what are the most important concepts in this lesson, what strategies or methods do you use to teach this lesson and why, what difficulties and limitations are associated with teaching this lesson, and how do you know when your students have learned the content in this lesson. These questions evolved throughout the grounded theory process to meet the needs of the concepts being investigated (Corbin & Strauss, 2008). As data collection and analysis continued, teachers in the study were contacted via e-mail for follow-up information as a part of the constant comparative analysis of grounded theory. The data from these e-mails were used to corroborate findings and establish relationships between data. All video and audio recordings were transcribed verbatim.

## Data Analysis

To analyze the data, field notes from the observations, transcriptions of the teaching videos, and transcriptions from the interviews were used to achieve triangulation of the data (Creswell, 2013). As recommended by Corbin and Strauss (2008), analysis involved open, axial, and selective coding. To form initial codes, NVivo 10 software was utilized. As data were collected, a constant comparative method was used to compare data against data (Corbin & Strauss, 2008). Additionally, interview questions were adapted to follow emergent categories. A good portion of data analysis centered on the axial coding phase looking for relationships amongst the data. These relationships were then used as the basis for the selective coding phase and subsequently the findings.

Because this was part of a larger exploratory study, the findings are discussed in themes, and a substantive theory is not presented in this manuscript. Following recommendations of Charmaz (2006) sometimes emergent concepts from a grounded theory study can be so rich they warrant deeper exploration and may not be best represented as a model. However, it is important to note that a substantive theory depicted as a model was developed and presented in the larger study (Rice & Kitchel, 2016). In developing the themes, memoing and writing up the final findings were crucial exercises to make sense of the data. Using writing as a tool for meaning making fits with Denzin and Lincoln's (2000) argument that writing is not simply the end product of the research process but a way to inquire into the process. To ensure trustworthiness of the original data, member checking was utilized as the study evolved (Creswell, 2013). Credibility of the data was insured by the richness of the data obtained and reflexivity through memoing throughout the data collection and analysis process. Additionally, relevant literature in the field provided sensitizing concepts for this study (Corbin & Strauss, 2008).

## Findings

Beginning teachers' knowledge of content and students (and lack thereof) greatly influenced how they broke down content knowledge for student understanding. Specifically, five major interwoven themes emerged through data analysis regarding how this unique knowledge base influenced teaching agriculture content.

### Students' Prior Knowledge and Enrollment in Sequences of Agriculture and Science Courses Influenced Type and Depth of Content Covered by Teachers

All of the teachers in the study referenced making an effort to consider their students' prior knowledge in the content when planning and teaching their lessons. This included prior knowledge from other agriculture classes the students had taken and prior knowledge from core content classes such as biology or chemistry. In my field observations, multiple teachers referenced to students they had learned certain pieces of content in 6$^{th}$ and 8$^{th}$ grade. Often, the students recognized their own prior knowledge and communicated that to the teacher. In an observation of a plant science lesson with Tiffany, one of the students commented they had to know the formula for photosynthesis for their biology class, as well. Tiffany responded by emphasizing the cross-curricular nature of the content. In the same lesson, when she was explaining cellular respiration, Tiffany asked the students if they had learned this yet in their biology course, possibly prompted from the previous student interaction.

In the interview following the lesson, Tiffany stated, "We do talk about plant science in 8$^{th}$ grade, I reminded them of that today. I want to be a step up from that, but I also want to leave them something to learn in plant science in greenhouse class." Tiffany was from a single teacher department, so she knew she would be having many of these same students in future classes. Agriculture teachers have to balance curriculum across multiple courses and attempt to avoid unnecessary repetition or leaving out certain content. Jordan discussed how he had to balance content across multiple agriculture courses in order to teach all of the content he felt was important for students to learn. "You just look for ways to maybe incorporate [content] in other classes or try to switch out your class and that's where you can cover the information you want to cover."

