

Using Inquiry to Develop Agricultural Education Preservice Teachers' Disciplinary Literacy Pedagogy

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Abstract

In this study, we examined using a Disciplinary Literacy Project (DLP) to develop secondary agricultural education preservice teachers' disciplinary literacy perspectives and practices. Our findings revealed that the three preservice teachers developed a deeper understanding of agricultural literacies and applied this knowledge in different ways to scaffold students' engagement with discipline-specific practices. Implications include that disciplinary literacy inquiry projects can strengthen beginning teachers' understanding of discipline-specific literacy practices and habits of thinking and encourage teachers to scaffold their students in authentic disciplinary practices.

Keywords: disciplinary literacy; agricultural education; inquiry

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Introduction

In recent years educational organizations have made calls to foster disciplinary literacy instruction in secondary students so that the students are more proficient in discipline-specific practices (National Council for Agricultural Education, 2015; National Council for the Social Studies, 2013; National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010; NGSS Lead States, 2013). This new shift posed by these national organizations expands literacy expectations to include teaching discipline-specific practices in not only the “core 4” of English/Language Arts, science, social studies, and mathematics but also non-core courses such as agriculture, music, art, and physical education (Lemley & Hart, 2018; Chandler-Olcott, 2017; Clemons, Lindner, Murray, Cook, Sams, & Williams, 2018; Park, van der Mandele, & Welch, 2010; Wickens, Manderino, Parker, & Jung, 2015). As teacher educators, we are expected to support our secondary students to meet these shifting expectations; however, there is little research on how teacher educators are doing so (Conley, 2012; Draper, Broomhead, Jensen, & Nokes, 2012; Masuda, 2014; Moje, 2008). Further, there is limited research on how to support this process with preservice teachers (Bennett & Hart, 2015; Conley, 2012; Draper, Broomhead, Jensen, Nokes, & Siebert, 2010; Hart & Bennett, 2013; Lemley & Hart, 2018; Masuda, 2014; Moje, 2008). Thus, our research into disciplinary literacy is prompted by the current status of the field. On one hand there have been increased calls for disciplinary literacy instruction in grades 6-12; on the other, there is limited research on how to support preservice teachers in this endeavor.

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Purpose

There is a minimal amount of research on what disciplinary literacy could look like in the agricultural sciences (Clemons, et al., 2018; Park, et al., 2010); this literature base is not nearly as developed as the disciplines of history, science, and mathematics (Hynd, Holschuh, & Hubbard, 2004; Massey, & Riley, 2013; Shanahan, 2012; Shanahan & Shanahan, 2012; 2008; Wineburg, 1991). Thus, the purpose of this study was to provide agricultural education teacher educators with a better understanding of the development of agricultural education secondary preservice teachers' disciplinary literacy pedagogy and beliefs, as well as shed light on the more general processes in learning through disciplinary literacies in teacher education.

Theoretical Framework and Literature Review

To situate our work, we enter this process with a view of disciplinary literacy aligned with Moje's (2015) 4 E's Heuristic of Disciplinary Literacy Instruction (engage, elicit/engineer, examine and evaluate). In this sense, we define disciplinary literacy as knowledge of and skill with the specialized linguistic codes, technical vocabularies, and discourse practices- coupled with examination and critique (Moje, 2007, 2015).

Moje (2015) proposed that there are four dimensions required to teach disciplinary literacy in the classroom--engage, where classroom practices mirror those of the discipline; elicit/engineer, where literacy skills are scaffolded by the teacher; examine, where discipline-specific vocabulary is closely examined; and evaluate, where the students consider when disciplinary literacy practices are appropriate to engage in or not. Moje noted that disciplinary literacy learning is a sociocultural experience. This heuristic emphasizes that disciplinary literacy instruction is an apprenticeship model where the teacher scaffolds the students through disciplinary experiences. However, Moje posited that this apprenticeship model can be difficult for both teachers and secondary students since many teachers may be refining their understanding of discipline-specific practices as they work with secondary students.

