Journal of Agricultural Education
Volume 51, Number 3, pp 100 – 113
DOI: 10. 5032/jae.2010.03100

Creating a Culture that Fosters Disciplinary Literacy in Agricultural Sciences

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In the discipline of agricultural science education, which is taught in 7,500 secondary schools across the country, teachers have a responsibility for contributing to students' overall academic achievement. These interviews, conducted with five secondary agricultural science teachers, concerned teachers' perceptions of their role in developing students' literacy. These teachers believed that (a) reading is necessary for success in life but supplemental in agricultural sciences; (b) literacy instruction was embedded into agricultural science teaching; (c) teachers asked students to read to apply; and (d) they used authentic texts, which they often referred to as outside readings. These conclusions provide insights into avenues for which disciplinary literacy instruction in agricultural science may contribute to students' overall academic achievement, engagement with texts, and learning from reading and literacy, as well as further the notion of disciplinary literacy.

Keywords: disciplinary literacy, reading, classroom teaching, content area reading, agricultural literacy

Disciplinary Literacy in Agricultural Sciences

Researchers at ACT assert that many high school graduates are not ready for workplace reading (2006). Consequences of illiterate graduates may be severe, detrimental, and restrictive. Illiterate individuals often fail to fully participate in careers and society (Cappella & Weinstein, 2001; National Association of Secondary School Principals, 2005; National Association of State Boards of Education, 2006; National Governors Association, 2005). With the emphasis on applied literacy across the curriculum, intentional and explicit instruction using texts as learning tools cannot be relegated solely to English courses. Reading must occur in *all* disciplines.

Agricultural science education and most of the secondary education programs in the United States are under increased pressure to demonstrate positive impacts on students' academic achievement. The No Child Left Behind (NCLB) legislation had the intent of ensuring all students meet the same academic standards (Martin, Fritzche, & Ball, 2006). The United States Department of Education stated that career and technical education (CTE) has a role to play in raising academic achievement (Martin et al., 2006). This role for CTE will involve greater integration of academics into the traditional curriculum (Martin et al., 2006). The challenge for agricultural science teachers is to determine how they can positively impact students' overall academic achievement through use of disciplinary literacy and reading strategies that align with the kinds of texts found in agricultural science education and satisfy the purposes for reading in agricultural science.

Reading is a critical area of academic integration into agricultural science education. Specifically, the teaching or reinforcing of reading comprehension tends to be challenging for agricultural science teachers, especially because the teaching of reading strategies tends to be viewed as separate from learning the discipline (Moje et al., 2004). Disciplinary reading, like that found in agricultural science, requires more advanced reading skills than what students are taught in the elementary and middle grades (Moje et al., 2004; Park & Osborne, 2007). Students must also develop literacy skills to keep up with the pace of the rapidly changing

information age (Alvermann, 2001), including changes within and about agricultural sciences. Adolescents have to tackle increasingly difficult and complex reading assignments (Alvermann, 2001). The agricultural science teacher must build on students' foundation of the mechanics of reading and help students develop competency in disciplinary reading strategies that will improve reading comprehension within the broad field of agricultural science.

Due to a lack of understanding and familiarity with specific reading strategies (Park & Osborne, 2006, 2007b) teachers often fail to implement reading strategies in their courses (Bean, 1997; Jackson & Cunningham, 1994–95; Stewart & O'Brien, 1989). In addition, Park and Osborne (2006) found that less than 40% of agricultural science teachers had completed a content area reading course in their college education. When they do engage in literacy instruction, agricultural science teachers often focus on comprehension after the reading actually occurs, which is essentially an assessment of their comprehension after reading (Park & Osborne, 2006). Instruction during all three micro–periods gives students a greater opportunity to learn and construct meaning from assigned text.