In some schools, there was an effort to teach complimentary curriculum across subject areas to increase transfer. Tiffany elaborated,

> So I am kind of getting a sense now of stuff that I either withhold or go ahead and teach them. I know where they are at in their other classes, so it's trying to work with that so they are hearing the same level of stuff in my class that they are hearing in other classes.

In multi-teacher departments sometimes the pressure wasn't just to teach complimentary content across the different disciplines, but also to be consistent with other agriculture courses. Melissa reflected on her efforts to keep the content the same. "There's a big push to make your classes similar. If another agriculture teacher is teaching wildlife, then our curriculum is the same." As the newest and youngest teacher in her department, Melissa often felt like she was the one who had to adapt her content. "I know that they are not going to change what they are teaching since they have been here, so I have been trying to take the big idea of what they are teaching and teach that."

### Student Engagement Methods in the Classroom were not Primarily Driven by the Nature of the Content

A common method to engage students in the classroom was to have them participate in activities. Engagement of students seemed to be a struggle for many of the teachers. Jeff discussed his engagement strategies for a parliamentary procedure lesson and his frustration with keeping students engaged in the content. "I throw the video in there. That's the number one problem I run into though is engagement and keeping kids focused on the topic, especially on some very hard and boring stuff." Jeff referred to learning how to take minutes in a meeting, the content he was covering that day in class, as difficult and boring on multiple occasions throughout the interview.

When I asked Melissa about how she decided what methods were best suited for teaching specific content, her answer had very little to do with the actual content itself.

> It probably depends on whatever I have done in the class before because I don't want to do lecture every time. If I have just done a research project, I don't want to do that same thing with kids that next class period. For me, that is probably the driving factor in whether I am going to study and read up on this or am I going to create a project for them to research or do a group project on. Right now that is probably my driving factor, making the class different so I can try to engage them.

While student engagement is important for learning to take place, the role of content was often absent in the decision. Instead, the focus was more on keeping the students entertained than how to best represent a particular piece of content for student understanding.

### Differing Perceptions of what Content is "Difficult" for Students Shaped Teaching Decisions and Reflection

Another component of knowledge of content and students that influenced how the teachers approached the content was the difficulty or perceived difficulty of the content for the students. Tiffany described her experience with teaching content in a farm management course during her interview. "When I taught it the first time, elasticity of demand blew a few kids' minds. It was to the point where we took a test and they just didn't even try it." Jeff commented on how effort was one of the biggest problems he saw with teaching content to students. Students' negative experiences with difficult content in previous classes also influenced how teachers created interest and tried to motivate them to be excited about agriculture content. Tiffany described how this unfolded in her plant science unit. "They bring negative opinions about the content. I say this is biology to try and get them to relate to biology class. Turns out they hate biology class and they just shut down." Plant science was not the only content area Tiffany experienced students shutting down. She described a similar instance in the aforementioned farm management course showcasing how students' negative experiences with content extended beyond the sciences. "There are kids that refused to take a math class beyond what they had to and they are sitting there during any of our equations and they are shutting down, not listening, and not even trying."

In response to the perceived difficulty or negative experiences, sometimes the teacher decided to focus more on particular content because they felt it was important for the students to learn. Jeff illustrated this with his agriscience class.

> The reason I thought to teach parli [parliamentary procedure] is our FFA meetings were disasters last year. Nothing happens at their meetings, kids hate going to them, they are not enjoying being around their friends, and it's because they're not getting things accomplished. So I thought this was important to do.

Often the teachers experienced frustration with teaching content the students struggled with but they perceived as lower level knowledge. Many of the teachers discussed identification as a topic many of their students struggled to master. Since identification is a component of many career development events (CDEs) within FFA (National FFA, 2012), it was also an important part of the agriculture classroom curriculum and the foundation for future knowledge.

