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Undergraduate Knowledge Legitimation Strategies: Metacognition and Epistemological Development

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Abstract

Undergraduate epistemology typically transitions from an absolute perspective with a reliance on external knowledge authority to a more open epistemology that utilizes metacognition to evaluate knowledge claims. In the undergraduate agricultural classroom, student epistemic development, combined with deeply embedded agricultural beliefs and values, can lead to rigid perspectives that may inhibit effective communication and collaboration between diverse students, and thwart epistemic development necessary for students to entertain and synthesize widely divergent knowledge claims. This research sought to explore the characteristics and sources of knowledge undergraduates considered legitimate, and the internal processes undergraduate agricultural students used to assess the legitimacy of knowledge claims. Findings from this qualitative, multiple case study revealed students utilized specific metacognitive processes to assess the validity of conflicting agricultural knowledge claims. In addition, findings indicated students implemented specific legitimation criteria when assessing professors as credible sources of agricultural knowledge. These findings suggest educators should recognize and validate students' prior experience, social affiliations, and implement pedagogies that facilitate student learning through dialogue involving students holding diverse agricultural perspectives.

Keywords: Undergraduate; epistemology; student development; metacognition

Introduction

Higher education graduates will be working and living in a climate characterized by complexity and wickedness (Conklin, 2005). In *Managing Wicked Problems in Agribusiness: The Role of Multi-Stakeholder Engagements in Value Creation*, authors Dentoni, Hospes and Ross provide a characteristic definition of wicked problems stating "wicked problems have cause-effect relationships that are difficult to impossible to define, cannot be framed and solved without creating controversies among stakeholders and require collective action among societal groups with strongly held, conflicting beliefs and values" (2012, p. 1). Dentoni et al. (2012) list environmental degradation, biodiversity loss, persisting poverty, obesity, food insecurity and widespread use of biotechnology as examples of wicked problems within the agro-food sector.

Agriculture is deeply embedded in food system controversies being portrayed at once as both deliverance from, and origin of, many issues. Fundamental differences and tensions dividing diverse approaches to agriculture increasingly encompass aspects of social, economic and environmental systems demonstrating the interconnectedness and complexity of wicked agricultural issues. Undergraduate agricultural education classrooms must at once recognize the

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controversy surrounding agriculture and prepare our students to work in the arena of wicked agricultural problems after graduation.

Differences can and will continue to exist in the undergraduate classroom. It is differences which invite innovation, a necessary requisite for progressing toward adaptive responses to wicked problems (Conklin, 2005). Yet, in the undergraduate agricultural classroom, differences can result in criticism, discord and condemnation (Gordon, 2014; Martin & Enns, 2014). Non-conciliatory attitudes and conflict in the classroom may continue to perpetuate existing agricultural tensions, inhibit undergraduates' epistemological development, and possibly translate to agricultural attitudes which exemplify an "either-or", "right-wrong" perspective. Compounding these difficulties, most undergraduates are developmentally situated in a relatively undeveloped stage of epistemological absolutes (Baxter Magolda, 1992; Perry, 1999). At this stage of student development, entertaining multiple, diverse perspectives as plausible and valid alternatives can be a disorienting and emotional process.

If we are to prepare our students to effectively embrace agricultural wicked problems, we must help them clearly articulate their deepest values, think critically, consider multiple and conflicting perspectives, negotiate differences with confidence and seek common ground. Hence, we need to understand undergraduate students' development and epistemology, as it relates to their respective agricultural paradigms, to create opportunities to further epistemological development in the classroom. Higher education has an obligation to prepare students to verbally and cognitively consider multiple and diverse perspectives to engage the arena of wicked agricultural problems after graduation.

Theoretical Framework

We used Perry's (1999) theory of student ethical and intellectual development and Mezirow's (1981) transformative learning theory to frame this study. Student development plays an important role determining students' epistemic authority, responsibility, and ability to engage and validate alternate peer perspectives (Baxter Magolda, 1992; Perry, 1999). From the field of education, we drew on Transformation Theory, a theoretical perspective that focuses on the integration of student paradigms, positive cognitive development and educational practices (Mezirow, 1981).