One way to alleviate that difficulty is through an embedded professional development model where teacher learning occurs through lived experiences such as teacher inquiry in the classroom (Desimone, 2009). Desimone (2009) proposed that high quality professional learning is made up of five factors: focused on content; coherent with teachers' practice; active learning; duration; and collaboration. In an embedded professional development model, all five factors of high-quality professional learning are present. In a longitudinal study, Desimone, Porter, Garet, Yoon, and Birman (2002) found that professional learning is enhanced when teachers work on improving their classroom instruction in a specific content area and are immersed in structured, ongoing analysis of their own teaching and learning. Guskey (2002) noted that one of the major goals of professional development is to change classroom practice through the incorporation of a new classroom strategy, a new instructional approach, trying a new curriculum, or a modification of current practice.

Literacy in Agricultural Sciences

As Clemons et al. (2018) noted, the terms agricultural literacy and agriculturally literate are used interchangeably by agricultural professionals, though the two terms refer to different things. Further, they posited that the reason this is so is because agricultural professionals do not discern a difference between the two terms. Moreover, Clemons, et al. (2018) argued that to increase agricultural literacy in the public, it might be more productive to not teach discipline-specific vocabulary. Rather, teaching "basic words and terms of which the public has a higher percentage of ability to read, write, and communicate" (p. 249) might be the solution.

The American Farm Bureau Foundation for Agriculture recently developed the Pillars of Agricultural Literacy (2012), which aligns with the call of Clemons et al. (2018) to emphasize the communication of agricultural language. The authors emphasized that the intention of this framework is to develop consistent messages across the lifespan. The pillars serve to guide educators (both formal and informal) in incorporating and implementing agricultural literacy practices into pre-K through adult instruction with the end goal of developing citizens' understandings of the relationship between agriculture and society. Though the pillars are grounded in foundational knowledge about the broad agricultural industry, this framework places strong value on understanding of relationships and the development of learners' capacities to "analyze the impact farmers' actions make on their everyday life with the intent that they will use this knowledge to inform personal decisions (e.g., voting, food consumption habits, lifestyle, etc.)" (p. 7). Thus, discipline-specific literacy entails not only understanding basic content knowledge and terminology, but also the habit of thinking to use that knowledge in daily life decision-making.

Park and Osborne (2006a, 2006b, 2007) wrote about secondary agriscience teachers and their beliefs and implementation of content area literacy in the agricultural science classroom. Specifically, in a study of 216 agriscience teachers, Park and Osborne (2006a) found the teachers believed reading was an important part of the agriscience curriculum and their students spent nearly 20% of their class time reading. However, the teachers were less knowledgeable about, and subsequently less frequent in implementing, content-area reading strategies in the agriscience classroom. Further, Park and Osborne's (2006b) study reaffirmed the lack of knowledge and comfort level that some agricultural science teachers have with content-area reading strategies. However, they found all of the teachers in their study implemented content-area reading strategies in the classroom, either with or without prompting from the researchers. The teachers noted they felt pressure from administration to help improve their students' overall levels of achievement, therefore they implemented content-area reading strategies in the classroom. Moreover, teachers noted the importance of using authentic texts in the agriscience classroom and having the students read to apply information from those texts into practice (Park, et al., 2010). Research confirmed that instruction in content-area reading in the agriscience classroom improves students' overall reading ability (Park & Osborne, 2007).

Methodology

We chose a case study design because it allowed us to examine the preservice teachers' perspectives and instruction in agricultural science "within a bounded system [...] over time, through detailed, in-depth data collection involving multiple sources of information" (Creswell, 2007, p. 73). Our case study was exploratory in nature and was guided by two research questions: (1) How does engagement within a DLP influence preservice secondary teachers' *perspectives* on literacy practices in agricultural science? (2) How does engagement in a DLP influence preservice secondary teachers' literacy *instruction* in agricultural science?

Context

This study took place during coursework taught by the second author and is part of a larger research project examining how content literacy courses can be restructured to support preservice teachers' knowledge and application of disciplinary literacy instruction. We restructured the present course around a Disciplinary Literacy Project (DLP), which is a structured inquiry project that guides preservice teachers to explore the sociocultural philosophy of literacy, the literacy practices of their respective discipline areas, and the application of these practices in their instruction. Specifically, the preservice teachers engaged in inquiry to explore how particular reading, writing, and habits of thinking are valued by their discipline and how to make these distilled habits of thinking become part of subsequent instructional practices.