The theory of disciplinary literacy posits that literacy is highly contextualized within disciplines (Moje, 2007; Shanahan & Shanahan, 2008), especially CTE. Literacy, and how individuals define and use it (Lewis & Moje, 2003), is dependent upon the context in which it is situated, and thus engagement in literacy activities may differ from one context to another. Situated literacy is literacy that takes place in a distinct discourse community (Darvin, 2006). Vocational, or career and technical education, teachers use texts and language differently than their academic counterparts (Darvin). Barton, Hamilton, and Ivanic (2000) explained that the concept of situated literacy allows researchers to "accept the multiple functions literacy may serve in a given activity, where it can replace spoken language, enable communication, solve a practical problem or act as a memory aid—in some cases, all at the same time" (p. 13). Within career and technical education, opportunities exist to use text in authentic ways that utilize multiple disciplines for the purpose of applying information from texts to real–world situations (Darvin, 2006). Thus, learning in and about agricultural sciences is situated within the specific discourse communities of the field (Lewis & Moje, 2003). When used in the context of agricultural science education, literacy is *disciplinary literacy*, as described by Moje (2008): "a form of critical literacy because it builds an understanding of how knowledge is produced in the disciplines, rather than just building knowledge in the disciplines" (p. 97).

Within this situated literacy and within the sociocultural environment of the classroom, social patterns, often governed by the teacher, influence students' reading, both in breadth and depth (Guthrie, Schafer, Wang, & Afflerbach, 1995; Moje, 1996). Disciplinary teachers who provide instruction in the use of reading strategies help students succeed at reading tasks. Students read more when their teachers have helped them activate background knowledge, set purposes, develop vocabulary, and ask questions about the reading. However, the increase in student reading has only been evident when teachers made students aware of cognitive reading strategies and created a social environment that encouraged interactions with reading.

Teachers can make a difference in the reading achievement of students (Forget & Bottoms, 2000), and they can influence student motivation to read through emphasis on classroom reading (Moje, 1996; Park & Osborne, 2006). Secondary teachers, including many agricultural science teachers, view their main objective as teaching in the discipline (Park & Osborne, 2006) because they expect students to know how to read before they arrive in their classroom. Teachers' orientations to reading are reflected in the decisions that they make regarding instruction (Konopak, Readence, & Wilson, 1994). McKenna, Kear, and Ellsworth (1995) determined that attitudes toward reading may be affected by attitudes of influential others, including those of the teacher, toward reading. However, not all teachers are created equal when using texts and influencing their students to read. Experienced teachers tend to provide more in–class time for reading and rely less on the text to supplement instruction (Menke & Davey, 1994). More experienced teachers also tend to teach students how to use textbooks more frequently than less experienced teachers (Mehnke & Davey, 1994). Still, most teachers, regardless of

experience levels, do not engage students in book discussions.

Researching content area literacy implementation in classrooms, O'Brien, Stewart, and Moje (1995) concluded that disciplinary boundaries may cause students to view reading and writing as "a set of routinized, limited responses to bland texts rather than as a way to interpret texts or a means of producing texts to understand broader social and political issues" (p. 449). They advocated that disciplinary literacy research and teaching "move beyond the teaching of strategies alone toward teaching pre– and in–service teachers to recognize, analyze, and work within the complexities that shape secondary teaching and learning" (p. 447).

Purpose and Objectives

The purpose of these interviews was to investigate how agricultural science teachers perceived literacy in their agricultural science courses. The objectives of this study were (a) to examine teachers' perception of their role in developing literacy in their students, and (b) to determine how teachers approach disciplinary literacy in secondary agricultural science.

Procedures

In order to begin to explain disciplinary literacy in agricultural science, the researchers conducted extensive individual interviews with five teachers to gather information about teachers' construction of reality regarding literacy in secondary agricultural science (McCracken, 1988). Similar to a formative design experiment (Reinking & Bradley, 2007), the interviews were part of the initial design of an experimental study in order to gain insights and greater levels of detail about the use of literacy and strategies in agricultural science courses. These teachers comprised the treatment group of the experimental study on reading strategy use in agricultural science education. Interviews were conducted prior to implementation of strategies and after conclusion of students' posttesting in the experiment to gain understanding of the teachers' perceptions and use of literacy in agricultural science.