In the lesson on monocots and dicots I observed, I asked Tiffany afterwards what was the most difficult part of the lesson for her students to understand. She responded, "Maybe just the sight identification of monocots and dicots, like they can describe them but they can't identify them….There will be times when they seem to get it and then something will throw them." Tiffany began spending more time on identification in plant science because her students were struggling. "Identification with the plant science stuff is an area that they have struggled with and that's why we have started hitting it a little harder this year." Melissa described identification as being a barrier to student learning. "Weed and grass identification, that was really hard, just the ID-ing part, getting them to differentiate between plants and why is this plant this one. That was probably one of the difficult things." Beyond the plant sciences, animal science identification and terminology was also an area of concern. Mary indicated terminology in relation to veterinary science and animal science was an area in which her students struggled to grasp the content. "If they haven't taken anatomy yet then they struggle a lot with the different parts of the body and the different bones and the technicality of it."

Tiffany described her frustration with re-teaching identification and her students still not grasping the material:

> And I'm not understanding. I feel like I've been through it enough that when we go through contests I can identify all the plants and they still don't know. There's some jump that they are not making in terms of identification and like I said before I think that's a really important part of plant science.

Many of the teachers experienced frustration with this perceived "easy" content and the students' difficulty with mastery. Melissa described her reflection on re-teaching content. "I have struggled with trying to go back and say, oh shoot, I needed to teach that better because I can't just rattle that off [specific content terminology] and them [students] understand it because they don't really know."

Another component to the teachers' perceived student difficulty with content centered on where the students were developmentally in terms of content knowledge acquisition. I asked all of the teachers during the interview if there was anything they knew about the content they purposefully didn't cover in class and their rationale for excluding that content. In reference to his lesson on meeting minutes in the parliamentary procedure unit Jeff said, "I mean you don't want to overload them with information. I've seen a lot of teachers teach it with a PowerPoint and they cover twenty motions in one…but the kids don't know how to use it in action." Describing a farm management course, Tiffany expressed a similar sentiment:

> But we basically talk about the relationship, if the supply is this and the demand is this…but I don't even try to get my freshmen to really get into that. In farm

> management I talk about it enough for them to get the idea behind it, but I'm not going to try to get freshmen to understand economic principles like that. So yeah, with that class I definitely withhold some of it; they know what they need to know to be functional and then the rest of it they wait.

Sometimes the teachers were not sure what their students were developmentally ready for in terms of content. When asked if there was ever any content he withheld Jordan replied, "Yes, partially because of time and partially because I do think it's over their head whether it's pertinent or not." Mary expressed her concern for not knowing what to withhold from students, "Because sometimes I read through this stuff and I am like, do they know this? Should they not know this?" A lack of a defined curriculum in agricultural education could be perpetuating this uncertainty of what content is developmentally appropriate for students.

**Deconstructing Content for Students was Deemed Important by Teachers**

Many of the teachers discussed how they deconstructed content in a step-by-step fashion beginning with the lowest level knowledge and building from there as a strategy for teaching content. Jeff described deconstructing content in this manner when teaching a lesson in forestry. "You have to slow down and take time to explain and then you reinforce those points every single time. Because if they don't understand the simplest thing I can't move on…" Tiffany also describes her reasoning for laying out the content step-by-step. "They are either just not getting it right or they are telling you they don't get it. So that doesn't tell me specifically why or where they are lacking. So having them step by step…"

The concept of "forced learning" was one technique utilized by Tiffany when teaching content her students struggled with. To Tiffany, forced learning meant 100% of the content was learned by 100% of her students. She felt it was important to make sure each student understood the basics of content before she was able to build on that content. This technique also involved a step-by-step process of breaking down the content. Tiffany described how this technique worked for her as an intervention strategy.

> So I would sit down with them during class and go through it step by step with them until they got it and just force them to think about it. So just sitting there and hanging with them until they understand it one-on-one I think is the most effective intervention.

Often the teachers self-identified as lacking content knowledge in many areas of agriculture. However, some teachers had a specialty area of content in which they had high self-efficacy. Sometimes this expertise in a particular content area could actually be a barrier to breaking down content. When describing a lesson in meat science, an area Jeff had background in from working in a meats lab, he indicated it was hard to explain some of the concepts to the students.