In the DLP, the preservice teachers formed an agricultural sciences group where they interviewed experts and practitioners in their field and wrote a literature review on literacy in their discipline. Individually, each preservice teacher kept an ongoing reflective journal and participated in weekly class discussions about their group's findings, and applied what they learned in their research in their weekly field experience in the course, which amounted to 30 hours per week observing and teaching in a secondary agricultural science classroom. The agricultural science group presented their findings to the rest of the class in a final report and presentation at the end of the semester.

We framed the DLP based on a current literature regarding effective teacher professional learning and disciplinary literacy instruction. Specifically, when reviewing the literature we found that high-quality professional development focused on content, was coherent with teachers' practice, allowed for active learning, was lengthy in duration, and involved collaboration among teachers (Desimone, 2009). Further, we wanted our secondary preservice teachers to be able to participate in disciplinary cohorts (Bain, 2012; Moje, 2008) where they unpacked their discipline and collaborated with disciplinary experts (Conley, 2012; Draper, et al., 2010; Goldman, et al., 2016). We also wanted to avoid the content-area literacy-disciplinary literacy dichotomy (Brozo, Moorman, Meyer, & Steward, 2013; Draper, et al., 2010) where one area of literacy was privileged over another.

Table 1 illustrates how we framed the DLP based on current literature regarding effective teacher professional development and disciplinary literacy instruction. Namely, the inquiry was an ongoing collaborative process across the semester, focused on the preservice teachers' particular discipline areas, connected to their work in the classroom, and involved active research.

Table 1

Convergence of Literature on Effective PD and the DLP

Effective Professional Development	Disciplinary Literacy Project
Focused on content	Researched with literacy looks like in agricultural science
Coherent with teacher practice	DLP was connected to their work in the classroom; they applied what they were learning to classroom instruction in real time.
Active learning	DLP was connected to their work in the classroom; they applied what they were learning to classroom instruction in real time.
Lengthy in duration	Semester long inquiry
Disciplinary cohorts	Worked with other PST's who were also in credential program for Agricultural Education
Unpacked discipline	Course readings, discipline-specific lit review, interviews
Collaborated with disciplinary experts	Interviews of agricultural education faculty

(Bain, 2012; Conley, 2012; Desimone, 2009; Draper, et al., 2010; Goldman, et al., 2016; Moje, 2008)

Participants

Our participants were three secondary preservice teachers who were candidates in the single subject Agricultural Education credential program at California State University-Fresno. They had all successfully completed a Bachelor's degree in agricultural science and decided to pursue a teaching credential to teach middle and high school agricultural science. Mitchell, a self-identified male, taught an agricultural mechanics course. Valentina, a self-identified female, taught an introduction to agriculture course. Brenda, a self-identified female, taught an animal science course. We utilized convenience sampling (Merriam, 2009), which, for this study, signifies that the secondary preservice teachers were enrolled in the class and willing to participate.

Data Sources and Analysis

Data sources for the study included the Disciplinary Literacy Project reports, DLP presentation materials and transcripts of the presentations, four lesson plans, and reflective journals. All of the journals and lesson plans were uploaded to the course site at specific intervals across the semester. The journals served as a way to document the preservice teachers' disciplinary literacy beliefs and practices across time. The self-selected lesson plans served as a way to capture how the DLP was impacting the preservice teachers' instructional practices. The instructor collected the DLP report and presentation materials at the conclusion of the semester. The first author had no interaction with the students within the course and therefore provided an outside perspective for data analysis and interpretation. This strategy helped maximize validity and reliability of the data analysis. Further, the data analysis did not occur until once the semester was completed and grades were finalized. In addition, we received Institutional Review Board (IRB) approval and followed the procedures that were approved to collect the data sources.