All teachers in the experiment initially volunteered to participate in the experiment on reading strategy use in agricultural science courses. The teachers were then randomly selected to participate as treatment or control group teachers in the experiment, and, because of their selection for the treatment group, the teachers were subsequently selected for these interviews. Table 1 (all teacher names in this manuscript are pseudonyms to assure anonymity and confidentiality of the teachers according to the Cornell University Institutional Review Board certificate of approval) provides information about the teachers and their students to provide context for their comments, as well as to establish conditions for transferability of the findings. All five teachers had earned a master's degree. The teachers represented diversity of gender, diversity of years of experience, and varying degrees of reading achievement and socioeconomic status of students in their schools. The New York State Regents Examination categorizes students based upon their scores; students scoring at levels 1 and 2 are the lowest performing students in reading, thus reading below grade level.

Table 1
Demographic Information about Agricultural Science Teachers and their Schools (n = 5)

	Teacher Information				School Information		
Teacher	Gender	Experience (years)	Degree	Reader	Students (*n*)	Students below level 3 on state assessment (%)	Free / Reduced Lunch (%)
Erin	Female	20	MS[a]	Yes	374	34	27
Nancy	Female	6	MAT[b]	Yes	695	21	32
Eric	Male	23	MAT	No	773	15	24
Rich	Male	22	MAT	Yes	427	30	65
Dave	Male	2	MAT	Yes	540	22	32
Average		14.6	—	—	562	24.4	36

[a] MS is the Master of Science degree.
[b] MAT is the Master of Art in Teaching degree.

Interview questions were generated from a review of the literature on content area reading (Park & Osborne, 2006). The interviews provided a rhetorical construction of the teachers' perceptions of reading strategies (Lindlof & Taylor, 2002). The review included an analysis of both analytic and cultural categories, encompassing an examination of the researcher as the measurement instrument (McCracken, 1988), as well as an assimilation of ideas for constructing the interview questions. Questions used in the interview included, (a) how do you approach literacy in your agricultural science courses? (b) how important is disciplinary reading for learning in agricultural science?; and (c) as an agricultural science teacher, how do you view your role in teaching reading or developing reading skills in students?.

The researchers interviewed teachers in the classroom setting at the teachers' convenience. Interviews were digitally recorded, and audio files were transcribed for analysis (Creswell, 1998). Interviews resulted in over four hours of recordings and over 42,000 words (Table 2). The researchers emailed the transcribed interviews to teachers to ensure that their thoughts were represented accurately. The final step involved the inductive analysis of the interview transcriptions and discovery of themes within the interviewee's communicated ideas.

Table 2
Length of Teacher Interviews in Minutes and Words (n = 5)

	Time (minutes)			Words		
Teacher	Prior to Implementation of Treatment	After Conclusion of Students' Posttesting	Total	Interview 1	Interview 2	Total
Erin	27:00	25:08	52:08	4,653	5,270	9,923
Nancy	24:46	36:06	1:00:52	4,074	6,198	10,272
Eric	42:27	18:27	1:00:54	6,068	2,472	8,540
Rich	12:27	29:10	41:37	2,759	6,790	9,549
Dave	14:03	19:53	33:56	1,748	2,649	4,397
Total	2:00:43	2:08:44	4:09:27	19,302	23,379	42,681

Emerging themes from the interview transcripts were coded, sorted into categories of interest, and analyzed by the research team using inductive analysis. The inductive analysis followed other models of inductive analysis (e.g., Glaser & Strauss, 1967; Miles & Huberman, 1994; Spradley, 1979) and included a search for ''patterns of meaning in data so that

general statements about phenomena under investigation can be made'' (Hatch, 2002, p. 161). Researchers using inductive analysis implemented the following steps:

1. Read data and identify frames of analysis,
2. Create domains based on semantic relationships discovered within frames of analysis,
3. Identify salient domains and assign them a code,
4. Refine salient domains and keep record of emerging relationships,
5. Decide if domains are supported by data,
6. Complete analysis within domains,
7. Search for themes across domains,
8. Outline relationships within and among domains, and
9. Select data excerpts to support the relationships (Hatch, 2002, p. 162).