> Like on quality grading- Mr. W how do you know that's prime? Well because it's prime- you know? That's a common one. Or how do you know that number three is better than number four [referring to cuts of meat]? Because it is- you know?...The hardest thing is for me to translate things that you just instinctively know into ways for them to understand it.

This frustration Jeff experienced is consistent with literature stating expertise can sometimes be a barrier to teaching because experts don't always realize the steps they are taking to solve a problem because it has become so automatic (Bransford, Brown, & Cocking, 2000). This phenomenon of struggling to break content down due to expertise in a content area may occur more often in experienced agriculture teachers and could warrant further research.

### Teachers Engaged in a Form of Learning Egocentrism

Part of the concept of "forced learning" stemmed from the teacher relating students' learning with her learning. This is common in education, because teachers often teach how they were taught and how they learned best as students (Darling-Hammond & Bransford, 2005). This egocentric learning philosophy altered the approach many teachers utilized when determining the best methods for teaching content. Instead of investigating the most effective method for teaching content or how students responded to different teaching methods, the teacher taught how they would prefer to learn. Tiffany continues regarding why she used "forced learning" as a technique in her classroom for certain content:

> I think that was an area I struggle with and no one ever forced me to think through things…Forcing them to sit there and tell you why they don't get it and then tell you why they do get it is going to help them a lot.

When referring to another content area, Tiffany again referred to how she learned and its influence on her teaching. "I tell them with math, if I can understand it well enough to teach you, you guys can understand it. I break it down to the absolute lowest level because for me to understand it that's what I have to do." It appeared Tiffany was attempting to empathize with her students' struggle with particular content and wanted to assist them with mastery; however, her methods were still focused on how she personally learned best. Jordan also acknowledged how his own preferences for learning dictated what he chose to do in the classroom. "One time it just come to me in a dream or something or whatever when I'm just thinking back and think what would be cool and what I'd like to do as a student."

Sometimes the teachers began thinking about their own learning, but were influenced by others to re-examine their thought process. This was evidenced through an interview with Melissa:

> I start looking back to when I was in high school and thinking about being on the floriculture team and how hard it was trying to remember all the plants. Now I am like what's so hard about this? Once you learn it what's the big deal? The other teacher that does grasslands, that I went to the practices with, I was like it is so much easier now, I don't get this. He was like it is probably because you have a lot more background experience and knowledge now; certain things stand out more. I was like I guess that's true. I guess you get more background knowledge as you go and you have done it. But I am sure someone else that has never done it, if they were however old, may not get it either.

It is possible many of the teachers do not realize they have engaged in learning egocentrism, as evidenced by Melissa's passage above. Looking at the influence of teacher preparation programs on this phenomenon could be important future research.

## Discussion

All teachers in the study recognized the importance of students' prior knowledge in learning new content. This is consistent with literature stating students enter learning environments with preconceptions about content that influences how they grasp future material and the impact this can have on instructional practice (Bransford et al., 2000). However, while the teachers did recognize the importance of students' prior knowledge, there were many instances where they did not know how to use that awareness to facilitate further learning of agriculture content. This disconnect could potentially impede students' learning of new content, inhibiting transfer. It is recommended teachers, both at the preservice and inservice level, are provided more opportunities to explore integrating students' prior knowledge into the curriculum, possibly through inquiry-based learning approaches. The majority of the time, the teachers in this study relied on students'

verbal assertions to assess their knowledge of content. Engaging in pretests before beginning a unit and purposefully designing instruction around those results could strengthen students' understanding of content. Additionally, the overlap in content from the core content areas, primarily science and math, necessitates working with core content area teachers to align and compliment curriculum. With the emphasis on high stakes testing (NCLB, 2002), this could be one way to substantiate the role of agricultural education in student learning school wide. If the agriculture program or class emphasis is on agriscience, it could be important to work with other science teachers in developing those science concepts across classes and grade levels. Finally, a lack of a defined curriculum in agricultural education could also be a contributing issue to teachers' decisions of what content to teach in which classes and the appropriate depth of content. Investigation into potential overlap of career pathways (National Council for Agricultural Education, 2009) could be important future research.