We applied a systematic procedure for our data analysis, which was influenced by our previous work on elementary and secondary disciplinary literacy perspectives and practices. First, we coded individually for preservice teacher understandings and beliefs about disciplinary literacy pedagogy and practice using codes from relevant literature--content knowledge, identity, and discourse as framed by Moje (2008) and basic, intermediate, and disciplinary literacy levels as framed by Shanahan and Shanahan (2008) to generate a broader understanding of the preservice secondary agricultural education teachers' evolving beliefs and practice on disciplinary literacy. We also used the six Pillars of Agricultural Literacy (American Farm Bureau Foundation for Agriculture, 2012) as an analysis tool to help us identify specific agricultural literacy practices that the preservice teachers used in their lessons.

We then engaged in a deeper level of analysis by coding for Moje's 4E Framework (Moje, 2015). We did so because her framework provides an intersecting view of literacy, which focuses around authentic practice. Thus, our codes included a) Engage (engaging middle and high school students in disciplinary practices), b) Elicit/Engineer (scaffolding middle and high school students' the necessary knowledge), c) Examine (developing disciplinary discourse/vocabulary), and d) Evaluate (application of discourses). In our analysis, we used Moje's definitions for each of the codes.

In this deeper analysis, we conducted the first iteration of the 4E coding independently, recording instances of the 4E's in the data sources for a single preservice teacher. To reach a high level of agreement we engaged in independent analysis and then met to collaboratively analyze the total within the 4E framework, and then discussed discrepancies to reach agreement. Interrater reliability checks were conducted through which we were able to confirm our coding process and continued to code the rest of the agricultural education preservice teachers. We engaged in within-subject analysis to compare the three agricultural education preservice teachers and cross-case analysis was employed to compare their beliefs and practices.

Results

Overall, the data demonstrate that participating in the DLP influenced the preservice teachers' awareness and identification of disciplinary literacy practices in agriculture science. Reflecting back on their initial thoughts about literacy in their final DLP report, they wrote,

Initially as a group [...] it is safe to say that we did not think too much about literacy. In fact the most of us viewed literacy specifically as a reading comprehension ability and nothing more. We did not think that literacy or the lack thereof was an issue at all. As educators we knew that it would be our responsibility to expand our students vocabulary but beyond that we did not give literacy any credence.

This initial perspective emphasized a lack of attention to the literacies of their discipline, beyond developing secondary students' knowledge of disciplinary terminology. As the group continued reflecting on the ways their perspectives changed, they collectively identified how the inquiry process of the DLP influenced their perspectives, "Through our reading, research, interviews, student teaching and this course, we have a much greater understanding of what it mean to be literate as well as areas which we need to focus to help our students."

At the end of the semester, these preservice teachers noted that they needed to provide their secondary students with the proper scaffolds in order to access the agriculture discipline. Specifically, they identified how disciplinary concepts are tools that are applied through disciplinary practices to solve problems. In their final DLP report, the preservice teachers wrote,

For certain each of our definitions of literacy has changed, how it impacts our planning and teaching in the classroom has changed, most of all how we address and prioritize what and how we teach in the classroom has been impacted the most. We now feel that it is most important for our students to understand the concepts, models, and specifically how they are used to help solve any given problem. Focusing on skills rather than specific content has become more important than ever to help our students become the critical thinkers that we are trying to shape them to be.

As such, by the end of the project, the preservice teachers were able to recognize and incorporate into their practice many of the Pillars of Agricultural Literacy (American Farm Bureau for Agriculture, 2012). As noted in the final reflection above, these preservice teachers had a stronger grasp and the underlying principle of the pillars- develop citizens' understandings of the relationship between agriculture and society. Further, this quote illustrates how the preservice teachers shifted from viewing literacy as focused on vocabulary development and content knowledge to views that included the application of this knowledge to solve problems. Analysis of the agricultural literacy pillars revealed that all six of the pillars were frequently identified in the preservice teachers' views and instructional practices. The following sections detail how the pillars were developed through disciplinary literacy instruction.

Approaches to Disciplinary Literacy Instruction

Our analysis of how these preservice teachers applied the dimensions of the 4Es framework (Moje, 2015) identified a dominant use of engineering/eliciting instructional practices. Throughout the preservice teachers' reflections there was a consistent recognition of the need to scaffold their secondary students' understanding of disciplinary concepts and disciplinary literacy practices. Engaging students in disciplinary practices was also frequently identified as a component of instruction, though less so than engineering. However, the examining and evaluating dimensions were rarely identified; typically the examination of discourse practices was limited to learning meanings for disciplinary terminology.