The researchers used an open coding system, checked with interrater reliability. This open coding helped identify general comments and concepts that were further analyzed through axial coding and grouping the evidence into topical categories that were specific, descriptive, and useful in understanding literacy in agricultural science courses. Emergent themes were checked among the researchers for validation. To further ensure validity, themes were compared to classroom observation field notes and focus group transcripts for triangulation.

Confirmability was established with the audit trail for this research, which consisted of the audio recordings, interview transcripts, interview guides, list of interviewees, themes generated from the transcripts, and the working conclusions about teachers' perceptions of reading and reading strategy instruction in agricultural science. After interviews were transcribed, we read the transcriptions to identify themes (Creswell, 1998), coded pertinent themes, and reread the interviews to find specific examples to support the themes. The researchers wrote summaries of the interviewees' constructed realities from the final themes.

Credibility was established through member checks. Summaries were emailed to teachers to allow them space to comment on their thoughts, ideas, and voices, and to ensure that they were represented accurately. The participating teachers made no suggestions for altering their ideas in the manuscript. Dependability of the research and findings were established by maintaining a research journal of all procedures, analyses, and resultant themes.

Findings

Reading and Literacy are Important, but Supplemental to Learning in Agricultural Science

Three teachers agreed that literacy was necessary for students' future success in school and beyond. Nancy said, "I'm trying to prepare [students] for college. Any form of communication and professional communication, they're better off." Eric suggested that students are "going to have to develop strategies to survive out in the world." Dave said, even more assertively:

> I really have a strong conviction in reading and writing and that it's really, really important, and if you want to be successful and, you know, really explore ideas, those are key components to successful understanding… It's extremely important, because it's the applied science that's constantly living and evolving, and the only way the students are going to give themselves a competitive edge is to really understand what's going on.

Teachers did not suggest that reading or literacy comprised large portions of their courses. Eric explained that reading was "supplementary to the program." Erin explained that she provided limited opportunities for individualized student reading in class:

> Like 15 minutes of silent reading in my class is, it's kind of foreign… I'd rather assign reading as homework, come in, and do it. So, because I don't like spending class time on just the silent reading type stuff. I'd rather them read it, come in, be ready to roll with it.

Erin's comments indicated that her students enjoyed the hands–on applications of learning more than the reading. She stated, "I think the kids come in wanting to do stuff and they're

happier when they're doing stuff. And I put like the stuff they like to do with the stuff they, like reading, don't necessarily love to do."

Teachers indicated that they gave individual help to students who are struggling with reading. In terms of their role, they saw themselves as giving students applied opportunities for literacy, and offering a different perspective than what they might find in an English or reading course. Nancy described her job in helping her students to read in this way:

> I integrate more and more reading into the ag program because they need to know how to read specifically technical reading… I feel my job is to encourage them to read within the agricultural realm and that just makes them a better student – person.

Dave believed that his role was to assist students with understanding the language used in agricultural science, which may have specific applications and vocabulary in agricultural science. In response to the question of how he viewed his role in developing literacy as an agricultural science teacher, Dave said:

> My role is to really get [students] comprehending the agricultural terms. And the students need to understand that they can decode these words and understand and use them and talk coherently to another person in agriculture. So, it's vital if they're going to go into agriculture that they get it.

Thus, learning the language of agricultural science seemed important from his perspective, not only for learning in the course, but also for extending knowledge about agricultural science to others.