Student Development

Student development plays an important role determining students' epistemic authority and ability to engage and validate alternate agricultural perspectives. Perry (1999) offers a cognitive development theory that situates student maturation along an intellectual continuum with distinct stages. Perry (1999) introduces Basic Duality, a developmental stage which resides in an authority-oriented framework and is characterized by the unquestioned and unexamined adoption of parental or other authoritative views. In Duality, students conceive of knowledge as polar and absolute. The proposition of "we-right-good" is contrasted against "other-wrong-bad" (Perry, 1999). Relying on absolutism places implicit trust and epistemological authority in an external source absolving responsibility for critical analysis or comparative thinking. Absolutism results in the unquestioned assimilation of a fixed perspective, the mindless acceptance of ideology that can insidiously subjugate critical thinking and obstruct development.

In Perry's (1999) next stage of development, Full Duality, difference of opinion is conceived to be a result of uninformed, unqualified and confused individuals, allowing students to

dismiss, rather than entertain, differing perspectives. Both Basic and Full Duality oppose a classroom environment based on the exchange and validation of differing perspectives.

According to Perry, as students mature the safety of Duality's "absolute-correct-right" knowledge is replaced by uncertainty in the face of multiple perspectives. Peers take on a heightened importance at this point. It is the sense of solidarity among a community of peers that provides support for students to seriously entertain alternate perspectives, while simultaneously recognizing doing so involves the temporary suspension of their own. Students begin to employ comparative thinking, reasoning between various viewpoints and alternate possibilities, prompting acceptance of ambiguity and uncertainty. Perry (1999) provides a framework for college student development. However, it is learning theory that equates student development with classroom practices and learning.

Transformation Theory

Increasingly, Mezirow's Transformation Theory is cited as the most appropriate learning theory for achieving student outcomes deemed necessary for future graduates (Berger, 2004; Galt, et al., 2013; Snyder, 2008; Sterling, 2010; Taylor, 2008). Transformation Theory focuses on the integration of student paradigms, positive cognitive development and educational practices (Mezirow, 1981). Transformation Theory develops our understanding of teaching strategies and learning processes which can facilitate an individual's paradigm shift (Mezirow, 1981).

Transformative learning requires students become aware of the limitations of their current perspective while simultaneously engaging alternate perspectives (Merriam, 2004). In this way, perspective transformation enables development of more flexible, inclusive and discriminating perspectives. Mezirow explains perspective transformation is,

The emancipatory process of becoming critically aware of how and why the structure of psycho-cultural assumptions has come to constrain the way we see ourselves and our relationships, reconstituting this structure to permit a more inclusive and discriminating integration of experience and acting upon these new understandings. (1981, p. 6)

Exposure to diverse perspectives stimulates comparative thinking, ultimately exposing uncritically assimilated assumptions, beliefs and values.

Metacognition, the deliberate and critical evaluation of habitual thinking and acting, plays an important role in transformative learning. The process of thinking about thinking creates opportunity for an individual to recognize the assumptions, beliefs and values that frame their habitual thinking and actions (Taylor, 2008). Critical re-examination of assumptions may be prompted by an intuitive sense of inconsistencies between experience and habitual thinking, or alternately, by a discursive challenge to an assumption's validity (Carolan, 2006; Carolan & Bell, 2003; Mezirow, 1981; Taylor, 2008) that reveals the inadequacy of current assumptions.

Transformation theory and the communicative learning domain. Transformation is typically facilitated through communicative learning, the social, interpersonal activities which take place in the classroom (Bacon et al., 2011; Brundiers, Wiek, & Redman, 2010; Sipos, Battisti & Grimm, 2006; Thomas & Day, 2014; Walker & Seymour, 2008). In "Transformative Learning as Discourse", Mezirow (2003) defines communicative learning as learning that seeks understanding of the meaning underlying communication. This understanding includes becoming aware of the assumptions, intentions and qualifications of the person communicating. Mezirow is careful to clarify the role of communicative learning stating "This [communicative] understanding and mode

of inquiry has as its aim not technical control and manipulation, but rather the clarification of conditions for communication and intersubjectivity" (1981, p. 5).