Specifically, we found the preservice teachers used aspects of Moje's (2015) 4 E's as tools to scaffold their students understanding in their various agriculture classes. As such, we present the three participants as cases that exemplify different instances of the intersections and overlapping of Moje's (2015) 4 E's, specifically engaging and engineering/eliciting as ways to have their students engage in authentic disciplinary practices such as working with data and consulting and producing texts. Examine and Evaluate was scarcely identified; when it was identified, it was limited to the development of discipline-specific vocabulary. Below we describe the unique approaches our preservice teachers used to intersect engineering and engaging.

Mitchell-Engineering Across Time to Engage in Authentic Practice. Mitchell taught *Agricultural Mechanics* during his practicum experience at a local high school. In his journal he defined agricultural literacy as encompassing "agriscience language [...] used verbally in the field or onsite [and] the written form [...]safety signs and equipment directions to full written literature." This idea of agriscience language was the focus of much of his instruction in his practicum. His unit lesson plans revolved around introducing the students to types of lumber and woodworking. Throughout the unit on woodworking, he apprenticed his students through a series of steps of the woodworking process. At the end of the unit, the students built their own step stool chair in the woodworking shop. In his lesson plans, Mitchell focused on engineering his students' knowledge across time in order to engage them in the authentic woodworking practice of creating a step stool chair at the end of the unit. Specifically, Mitchell was concerned with his students developing precise language and being able to use that language in the construction of products. Thus, Mitchell demonstrated an awareness of how agricultural literacy is evident in agricultural mechanics field and connected his learning with several pillars of agricultural literacy. Specifically, he provided examples as to how the use of precise language is a key literacy component in woodworking tools and machinery (Connection Between Agriculture and Technology) and woodworking as a possible career (Relationship Between Agriculture and the Economy).

The vocabulary he introduced to his students included wood terms as well as the tools they would need to engage in the disciplinary practice of building a step stool chair from a design. In his journal he wrote about the importance of his students knowing the correct terminology for the equipment they were using in class--he called this "equipment literacy". He wrote,

This equipment literacy (what parts are called and general knowledge about equipment) helps reduce the risk of working with dangerous equipment as well as help effectively communicate what the instructor wants to get done. Also in an emergency the proper use of correct terminology will help save time and make potentially fatal situations clear to understand. This was emphasized in his lessons because the students were using woodworking equipment to build their step stool chair.

As evidenced in his lesson plans, Mitchell utilized intermediate literacy strategies to engineer or scaffold his students' learning of the disciplinary literacies. For example, in his first lesson, he focused his instruction on the different elements needed to construct a table (e.g., tools, cuts, joints, fasteners, quality of wood, and finishing products used in the making of the table). The lesson's goal was to introduce the students to the vocabulary that they would encounter throughout the rest of the unit on woodworking. He guided students to complete Frayer Models (Frayer, Frederick, & Klausmeier, 1969) for each a specific vocabulary term. Then the students played a vocabulary game called "Who Am I", where they had to guess the vocabulary word based off of clues (e.g., uses for the word, description, etc.) provided to them.

Once his students became comfortable with the discipline-specific language (or vocabulary), Mitchell had them practice using the language in an authentic context--measuring wood to build their

step stool chair and selecting a plan for their step stool chair. This pattern of building up language and then providing an opportunity to practice using that language in a real-to-life scenario continued throughout his lessons. In his third lesson plan, he introduced new terminology to the students--fasteners and joints. The students had to become familiar with fastening systems in order to build their step stool chair in the next class. Thus, his goal for this lesson was threefold--1) identify types of fasteners and joints, 2) select the correct method for joining wood for a particular project, and 3) properly join two pieces of wood together. In this lesson, to introduce the vocabulary, Mitchell provided them with visuals through a presentation on the different types of joints and fasteners. By the end of class, they were again engaged in disciplinary practices--consulting building plans and reference manuals to determine needed joints and fasteners.