Implicit, or Embedded, Literacy Instruction

Most of these teachers expressed the viewpoint that reading strategies should be implicit or embedded into the curriculum and instruction. Eric stated that his approach to literacy instruction "just kind of happens. Um, my focus isn't on reading. Does it happen and occur along the way? Absolutely." The embedded aspect of literacy instruction pervaded the participants' responses. Erin gave this description of her approach to literacy:

> I think most of it is just, it's so embedded. I don't even think about it. It's just when you do, we're doing a project and you have to be able to read and comprehend and do this in order to be able to, to finish.

She went on to explain the role of reading in student learning:

> I don't think I've ever said, 'Read this right here right now in class to do this.' It would be like, 'You need to read this so you can do this.' So it's embedded in the projects. It's not really something that's stand alone. … Like the day like we did the questioning and the post it notes and stuff, I gave them 15, 20 minutes to work on it in class. I was going crazy. It was me. They were fine. I was going crazy going, 'Let's do something now!' It's always just been in every project, that you're going to read this for a little while, then you're going to work on this.

As a teacher, Erin believed that she included reading as a natural part of all of her instruction. Still, the researchers were interested in evidence supplied by teachers to support their implementation of literacy strategies in their instruction.

The use of reading strategies was individualized to specific students and implicit within the instructional routine of the agricultural science course. Most teachers provided individual instruction with students that focused on reading and reading strategies. When asked about individualized instruction, Erin gave this response, "Oh yeah, I will help. Oh, absolutely, yes. No, I don't say, 'sink or swim.'" When asked to provide an example of how he implemented reading and reading strategies in agricultural science courses, Eric cited an example of providing individual help to students without overtly calling the student out in class. As a teacher, Eric would typically say:

> 'Here, we need to read through this. Now I know a few of you're going to struggle, so I'm going to help you out a little, pair you up. Jimmy, what did you just read? Well, I know you're struggling with the answer here. Johnny's going to help you a little bit, see if this is what you understand or what you read.' In doing that, I'm not saying,

> 'Jimmy, you can't read. Here, we're going to help you develop those strategies.'

While teachers stated that they included reading in agricultural science courses, their evidence of literacy instruction was somewhat lesser. Classroom observations revealed little evidence of explicit teaching of reading or literacy strategies.

Outside Reading, or Authentic Texts, are Often Used in Agricultural Science

While most teachers used a textbook to teach their courses, they also supplemented their instruction with other text sources. Their perception was that using relevant articles and other sources from outside of the textbook contributed to students' motivation to learn. When asked how they implemented literacy activities in their classes, most of the teachers cited assigning students to read what was universally called the *outside reading*. After reading the *outside reading*, students summarized the reading and presented it orally or included it in a class discussion. Teachers found that using the *outside reading* was more beneficial for teaching students and gaining their interest than using a traditional textbook. Rich provided a description of how he used outside reading:

> I would pull related topics to what we were currently covering in class and I would give them an outside reading assignment. I would then give them some general questions for comprehension and understanding to be brought in the next day.

Because the science and application of agricultural science is relatively fluid, these *outside*, or *authentic*, *readings* contributed context, relevancy, and immediacy to classroom instruction. Dave, a two–year teacher, explained his use of the *outside reading*:

> Trade magazines really helped the students keep current as to what's really happening in our community... It makes them reflect more on what they've read and tries to draw associations… I try not to use the textbook in its entirety, so the students aren't aware that they're really reading textbooks.

Erin, an experienced teacher, indicated that she also used authentic texts from the field of agricultural science: "I cut out the newspaper article and hand it out….it's more current. It's maybe more valuable. Stuff they're gonna [read] at home anyway." When asked about her thoughts on textbooks, Erin responded, "I've never been a textbook teacher. Like I don't have a classroom set of textbooks for any of my classes because it's just not my style to do that." Nancy went as far as to say, "I think too often we think teachers need to have a textbook, and you teach right out of a textbook, and I am as far as anti–textbook as you can possibly get. I think you limit yourself with using one source."