While the importance of student engagement pervades educational literature (Trowler, 2010), the emphasis for the teachers in this study was predominately centered on keeping the students entertained and less focused on using certain motivational techniques for particular content. This could lead to teachers not choosing the best methods for teaching content to facilitate student learning. Varying instructional strategies aligns with the principle of teaching and learning, variability, which was taught during teacher preparation to the teachers in this study (Rosenshine & Furst, 1973). However, has this principle, albeit important, been simplified by the preparation program or the teachers themselves to focus primarily on switching up strategies and less on which strategies are best for particular content? Selassie (1989) found the nature of students and students' intellectual development was less frequently used by teachers in the selection of the method by which material would be presented. Incorporating student thinking about agriculture content more explicitly in teacher preparation could be beneficial in agricultural education. Considering mathematics content from the perspective of the student and solving students' math problems were important exercises for preservice teachers in a mathematics content-focused methods course and led to the development of informed decisions about how to best teach the content (Steele & Hillen, 2012). Getting into the mindset of a learner and approaching content from that mindset could encourage student engagement with the content, eliminating some of the need for superficial activities.

The difficulty of tasks can also influence student learning. If an assignment is too 'easy' a student may become unmotivated because they are bored. The reverse is true if the assignment is too 'difficult' (Bransford et al., 2000). Vygotsky's (1978) zone of proximal development describes the amount of learning a student can accomplish with and without assistance. Knowledge of what was developmentally appropriate for students to know and how much they could learn was a source of concern for teachers in this study, which is a fundamental component of knowledge of content and students (Hill et al., 2008; Loughran et al., 2012). In a self-efficacy study of beginning agriculture teachers, Wolf (2011) reported moderate to low levels of capability for teachers for adjusting lessons to proper levels for individual students. In another agricultural education study, 36% of teachers expressed doubts about students' capacity to handle integrated science material in agriculture courses (Thoron & Myers, 2009). Investigating 'students as learners' courses at the teacher preparation level, which would include information surrounding learning theories, could be important future research. At the university the teachers attended, often the courses on student learning focusing on development were taught by the College of Education and did not focus solely on middle and high school age students, which is the target population of traditional agricultural education programs. This could be contributing to the teachers' uncertainty about what is developmentally appropriate. Again, lack of a defined curriculum, which includes the flexibility of what content to teach and the community based approach to teaching content, could be another contributing factor related to teachers' struggles with what content is developmentally appropriate to teach and how to sequence content.

In every teacher interview identification was highlighted as a skill students struggled to master. The teachers expressed frustration with the students' difficulty with 'easy' content. In the revised version of Bloom's taxonomy (Anderson & Krathwohl, 2001), identification falls under the lowest level in the hierarchy- *remember* (previously called knowledge). A learning objective falling under the remember category would include recognizing and recalling information from long-term memory (Anderson & Krathwohl, 2001). The perceived importance of this knowledge could stem from its role as a foundational knowledge base in students or its prevalence in CDEs (National FFA, 2012). Perhaps the frustration with students not grasping identification related content connects to the prior knowledge of students and teacher difficulty in using that knowledge in the classroom to build new content. It is also possible teachers are expecting students to already possess certain knowledge before they enter the classroom. Finally, it could be related to teacher learning egocentrism and teachers having difficulty understanding why such an 'easy' concept would be difficult to master. Future research should explore identification, situated within a variety of agriculture content areas, in more detail to pinpoint potential issues or barriers to learning and determine solutions.

Primarily due to their novice status, teachers discussed feeling deficient in various aspects of content; however, some also acknowledged a specialty area in which they excelled. Difficulty in deconstructing content in these specialty areas was expressed by teachers and could be a barrier to student learning. This is consistent with literature acknowledging expertise in a subject can sometimes actually impede teaching because experts forget what is easy and what is difficult for students (Bransford et al, 2000). The teachers in this study emphasized the need to deconstruct content, mostly in a step-by-step fashion, but didn't always know how to go about this process for specific content. Helping preservice teachers translate content they instinctively know for student understanding is an important component of teaching and should be addressed more explicitly in teacher preparation programs. Additionally, the step-by-step procedure assumes learning occurs in a linear fashion. This could be contrary to inquiry-based learning or other learning techniques and theories. Exploration into the repertoire of methods beginning teachers have for teaching content could uncover any potential weaknesses in or reliance on particular teaching methods.