In his final lesson plan, Mitchell engaged his students in using their newly developed vocabulary knowledge and equipment literacy in action as they built their own step stool chair. The students were required to write out their procedures for creating the step stool chair, using proper woodworking terminology for their tools and woodworking techniques. Once their plan was solidified, they drew out their plans and cut and assembled their step stool chair. As a result of this experience, Mitchell acknowledged that literacy is more than just knowing "the correct word or terminology." Rather, "it is the comprehension of the word or phrase that makes one literate." In his woodworking class, his students had to go beyond simply being familiar with woodworking terminology; they had to understand what the terms meant and how to use that knowledge to construct products.

Brenda- Intersecting Engineering and Engagement Through Disciplinary Tools. Brenda taught *Animal Science* sections during her practicum experience at a local high school. At the beginning of the project, Brenda described her view of disciplinary literacy as follows,

There are many different aspects of agriculture but most use some form of literacy. Whether it is in the farming aspect, where they use budgets and numbers as a form of literacy. There is also the production facilities, such as swine production, that created their own systems of identification of their animals using numbers, rather than names. The terminology used in agriculture is unique to the field and people who are not involved in the field may not know the terminology.

Brenda demonstrated an awareness of how various areas of agricultural science used literacy in different ways and emphasized the importance of vocabulary across these areas. Like Mitchell, she connected her understanding to pillars of agricultural literacy. For example, she emphasized the importance of utilizing precise language in her Animal Science class in regards to meat science (Relationship Between Agriculture and Lifestyle), equipment (Connection Between Agriculture and Technology), and history of agriculture (Relationship Between Agriculture and the Economy). Further, she identified how specific fields within the discipline used unique communication systems and mathematical practices.

Throughout her lessons, Brenda focused her instructional attention on developing students' understanding of disciplinary language as well as the unique agricultural practices she identified. Brenda's approach to disciplinary literacy instruction provides a unique example of engineering students' learning experiences through an intersection of generic literacy strategies and engagement in disciplinary literacy practices. Brenda viewed vocabulary and content knowledge as key foundations to developing disciplinary literacy, and she used generic literacy practices to engineer or scaffold her students' understanding of key disciplinary concepts. All of her lessons began with an overview of vocabulary and presentation of subject matter knowledge through lectures. Reflecting on her instructional decisions she noted,

While teaching this semester I used quite a bit of PowerPoints in my lectures. In order to help the students to understand the PowerPoints, I gave them skeleton notes so that they could write

the notes while being able to still pay attention to what I was saying. I also gave them some readings that they were allowed to highlight and write on to add to their notes. Through the generic literacy practices of note-taking and annotating, Brenda supported her students' acquisition of agricultural content knowledge. However, all of her lessons moved from delivering information to scaffolding students' engagement with various agricultural literacy practices through application activities. For Brenda this pedagogical practice was intentional and directly related to how she viewed the practices of her discipline, "From Moje's [2007] article, I realized that she discusses something that agriculture teachers do, use alternatives to textbooks. In the agriculture discipline, we tend to use more hands-on activities and skills."

Based in her value for active learning experiences, Brenda deliberately designed instruction with the intent to scaffold students' learning through activities that resembled authentic disciplinary practices. For example, in a lesson on how to determine meat quality through calculating a ribeye area (REA) Brenda identified that the literacy practice involved "using math and a specific grid used in the industry." She scaffolded the students' learning by providing an overview of the procedure, modeling how to calculate the area, and then explaining how the different measurements were used to determine the quality of the meat. She then engaged students in practicing the technique as they used the grid to measure pictures of meat. Reflecting on the lesson, she described how this engagement fostered student understanding and lamented that that activity could not have been more authentic,

Students had to measure their own ribeye pictures as a practice assessment, and they enjoyed being able to actually measure, instead of just watching me do it. If I would have been able to I would have liked to take them to the [University] Meats Lab to actually measure a ribeye themselves, however I was not able to.