Together, student development theory and Transformation Theory stress exposure to alternate perspectives and a community of discourse prompt epistemic development toward more open and inclusive epistemologies necessary for collaboration between diverse stakeholders engaging with wicked agricultural problems.

Purpose and Objectives

This study addresses the American Association of Agricultural Education National Research Agenda (2016-2020) Research Priority 4: Meaningful, engaged learning in all environments. We investigated how students from diverse agricultural backgrounds and perspectives legitimate knowledge claims. Research objective one sought the characteristics and sources undergraduate agriculture students associated with legitimate knowledge claims. Research objective two investigated the internal validation processes undergraduate agriculture students used, through metacognition or reflection, to assess the legitimacy of knowledge claims.

Methods

Research Design

Our methodology was qualitative multiple case study. Case study allows examination of the characteristics and complexity inherent in a single case and proves a useful methodology when researchers are interested in insight, discovery and interpretation (Stake, 1995). In addition, Stake (1995) asserts case study is the study of a bounded system, yet maintains the relationship between the case under study and its existence and operation within a real-world context. This provides the ideal research platform to examine an individual as a discrete entity which interacts and operates within a larger social context.

Dooley (2007) bases initial case selection on maximizing variation in order to capture the most divergent viewpoints, deemed appropriate for this study's objectives and supported by Stake's (1995) contention that more cases and greater variation creates a more compelling interpretation. Therefore, a multiple-case study approach was selected, allowing us to preserve the depth and complexity of each individual case while providing an opportunity for cross-case analysis to discern the presence of any shared characteristics or variations between cases (Merriam, 2009).

We drew on an interpretive-constructivist philosophical perspective that seeks culturally, historically, and personally situated interpretations of the world (Crotty, 1998), appropriate for placing participant understandings within the context of their development. In addition, an interpretivist-constructivist approach recognizes and validates individual and socially-negotiated constructions of reality, meaning-making, values and beliefs (Koro-Ljungberg, Yendol-Hoppey, Jude Smith, & Hayes, 2009). Our research purpose was not to determine an objective truth, nor to create identical constructions of reality. Rather, our intention was to arrive at shared, compatible constructions of a particular reality (Erlandson & Harris, 1993).

Sampling Procedure

We selected study participants from three undergraduate courses offered by University of Missouri College of Agriculture, Food and Natural Resources (MU CAFNR) that were likely to attract undergraduate students from varied backgrounds and majors. The three courses included a

large sophomore seminar course, an animal ethics course and an introductory sustainable agriculture course. Students received an introductory email describing the study and requesting volunteers for an initial 45 to 60 minute interview. The introductory email contained an online survey link that collected contact information, college major, hometown and agricultural background in order to generate a participant volunteer pool.

Background information guided our initial purposive sampling for maximum variation in order to capture the most divergent viewpoints, deemed appropriate for this study's objectives. Subsequent, ongoing sampling was based on emerging concepts and sought participants that provided opportunities to confirm and disconfirm emerging concepts. Henstrand (2006) describes this sampling procedure as a "most similar/most dissimilar" approach, appropriate when investigating influences on a central phenomenon. This sampling strategy allowed us to seek commonalities from widely divergent backgrounds, values and perspectives while also refining our understanding of each individual's perspective.

The final participant sample included 19 students, 13 females and six males. Nine students identified with a rural farm background, eight a suburban background, and two an urban background. The majority of the students were 19 to 21 years old. Sample class ranking included three freshmen, seven sophomores, six juniors and three seniors.