The teaching strategy 'forced learning' was mentioned by one teacher numerous times throughout the interview. It appeared to stem from relating students learning to her learning. Other teachers in the study also indicated that their views of how they personally learned best influenced their choices of teaching methods. Part of this phenomenon of teacher learning egocentrism could be a lack of understanding of how varied students learn. It could also be an inability to look at content in multiple ways, an important part of PCK (Shulman, 1986). Effective teachers need to know multiple ways to approach solving problems and be able to create multiple examples and representations of challenging topics for a wide variety of learners (Grossman, 2005). Teachers often know how to teach content in one way, the way they learned it (Darling-Hammond & Bransford, 2005). With the variety of students in agriculture courses, this is not sufficient. It is also important to acknowledge in Melissa's interview she addressed how her learning egocentrism was identified by a more experienced teacher and caused her to reflect on her own teaching strategies. Awareness of engaging in teacher learning egocentrism, strategies to avoid it, and additional knowledge and resources about how to represent material in various ways for a variety of students will be important in future preservice and inservice teacher development.

Overall, future research recommendations based on this study include examining a teachers' development of PCK (including knowledge of content and students) over time. Over the course of a class or a year in the field how does it change and grow and what aspects facilitate or impede the progression? Additionally, because PCK is developed over time as a teacher re-teaches a specific topic (Hashweh, 2005); investigation into expert teachers' use of knowledge of content and students in the classroom could be important future research. This could further illuminate how

this knowledge base is being utilized in agricultural education and provide important information for future teacher preparation and inservice teacher professional development.

## References

Abell, S. K., Park Rogers, M. A., Hanuscin, D. L., Lee, M. H., & Gagnon, M. J. (2009). Preparing the next generation of science teacher educators: A model for developing PCK for teaching science teachers. *Journal of Science Teacher Education, 20,* 77-93. doi:10.1007/s10972-008-9115-6

Anderson, L. W., & Krathwohl, D. R. (Eds.). (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives.* New York, NY: Longman

Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education, 59*(5), 389-407. doi:10.1177/0022487108324554

Ballantyne, J., & Packer, J. (2004). Effectiveness of preservice music teacher education programs: Perceptions of early-career music teachers. *Music Education Research, 6*(3), 299-312. doi:10.1080/1561380042000281749

Barrick, R. K., & Garton, B. L. (2010). Frameworks for agriculture teacher preparation. In R. M. Torres, T. Kitchel, & A. L. Ball (Eds.), *Preparing and advancing teachers in agricultural education* (pp. 31-41). The Ohio State University Columbus, OH: Curriculum Materials Service.

Baumert, J., Kunter, M., Blum, W., Brunner, M., Voss, T., Jordan, A., ... & Tsai, Y. M. (2010). Teachers' mathematical knowledge, cognitive activation in the classroom, and student progress. *American Educational Research Journal*, *47*(1), 133-180. doi:10.3102/0002831209345157

Berry, A. Friedrichsen, P., & Loughran, J. (Eds.). (2015). *Re-examining pedagogical content knowledge in science education.* New York, NY: Routledge.

Borko, H., Eisenhart, M., Brown, C. A., Underhill, R. G., Jones, D., & Agard, P. C. (1992). Learning to teach hard mathematics: Do novice teachers and their instructors give up too easily? *Journal for Research in Mathematics Education, 23*(3), 194-222. doi:10.2307/749118

Bransford, J. D., Brown, A. L., & Cocking, R. R. (Eds.). (2000). *How people learn: Brain, mind, experience, and school.* Washington, D.C.: National Academy Press.