As noted in this REA lesson, the constraints of the classroom context did not always afford for truly authentic practices. As in this example, Brenda reported how she relied upon bringing the tools of the discipline into the classroom. "One way that I helped my students to better understand what I was teaching them was to use a lot of visuals, whether it was pictures or actual physical tools or activities." In a lesson on swine production Brenda wanted to develop students' understanding of the disciplinary practice of piglet ear notching, "This form of literacy is a number system that is used in swine production. One way that I helped teach the students how to understand the system was that I had them make their own pig ears and notch the ears according to the system of numbers." Reflecting on this lesson, Brenda noted how the use of the tools to engage students in the practice facilitated their understanding,

I was able to show them actual equipment in the classroom so that they could physically see and touch them to get a better understanding. This activity was hands on and got them thinking. They were better able to understand without just simply reading about it.

Brenda also used tools of the discipline to intersect students' examination and evaluation of disciplinary language while engaged in specific agricultural practices. For example, in a lesson on the use of farrowing crates in swine production students examined the language of advocacy used within the agricultural field. First, Brenda engineered, guided, students' examination of the ways language is used to inform consumers and promote support for industry practices. After viewing two videos on the use of farrowing crates, Brenda guided the students to analyze the perspectives, target audiences, and purposes of the videos, with particular attention to language uses. After discussion, Brenda had the students engage in developing an argumentative essay to support the use of farrowing crates in swine production.

In another lesson students engaged in the examination of industry advertising language. Brenda guided students to analyze the language and design of advertisements from industry magazines and promotional videos. After discussion, students engaged in developing advertisements for purebred

swine farms. Though the authenticity of these practice was limited to the classroom context, the specific analysis and application of purposeful language provided students with opportunities to engage in discipline specific uses of literacy.

Valentina- Intersecting Engineering & Engaging Through Disciplinary Habits of Thinking. Valentina taught *Introduction to Agriculture* during her practicum experience at a local high school. At the beginning of the project, she described her view of agricultural literacy as follows,

Within agriculture, literacy plays a huge part. It is used in all forms from directions on how to use machinery to how much fertilizer to add to the crops. I do not think that there are any forms of communication that is unique to the field of agriculture, but all forms of communication and literacy is used. Agriculture is a field where specific and precise instructions and directions are needed to grow crops correctly or take care of the animals. It is a field that spans over many areas, from mechanics, crops, animals, plants, floriculture, and the likes.

While Valentina did not initially identify the uniqueness of agricultural literacy in comparison to other disciplines, she demonstrated an awareness of the different ways literacy is applied across the different areas of agricultural fields and connected these different applications with several pillars of agricultural literacy. In particular, she provided several examples of how the use of precise language is a key literacy component of crop production (Relationship Between Agriculture and Food, Fiber and Energy), animal welfare (Relationship Between Agriculture and Animals), and use of machinery (Connection Between Agriculture and Technology).

Valentina's views of agricultural literacy changed over the course of the inquiry process. In her final reflection she identified this new perspective and emphasized a deeper awareness of how literacy was represented by various agricultural practices,

Looking back to the beginning of the semester and how I looked at literacy in my content area, my thoughts and outlook have changed. I did not think about ALL the different ways literacy is used in agriculture. I never looked at when a student does a science experiment, and fills out a graph as being literacy. I learned that literacy is more than reading.

In this reflection, Valentina identifies that working with experimental processes are unique agricultural literacy practices. Engaging in these practices, requires unique skills to collect, organize, and communicate information.

Similar to Brenda's instructional practices, Valentina intersected the engineer and engage dimensions within each lesson. She also followed a similar procedure of engineering students' exposure to content and procedural knowledge through generic literacy practices, such as annotating and note-taking. However, in contrast to Brenda and Mitchell's emphasis on engaging students in the agricultural practices, Valentina focused on guiding students to understand the habits of thinking of various agricultural fields.

For example, in one lesson Valentina guided students through a deep analysis of the National Future Farmers of America Creed and had them write reflections of their personal connections to the principles of the document. Reflecting on the lesson, she expressed her aim to develop students' disciplinary habits of thinking, "I really wanted them to understand the important principles of the FFA and how these relate to farmers' beliefs and decisions about their work." Through the use of an authentic disciplinary text, Valentina was able to develop students' understanding of specific disciplinary ethics and values and connect with the pillars of agricultural literacy related to relationships with the environment; food, fiber and energy; and animals. This lesson illustrates how she intersected engineering and engaging domains. She scaffolded students through the analysis of the FFA creed, while simultaneously having them engage in the habits of thinking espoused by the creed.