Data Collection and Analysis

We collected data over a six week period through 19 semi-structured interviews, averaging 50 minutes, along with field notes before, throughout and after each interview. Interviews were audio-recorded and transcribed verbatim.

We created an interview summary for each participant which integrated field notes and insights generated during an initial reading of each transcript. Each transcript was coded as a discrete unit utilizing MAXQDA qualitative data analysis software. Open and in-vivo coding required mental restraint to give full attention to discovering the heart and mind of each participant, while holding comparisons between participants at bay. We maintained this balance through constant adherence to the meaning enacted in the language of each participant. At times, the constant interplay between language, meaning and individual perspectives was clarified by visually sorting, grouping and integrating emerging codes and concepts (Miles & Huberman, 1984).

We employed interpretation and the constant comparative technique to develop categories and themes. Interpretation is the method of all qualitative research where knowledge is the "successive accumulation or more informed and sophisticated constructions via the hermeneutical/dialectical process, as varying constructions are brought into juxtaposition" (Guba & Lincoln, 1994, p. 114). The constant comparative technique is a process of sorting and grouping data, moving beyond the data to interpret and reflect on emerging patterns and regularities (Corbin and Strauss, 2008).

Our final stage of analysis examined the phenomenon of epistemology through cross-case analysis. Miles and Huberman (1984) offer several rationales for conducting cross-case analysis. Some researchers seek assurance that their findings are not unique (Miles & Huberman, 1984) and therefore may be more generalizable to other contexts. An alternate and more applicable rationale is that cross-case analysis may foster a deeper understanding and more impactful explanation of findings. Cross-case analysis is particularly useful for understanding context, processes and outcomes, how findings are related, and to provide a more complex portrayal of a well-grounded context, reality, or even culture as a whole (Miles & Huberman, 1984).

Credibility and Trustworthiness

The merit of a study relies on credibility to ensure research findings are plausible, authentic interpretations of the data. We employed methodological rigor through reflexivity, memoing, reflective journaling, and adequate engagement with the data (Tracy, 2010).

Reflexivity, a form of critical self-reflection, requires a researcher to be continually and consciously aware of their role as an instrument of data collection (Merriam, 2009) and an integral part of the research process. This involves being aware of assumptions, biases, particular theoretical orientations and any relationship to the study which may affect interpretation; not to minimize their importance but to clearly communicate their influence during reporting. We practiced frequent memoing and reflective journaling throughout the study leaving an extensive audit trail that ensured the complexity and context of our research was preserved. Merriam (2009) asserts that adequate engagement in data collection is recognized when findings feel saturated, providing an additional validity strategy. Our extensive audit trail provided confirmation that we reached saturation during data collection.

Triangulation of data gave additional assurance that findings were credible. Triangulation of data involved utilizing multiple sources of data including initial participant surveys, interview transcripts and field notes. In some cases, participant validation was sought to ensure interview interpretation authentically represented a compatible, co-construction of participants' experience. Lastly, we communicated emerging findings during periodic peer reviews to ensure coding and theory development were plausible interpretations of research data.

Findings

Our first research objective sought the characteristics and sources undergraduate agriculture students associate with legitimate agricultural knowledge. Three themes emerged including: situated in real-world context, social affiliations, and specific credibility criteria for professors.

Characteristics and Sources Associated with Legitimate Knowledge Claims

Situated in a real-world context. Student responses indicated knowledge could be legitimated by its application in a real-world context. Each category and a representative quote is presented in Table 1. Proven, historical and old school indicated criteria involving repeated use over time. Students indicated knowledge was also legitimated by its use in a specific context, most notably accumulated while growing up on a farm. Students also judged the validity of knowledge by its ability to improve farm efficiency or farm production.