Reading in agricultural science extends beyond prose literacy or even document literacy (United States Department of Education, 2007) and encompasses many applications beyond text. Teachers cited the importance of students being able to read surveys and manuals. Eric, an experienced teacher, stated:

> When we are operating a backhoe, and it's a user manual or owner's or operator's manual, it's going to be vital information in there that the learner has to understand in operating that piece of equipment. So, some of those technical [manuals] are very, very important from safety, rules, et cetera.

Nancy agreed as she provided an additional example where:

> If you've got a kid that's going into [agricultural] mechanics, and they can't read an owner's manual or a technical manual, there is a problem there… Technical reading is involved in every aspect that we do in agriculture. They need to learn how to read technical manuals, technical bulletins, and, whether it's about science or Diesel mechanics, they have to be able to communicate effectively.

Again, the notion of learning the language of the discipline of agricultural science appears important to these teachers. Rich also mentioned the use of technical manuals and the fact that he did not define these activities as *literacy*: "In ag mechanics when they have to use a shop manual, you know, the Briggs [and Stratton engine]

manual to find information. I guess maybe I was doing it all along, just not calling it *literacy*."

Students Read in Order to Apply

All five teachers used reading for creating or elevating background knowledge before doing hands–on activity or application. Rich suggested that literacy was integrated in his curriculum by explaining that it was necessary in order for students to get to the fun of working in the shop. Rich stated:

> [Students] see [reading] as a part of, when we start a new unit, there is some homework assignment they have to complete or before they can go on, you know, when we do electricity. There's some reading assignment that they'll have to go through to complete before they can start in on the activities so—I guess it's just – it's always been integrated into the course.

In this way, literacy activities were conducted with students in order to test their readiness for hands–on, applied learning. The implied meaning is that these activities and reading were perhaps difficult for students and not particularly enjoyable. Nancy responded, "I will take certain material out, put it in a PowerPoint presentation or we'll just do it with notes on an overhead…, [and] then we actually go out and we apply it." Erin indicated that she would tell her students, "'You need to read this [text material] so you can do this [activity].' So it's embedded in the projects. It's not really something that's stand alone." Eric said, "It's really teaching with a backdoor method that 'Here is information, and once you learn that information then you are ready to apply it to an activity.'" Again, the embedded nature of literacy within the discipline is evident in teachers' perceptions.

Students enroll in agricultural science courses for a variety of reasons, including the application of science concepts to solve real–world problems. Thus, when they read about agricultural concepts, they are seeking solutions or constructing meaning that solves a real problem. Students apply the knowledge that they create. Eric realized that his students want to apply their learning:

> They don't want to sit and read another book… [They] want to go and do something. [They] want to get up, [they] want to move [their] hands, [they] want to operate things…Part of my task, too, is to keep those kids wanting to come back to school.

Rich also reinforced the idea that his courses could not be focused on reading: "If you made 75% [of the class] reading, yeah, they'd be hitting the door." Erin agreed, "I think the kids come in wanting to do stuff and they're happier when they're doing stuff… They don't take [agricultural science] classes thinking they're going to be sitting for 40 minutes for 40 weeks." Thus, herein, teachers justified the embedded nature of literacy in agricultural science without being implicit in their approach.

Dave suggested that his students did not like an increase in reading during agricultural science courses. Responding to an increase in reading, he said, "It felt like an English class and they were kind of frustrated with it and they were like, 'this is science class. This is supposed to be fun. You did cool stuff last year.'" However, Nancy leveraged reading in agricultural science courses by following the reading with applications of knowledge and comprehension:

> Too often in the other classes they're reading, and it's like, 'What am I ever gonna [*sic*] do with this stuff?' First of all, they're taking it because it's a fun class. Second of all, they wanna [*sic*] learn a little bit of something. Why they're in this class? 'Cause [*sic*] it's something of interest to them.