In another lesson, Valentina focused on the agricultural literacy pillars related to relationships with the economy as she engaged students in analyzing the processes of production and distribution. Similar to the previous example, she used authentic disciplinary texts, such as business agreements, record keeping logs, and calendar planning tools. Reflecting on the lesson, Valentina noted that her emphasis was on “getting the students to understand that there are many different careers related to agriculture.” She elaborated that she wanted to develop students’ understanding that “farming is a business” and that different careers in agriculture required “different ways of thinking.” Valentina’s comments demonstrate her consistent view of trying to develop students’ disciplinary habits of thinking.

Discussion

As this study focuses on one small sample of agricultural education preservice teachers, caution must be exercised in overgeneralizing the findings to other agricultural education preservice teachers or those in other programs. In addition, the study represents one single segment in time, a single semester in their credential program. However, this study does add to the limited body of knowledge on agricultural literacy (Clemons, et al., 2018; Park & Osborne, 2006a). Specifically, the findings indicate that the DLP inquiry process facilitated identification and integration of disciplinary literacies in agricultural science. As with our previous research (Bennett & Hart, 2015; Hart & Bennett, 2013; Lemley, Hart, & King, 2019), we found that the use of ongoing collaborative inquiry, in the form of the DLP, does support preservice teachers’ unpacking of disciplinary literacy practices. This unpacking fosters beginning steps to integrate these disciplinary literacies into classroom instruction. Thus, the DLP was productive in producing agricultural education teacher disciplinary literacy pedagogy.

In addition, we found that the 4E framework (Moje, 2015) served as a useful heuristic for conceptualizing disciplinary literacy instruction. Using the 4E framework may support agriculture teacher educators and agriculture teachers with a structure to support disciplinary literacy instruction in their classrooms. The 4Es as an embedded model of dimensions appears to be supported through the intersections identified in this study; more importantly, this study suggests that there are a number of ways for teachers to approach this model that may be linear, cyclical, and/or recursive.

Implications and Conclusions

Much of the work in secondary disciplinary literacy instruction has focused on the “core 4” (e.g., science, mathematics, social studies, ELA), therefore this study adds to a small, but emerging body of literature on disciplinary literacy pedagogy in non-traditional subject areas (Barton, 2015; Clemons, et al., 2018; Frambaugh-Kritzer, Buelow, & Steele, 2015; Huber, Dinham, & Chalk, 2015; Jensen, Asay, & Gray, 2010; Wickens, et al., 2015). The findings of this study hold interesting implications for teacher educators working with secondary teachers, in general, and agricultural education teacher in particular. The three teachers in this study consciously applied disciplinary literacy instruction in their classes. The Disciplinary Literacy Project described in this study provides an example of a different mode of inquiry that can strengthen teachers’ understanding of discipline-specific literacy practices and habits of thinking (Bennett & Hart, 2015; Hart & Bennett, 2013). Such inquiry may foster teachers’ adjustments in beliefs about literacy instruction in their content area classrooms and promote their use of disciplinary literacy instruction (Monte-Sano, De La Paz, & Felton, 2014). However, because our study examined their practice over the course of a semester, we believe the field would benefit from a longitudinal study examining how such inquiry projects like the DLP influence instruction over an extended period of time.

Further, as Moje (2015) posits, disciplinary literacy instruction should be grounded in engaging students in disciplinary practices. In line with previous research on non-core content areas (Barton, 2015; Clemons, et al., 2018; Frambaugh-Kritzer et al., 2015; Huber et al., 2015; Jensen et al., 2010; Wickens, et al., 2015), the preservice teachers in this study demonstrated a conscious desire to scaffold their students into the authentic practices associated with a variety of agricultural fields of study. Perhaps this intentionality to design authentic experiences for students in agriculture may provide examples for other teachers across disciplines. For future research, we encourage other researchers to take up Moje's (2015) 4E model and examine what strategies teachers use to successfully intersect the various dimensions of the model.

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