Table 1

Real-World Context Criteria with Supporting Quotations

Category	Example
Proven	What's been shown to work the best.
Historical	Looking through the years. Going back to the archives of what people did hundreds of years ago.
Old School	Hopefully get some of those small old fashioned farming styles back in.
	The blend of both new with GPS and satellites and everything and the Old School ways.
Pragmatic	I feel like I can apply that. You're going to use this information when you get out in the real world.
Accumulated growing up on a farm	I would say, growing up on a farm would be most significant.
Performance and efficiency directed	It helps me and the other people in the major go back to the farm and run the farm more efficiently to be the most productive and it' all about field efficiencies and yields and everything else.

Social affiliations. The second emergent theme involved students' use of social affiliations to legitimate agricultural knowledge. Trusted family members, local hometown community, peers, and MU CAFNR community were sources students considered credible. Students exhibited a great degree of trust in family members and relied on them as a resource, even in college. Other longstanding, familiar, community relationships with a degree of comfort and trust provided an expanded resource base. Students also spoke of finding and developing new social affiliations through CAFNR, affiliations that became part of a trusted and caring agricultural campus community away from home. The social affiliations students relied on to legitimate agricultural knowledge, with representative quotes, are summarized in Table 2.

Table 2

Social Affiliation Categories with Supporting Quotations

Category	Example
Family members	I went to the point I called my grandpa after class.
	Probably go to my dad because he keeps up with everything like that. He's a pretty smart guy, I have the same values as him.
Hometown ag community	I grew up in a town that everybody pretty much is a farmer.
	I have to say, just the whole community in general I think. most if not all of ... We were an agricultural based community.
Campus community	It's just such a huge department, the college of ag, it is so different from the other colleges because they actually care.

Specific legitimation criteria for professors. Within the MU CAFNR community, certain individuals stood out as particularly trustworthy, and therefore legitimate, resources. Students indicated that professors demonstrating a willingness to meet with students or discuss controversial agricultural issues outside the classroom were more caring and relatable, and therefore more credible. Credible professors had extensive, real-world experience and were actively involved in agriculture. Students placed a high value on professors that proffered multiple perspectives and supporting reasoning, or created a classroom environment where multiple perspectives were discussed in an open and non-judgmental atmosphere. Professors and experts that were able and willing to present multiple facets of an issue were considered unbiased and therefore more credible. Students developed links between broad perspectives and credibility further, tying a broad perspective to the ability to make sound judgments. Legitimation criteria for professors with supporting student quotations are summarized in Table 3.

Table 3

Professor Credibility Criteria with Supporting Quotations

Category	Example
Relatable	He's just really relatable.
Caring	I just think that here at MU, we're just blessed to have people who care so much about everything. They care about us students and they want to see us succeed.
Extensive practical experience	He knew a lot. He had experience. He had been in the field for a long time and I think he was able to take everything that he learned and make his own opinions or judgments about things.
Vested	If they have that connection they're gonna know because they're involved in it.
Understood and conveyed multiple perspectives	Like if they were able to get both sides equally I think so. Like I think if you honestly think something is better than the other thing that you're comparing it to then you should be able to give the facts on both things.
Offered reasoning to support multiple perspective	He's just a person that's well-educated, knows both sides of the argument, is willing to present both sides of the argument but still has an opinion and so has reasons for his opinion.

Research objective two investigated the processes students rely on to legitimate agricultural knowledge claims. The three emergent themes were: students must personally research and develop a comprehensive understanding of a topic, students judged the legitimacy of a knowledge claim by its alignment with personal morals, values and/or tenets of faith, and students judged knowledge by its alignment with their personal commitment to one of two overarching agricultural objectives.

Processes students rely on to legitimate agricultural knowledge claims

Develop a comprehensive understanding of a topic. Students expressed frustration and anger with peers, consumers and themselves when efforts to discuss their perspective seemed vague and ineffectual. In order to respond to controversy or criticism, many of these students acknowledged they must develop a comprehensive understanding of an issue, arrived at utilizing multiple sources representing divergent, even conflicting, perspectives. In addition, students emphasized developing a comprehensive understanding of an issue, combined with reflection, gave some assurance that they were able to make a valid judgment. Table 4 presents examples of student quotations for this category.