Charmaz, K. (2006). *Constructing grounded theory: A practical guide through qualitative analysis.* Thousand Oaks, CA: Sage Publications.

Chick, H. L., Baker, M., Pham, T., & Cheng, H. (2006). Aspects of teachers' pedagogical content knowledge for decimals. *Proceedings of the 30th annual conference of the International Group for the Psychology of Mathematics Education.*

Corbin, J., & Strauss, A. (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory.* Thousand Oaks, CA: Sage Publications.

Council for Accreditation of Educator Preparation. (2013). CAEP 2013 standards for accreditation of educator preparation. Retrieved from: http://www.caepnet.org/standards

Creswell, J. W. (2013). *Qualitative inquiry & research design: Choosing among five approaches*. Thousand Oaks, CA: Sage Publications.

Darling-Hammond, L., & Bransford, J. (Eds.). (2005). *Preparing teachers for a changing world: What teachers should learn and be able to do.* San Francisco, Calfornia: Jossey-Bass.

Denzin, N. K., & Lincoln, Y. S. (2000). The discipline and practice of qualitative research. In N.K. Denzin & Y. S. Lincoln (Eds.), *The handbook of qualitative research* (Vol. 2, pp. 1-28). Thousand Oaks, CA: Sage Publications.

Diakidoy, I. N., & Iordanou, K. (2003). Preservice teachers' and teachers' conceptions of energy and their ability to predict pupils' level of understanding. *European Journal of Psychology of Education, XVIII*(4), 357-368.

Etkina, E. (2010). Pedagogical content knowledge and preparation of high school physics teachers. *Physical Review Special Topics- Physics Education Research, 6*(2). doi:10.1103/PhysRevSTPER.6.020110

Gess-Newsome, J. (2015). A model of teacher professional knowledge and skill including PCK. In A. Berry, P. Friedrichsen, & J. Loughran (Eds.), *Re-examining pedagogical content knowledge in science education* (pp. 28-42). New York, NY: Routledge.

Grossman, P. (2005). Research on pedagogical approaches in teacher education. In M. Cochran-Smith & K. Zeichner (Eds.), *Studying teacher education: the report of the AERA panel on research and teacher education* (pp.425-476). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Halim, L., & Meerah, S. M. (2002). Science trainee teachers' pedagogical content knowledge and its influence on physics teaching. *Research in Science and Technological Education, 20*(2), 215-225. doi:10.1080/0263514022000030462

Hashweh, M. Z. (2005). Teacher pedagogical constructions: A reconfiguration of pedagogical content knowledge. *Teachers and Teaching: Theory and Practice, 11*(3), 273-292. doi:10.1080/13450600500105502

Hill, H. C., Ball, D. L., & Schilling, S. G. (2008). Unpacking pedagogical content knowledge: Conceptualizing and measuring teachers' topic specific knowledge of students. *Journal for Research in Mathematics Education, 39*(4), 372-400.

Hill, H. C., Rowan, B., & Ball, D. L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Educational Research Journal, 42*(2), 371-406. doi:10.3102/00028312042002371

Hume, A., & Berry, A. (2011). Constructing CoRes- a strategy for building PCK in pre-service science teacher education. *Research in Science Education, 41*(3), 341-355. doi:10.1007/s11165-010-9168-3

Kaplan, L. S., & Owings, W. A. (2002). *Teacher quality, teaching quality, and school improvement*. Bloomington, IN: Phi Delta Kappa International Press.

Kind, V. (2009). Pedagogical content knowledge in science education: Potential and perspectives for progress. Studies in Science Education, 45(2), 169-204.

Lannin, J. K., Webb, M., Chval, K., Arbaugh, F., Hicks, S., Taylor, C., & Burton, R. (2013). The development of beginning mathematics teachers' pedagogical content knowledge. *Journal of Mathematics Teacher Education, 16*(6), 403-426. doi:10.1007/s10857-013-9244-5

Lee, Y. (2011). Enhancing pedagogical content knowledge in a collaborative school-based professional development program for inquiry-based science teaching. *Asia-Pacific Forum on Science Learning and Teaching*, *12*(2), 1-29.