Prior to this study, few of the teachers also provided opportunities for practice with reading strategies. All of these teachers did use some type of literacy activity to enhance student learning, though they may not have perceived their approaches to instruction as a reading or literacy activities. Erin explained her role as giving students another opportunity to practice reading and use of reading strategies through agricultural science:

> Well, it's one of those practice things. If you can practice here, and if you can practice in English, and if you can practice in Social Studies, the more you practice [reading], it's got to get better…They may not learn tons of reading strategies from me, but if they learn one or two, and if they learn one or two from the social studies teacher, and one or two from the English teacher, and one or two from the math teacher. Or, you know, [it's better] if they learn a little from everything.

Conclusions/Implications/Recommendations

The teachers who participated in the interviews were self–selected to participate. Thus, they are most likely not typical agricultural science teachers, but have motivations and interests about improving students' reading and literacy skills, as evidenced by their volunteering to participate in the study. Therefore, the findings of this study may well represent the perceptions and practices of teachers who are early adopters of literacy engagement and reading strategy instruction in agricultural science. In essence, the limitation is that these teachers may represent a best–case scenario of agricultural science teachers with regard to literacy.

Several conclusions may be reached about the teachers in this study. These teachers believed that (a) reading is necessary for success in life but supplemental in agricultural science, (b) their literacy instruction was embedded into their agricultural science teaching, (c) teachers expected students to *read in order to apply*, and (d) they used authentic texts which they often referred to as *outside readings*.

Agricultural science teachers did not see themselves as English teachers, which is consistent with current thinking in disciplinary literacy (Moje, 1996, 2007; Shanahan & Shanahan, 2008). Still, these teachers perceived that literacy and reading were important to learning in agricultural science, as well as later in life. They believed that if students lack reading skills, then they will have a lower chance of being hired for productive careers, and they will have fewer opportunities for success in life. Students need literacy skills to be able to read manuals and other technical texts, including research publications, if they want to pursue a career in agricultural science. Teachers should stress the importance of reading for both learning in the discipline and for future success.

Although literacy can benefit all students, it is important to question the appropriate implementation of literacy programs, both in locus and quantity. Viewing literacy as supplemental to the agricultural science course is consistent with previous findings (Park & Osborne, 2006) and may be appropriate for agricultural science education. Teachers reinforced the importance of reading in agricultural science *and* they still believed that hands–on learning was essential. They felt that to understand the lessons and texts used in agricultural science, students must be able to apply the content in action. Teachers should emphasize the importance of reading in order to complete and learn from projects safely and correctly. It should also be emphasized that reading is important for gaining background knowledge about a lesson.

The embedded nature with which these teachers described their reading and literacy in agricultural science education contrasts with contemporary thought in the larger literacy field where reading strategy implementation and literacy instruction should be explicit (e.g.: Shanahan & Shanahan, 2008; Snow, 2002) and the research that suggests that teachers disavow reading and literacy instruction as vital to learning in the content area (Alvermann & Moore, 1991; O'Brien & Stewart, 1990). Whereas these teachers suggested that their disciplinary literacy instruction was embedded, Draper (2008) posited that Vacca's (2002) invisible, or implicit, literacy instruction may allow a more authentic transaction with texts in agricultural sciences. This is the most prevalent finding of this study and one that should be explored further. Why do teachers feel that reading and literacy should be implicit? How do they manage to embed literacy activities and reading strategies into their curriculum? What is the effect of this implicit approach to literacy on student level factors, such as comprehension, reading skills, and motivation to read? Do other disciplinary teachers harbor similar perceptions of literacy?

Although a large portion of agricultural science courses involves applied learning, all the teachers felt that it was important for students to be able to read to activate background

knowledge before starting a project. Students need to be able to read instructions and understand the questions they are trying to answer before they can start a new project. Students must develop a basic understanding of what they are learning about, so they can apply the knowledge. Teachers should provide relevant and interesting reading before lessons so their students maintain an interest in the lesson, as well as create the knowledge necessary to learn effectively from an activity.