Table 4

Example Quotations Indicating Students Seek Comprehensive Understanding

Example Quotation
I think the more somebody understands a topic, the more they can sort through the information that they're being given for that and figure out what is probably the most true.
If I can get 'em from both sides. Like I may get one side from one article and one side from the other, ummmm, I just think it makes you kind of stop and think about maybe what their, like, argument points are...
I try to read more about it from a lot of different perspectives, especially perspectives that I know are going to be in conflict with one and other, to try to get a well-rounded view of what's going on with that particular issue or story or whatever it might be.

Commitment to an overarching agricultural mission. Student responses indicated their agricultural perspectives were divided by a commitment to the directive, "we have to feed the world" with its concomitant emphasis on technology, efficiency and production, or a commitment to maintaining environmental integrity. Students identifying as having a rural farm background perceived immediately ameliorating world hunger as their overriding directive. Students identifying with a more environmental approach perceived all humanity as dependent on the environment, subsuming humanity under the environment. In addition, the environmental paradigm subsumed immediate world hunger under long-term, sustainable food production. For these students, sustainable food production involved aligning agricultural practices with ecological principles and natural processes (see Table 5). Just as the mandate to produce more food to alleviate world hunger drove values and practices for students from family farms, the need to maintain long-term environmental viability drove the values and accepted agricultural practices of students professing an environmental perspective.

Alignment with personal morals, values and/or tenets of faith. When faced with an agricultural ethical dilemma, morals, values and faith played a role in many students' decision-making process (see Table 5). One student, when faced with decisions regarding the use of genetically modified organisms, linked her faith and ecological principles explaining "God did things the way He did so that natural selection could come into practice and we are messing with natural selection." Another student related economic gain and particular advances in agriculture were incompatible saying "I feel like you created that for the good of humanity."

Table 5

Example Quotations Indicating an Overarching Agricultural Commitment

Category	Example
Align with ecological principles and natural processes	Populations that I think grow beyond the carrying capacity of the environment open themselves up to all kinds of disasters.
	The best advancement I would say is the one that, I don't know, maybe helps what is already happening, working with nature instead of working against it.
Commitment to feeding the world	It's great to do the all-natural in the small community, but you can't do that to feed the whole world.
	Everybody shares a common goal, is to produce more on less available acres or on less available resources to feed the current population, as well as the projected population.

Conclusions, Discussion and Implications

Our research was conducted over the course of a single semester, a sixteen-week period. As such, findings were derived from a relatively narrow point in time and should be interpreted accordingly. Our findings are context-dependent and subjective, founded in individual interpretations of experience and derived from a relatively small number of participants. It is therefore prudent to limit generalizability to different contexts and individuals. Any applicability of research findings is at the discretion of the reader.

We concluded student legitimation criteria, their sources of knowledge, and their internal knowledge legitimation processes were closely associated with their criteria for credible professors. Many students associated valid agricultural knowledge to close social affiliations and felt credible professors should be relatable and caring. Students required a comprehensive understanding of issues to engage in conversation and come to dependable judgments, and expected the same from professors. Lastly, students felt knowledge was validated when used in a real-world context and expected professors to have extensive practical experience.

Multiple students from rural family farms identified agricultural knowledge claims with strong, trusted, social affiliations that included multiple generations, family, and hometown community. Students also stated credible professors were relatable and caring, suggesting students residing in Perry's (1999) developmental stage of Duality could transfer their dependence on prior social affiliations to their new college environment, including professors. Duality (Perry, 1999) is characterized by the unquestioned and unexamined adoption of parental or other authoritative views. Students residing in Duality place implicit trust and epistemological authority in external sources of knowledge.

Providing a supportive and caring environment is important during transformation and epistemological development. However, support and caring becomes problematic if it provides students with an opportunity to transfer implicit trust in one authority figure, e.g. parent, to another authority figure, e.g. a professor, with the same absolution of responsibility.