Loughran, J., Berry, A., & Mulhall, P. (2012). *Understanding and developing science teachers' pedagogical content knowledge.* Netherlands: Sense Publishers.

Magnusson, S., Krajcik, J., & Borko, H. (1999). Nature, sources, and development of pedagogical content knowledge for science teaching. In J. Gess-Newsome & N. G. Lederman (Eds.), *Examining pedagogical content knowledge* (pp. 95-132). Netherlands: Kluwer Academic Publishers.

Mulhall, P., Berry, A., & Loughran, J. (2003). Frameworks for representing science teachers' pedagogical content knowledge. *Asia-Pacific Forum on Science Learning and Teaching, 4*(2), 1-25.

National Council for Agricultural Education. (2009). *Agriculture, food, and natural resources (AFNR) career cluster content standards*. Alexandria, VA: National FFA Foundation.

National FFA. (2012). *National FFA career development events*. Retrieved from https://www.ffa.org/documents/cde_handbook.pdf

No Child Left Behind (NCLB) Act of 2001, Pub. L. No. 107-110, § 115, Stat. 1425 (2002).

Nilsson, P. (2008). Teaching for understanding: The complex nature of pedagogical content knowledge in preservice education. *International Journal of Science Education, 30*(10), 1281-1299. doi:10.1080/09500690802186993

Rice, A. H., & Kitchel, T. (2015). The relationship between agriculture knowledge bases for teaching and sources of knowledge. *Journal of Agricultural Education, 56*(4), 153-168. doi:10.5032/jae.2015.04153

Rice, A. H. & Kitchel, T. (2016). Deconstructing content knowledge: Coping strategies and their underlying influencers for beginning agriculture teachers. *Journal of Agricultural Education, 57*(3), 208-222. doi:10.5032/jae.2016.03208

Roberts, T. G., Harder, A., & Brashears, M. T. (Eds). (2016). *American Association for Agricultural Education national research agenda: 2016-2020*. Gainesville, FL: Department of Agricultural Education and Communication.

Rosenshine, B., & Furst, N. (1973). Research on teacher performance criteria. In B.O. Smith (Ed.), *Research in teacher education: A symposium.* Englewood Cliffs, NJ: Prentice-Hall.

Selassie, M. H. (1989). Methods used to teach agriculture. *Dissertation Abstracts International, 51*(02), 0386A.

Shulman, L. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4-14. doi:10.3102/0013189X015002004

Steele, M. D., Hillen, A. F., & Smith, M. S. (2013). Developing mathematical knowledge for teaching in a methods course: The case of the function. *Journal of Mathematics Teacher Education, 16*(6), 451-482. doi:10.1007/s10857-013-9243-6

Thoron, A. C., & Meyers, B. E. (2009). Perceptions of preservice teachers toward integrating science into school-based agricultural education curriculum. *Proceedings of American Association for Agricultural Education Research Conference,* Louisville, KY, 528-541.

Trowler, V. (2010). *Student engagement literature review.* York, UK: Higher Education Academy.

Van Driel, J. H., & Berry, A. (2012). Teacher professional development focusing on pedagogical content knowledge. *Educational Researcher, 41*(1), 26-28. doi:10.3102/0013189X11431010

Van Driel, J. H., Verloop, N., & De Vos, W. (1998). Developing science teachers' pedagogical content knowledge. *Journal of Research in Science Teaching, 35*(6), 673-695. doi:10.1002/(SICI)1098-2736(199808)35:6,673::AID-TEA5.3.3.C0;2-9

Vygotsky, L. (1978). *Mind in society: The development of higher psychological processes.* Cambridge, MA: Harvard University Press.

Wolf, K. J. (2011). Agricultural education perceived teacher self-efficacy: A descriptive study of beginning agricultural education teachers. *Journal of Agricultural Education, 52*(2), 163-176. doi:10.5032/jae.2011.02163