An interesting dichotomy arose during these interviews, namely *reading to apply* compared with either *learning to read* or *reading to learn*. *Reading to apply* has, to date, not been mentioned as a major area of study within reading or literacy research and instruction, yet, clearly, within agricultural science education and many other CTE areas, teachers strive for students to apply their learning so solve problems, create new products, or some other meaningful way. In this context, *reading to learn* still connotes the extraction of meaning from text; whereas *reading to apply* extends reading to the creation of new knowledge on the part of the reader. Jacobs (2008, citing Chall, 1983) suggested that as readers move into and beyond college, they establish their own purposes for reading, evaluate what they read from multiple perspectives, and construct their own knowledge after reading. These agricultural science teachers indicate that they ask their students to engage in this kind of abstract and concrete construction of knowledge as high school students. Further studies should be examined to further define what teachers mean by *reading to apply*. As additional research is needed to "clarify how cognitive strategies operate in content–area classrooms to prepare adolescents for their future" (Conley, 2008, p. 85), this research contributes to the notion of a "complex view of literacy instruction" (Moje, 2008) in the disciplines of the agricultural sciences.

Teachers in this study held the belief that reading activities should either introduce new learning to students or should be used as a gateway for hands–on applications of learning new concepts. This perception poses potential pitfalls for agricultural science students who struggle with reading unless teachers scaffold reading experiences to help students comprehend what they read. For example, if students are expected to read on their own to learn baseline information about a new topic, then the students who struggle with reading will not gain this learning and lag behind their fellow students who read and comprehend effectively in the discipline. Subsequent classroom discussions, activities, laboratories, field trips, and other hands–on activities will hold less meaning for these students who struggled with reading and failed to grasp the initial concepts. Thus, students with reading difficulties have little opportunity to gain the help that they need to navigate difficult agricultural texts and learn key agricultural concepts.

Teachers provided much evidence of implementing literacy through the use of the *outside reading*, which included trade books and magazines in agricultural science courses. With regard to reading in agricultural science, teachers believed it to be imperative for students to be able to read different genres, such as manuals, survey maps, and instructions – indications of both document and prose literacy (USDE, 2007). While not employing general reading strategies when reading these authentic texts within agricultural sciences, teachers and students reinforced the kinds of interactions with texts that are necessary to learn in "upper–level, academic, and content–area classes" (Moje, Overby, Tysvaer, & Morris, 2008). Teachers realized the importance of reading safety texts, because, if students lack the skills to read or read instructions and manuals properly, then they may not know how to safely operate equipment both now and in future careers where literacy skills are essential. Teachers also believed that students were averse to reading textbooks because when doing so students felt like they were engaged in busy work and got discouraged. Students read textbooks in other content courses, and they seek alternative and authentic learning experiences in agricultural science courses. This may be an expectation and/or culture created by the agricultural science teacher. Most teachers felt that outside articles were more useful than textbooks because these are current, relevant, and applicable in students' lives.

These interviews instigate several questions for further research. First, what is the balance between too much literacy instruction in the agricultural science classroom and not enough? What and how do professionals in agricultural science industries read? How do teachers feel

that their role as educators changes upon implementing more literacy into their courses?

Further studies should be conducted to define what teachers mean by *reading to apply*. How does *reading to apply* extend our understanding of the theory of disciplinary literacy? What strategies facilitate *reading to apply* the information and ideas that are co–constructed when students read within the context of agricultural science? How does *reading to apply* change the process of reading comprehension? How do we measure the application of ideas, concepts, and processes arising from reading?

With the increasing emphasis on core academics, especially literacy and reading, progressive agricultural science teachers appear to be more aware of the need to implement reading strategy instruction and literacy engagement opportunities in their agricultural science courses. This research also highlighted the need for further study of the embedded, or implicit, nature of literacy in agricultural science and *reading to apply*. Both of these may provide insights into avenues for which agricultural science education may contribute to students' overall academic achievement and learning in reading and literacy, especially within the context of issues related to agricultural science, such as food, energy, sustainability, and the environment.

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