We recommend educators reduce their authority in the classroom to reduce the possibility for transfer of epistemic authority from a student's prior social affiliations onto a professor. Educators can assume a transparent and non-authoritative role in the classroom, become co-learners alongside students, disclose personal struggles to reconcile different perspectives, and demonstrate openness to revising current judgments in light of new information. In addition, taking the role of devil's advocate, exposing students to other sources of knowledge such as guest speakers, and exposing students directly to the concept of epistemology can help shift accountability for knowledge construction onto students. Developing a sense of solidarity among a classroom community of peers also provides new social affiliations and an environment of support in which to construct new understandings.

We conclude the complex and controversial nature of agricultural issues provides educators with a unique opportunity to advance student epistemological development. Students are aware of the controversy and criticism surrounding various agricultural practices and desire a comprehensive understanding in order to effectively engage in discussion. Similarly, students expected credible professors to have a comprehensive understanding of agriculture.

Perry (1999) tells us a necessary step in epistemological development involves students discerning their own perspectives and assumptions and becoming more willing to entertain others' as plausible. According to Perry (1999), exposure to multiple perspectives, combined with critical reflection, prompts epistemological development. We recommend presenting multiple perspectives behind a wide range of agricultural practices, the standards of judgment for various practices, as well as limitations of different practices. Discussion panels comprised of varied agricultural field practitioners can help students recognize different epistemic perspectives and their underlying legitimation criteria, prompting student metacognition. Educators can utilize ill-structured problems requiring analysis from multiple perspectives, perspectives that require students to consider alternate arguments, establish evaluation criteria, propose action and predict consequences. In addition, educators can ask student to identify the conditions necessary for them to embrace a new perspective (Perry, 1999).

Students highly valued knowledge situated in a real-world context. Based on this finding, we recommend experiential education opportunities. Engaging with varied practices would allow students to explore the legitimation strategies for different agricultural systems, thereby linking classroom content to real-world contexts. Varied experiential learning experiences could bridge disparate aspects of agriculture and reveal the larger context of food systems. For instance, work in community gardens and with local food banks could expose the incongruence between living in a productive agricultural region, the state's high level of childhood food insecurity, and the presence of local food deserts. It is important to note educators must be intentional and ask students to reflect and explore their own values and then link student values to course content and experiences.

We also conclude student's personal commitment to an overarching agricultural objective, and alignment with personal morals and values, drove their adoption of agricultural perspectives and practices. We recommend helping students elucidate underlying values and epistemology that intersect various perspectives through intentional dialogue and reflective prompts. Elucidating underlying values and epistemology can help students understand how their values drive and inform their decisions and may provide a pedagogical bridge to enable comparative thinking between differing perspectives and value systems. Gaining an understanding of different value systems, epistemologies, and the defining characteristics of wicked problems eliminates a dichotomy and recognizes multiple possibilities.

Agricultural pedagogy designed to facilitate epistemological development and transformative learning requires an approach founded in a constructivist perspective. Educators from a strong positivist perspective may not readily embrace the suggested pedagogical strategies. Research is needed to illuminate how educators' epistemology influences their pedagogical strategies (Brownlee, 2004) and their ability to understand, validate and convey multiple perspectives to students.

This research captured one stage of a participants' undergraduate experience. To better examine the process of epistemological development, Taylor's (2008) 1999-2005 review of transformative learning literature recommends longitudinal studies and utilizing multiple methods of data collection including observation, interviews and student reflections. Longitudinal studies combined with classroom observations may expose additional classroom dynamics that prompt and sustain student epistemological development.

Central to this study's findings, research regarding peer-dynamics, specifically in diverse undergraduate agricultural classrooms, is needed. As educators, we need to explore and discover how to establish a dialogic classroom environment conducive to challenging student perspecitives and exploring underlying student values in order to help students find and establish common ground between divergent agricultural perspectives. Perhaps, most important, as educators we must recognize our students are aware of the controversy surrounding agricultural practices and seeking a way to understand and respond to the critical issues of our present and future.

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