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Teaching Introductory Life Science Courses in Colleges of Agriculture: Faculty Experiences

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Abstract

Insignificant numbers of college students declaring STEM majors creates concern for the future of the U.S. economy within the global marketplace. This study highlights the educational development and teaching strategies employed by STEM faculty in teaching first-year students in contextualized life science courses, such as animal, plant, and food sciences. Teaching strategies employed by faculty were reported as largely influenced by the "way they were taught." Faculty members shared they used 'lecture' and 'laboratory' interchangeably as both educational environment and instructional practice. This study provides evidence for engaging university teaching faculty in a systematic process of professional development in teaching and learning processes.

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Higher education faculty play an important role in the science, technology, engineering and mathematics (STEM) pipeline as they assist in developing the next generation of scientists and engineers (Executive Office of the President of the United States, 2013). Particularly, faculty teaching introductory STEM college courses play a critical role as the courses they teach serve as a gateway for students to either continue or exit their scientific interests pending their learning experiences and evaluative performances (Labov, 2004). These early educational experiences are critical as there is an urgent need to attract and develop the next generation of agricultural scientists (Association of Public and Land-grant Universities, Experiment Station Committee on Organization and Policy—Science and Technology Committee, 2010). This urgency is predicated by projections indicating that STEM occupations are expected to grow in the years 2008-2018 by 17%, doubling the rate from the previous decade (U.S. Department of Commerce, 2011). These projections leave industry professionals questioning the ability of the U.S. workforce to meet the global demands of the 21st century (Chen, 2009). Their questions are valid when examining the minimal number of college students declaring STEM majors (Chen, 2009; Duncan, 2009; Executive Office of the President of the United States, 2013) furthering the concern that a lag in the development of skilled STEM professionals has serious implications for the future of the U.S. economy within the global marketplace.

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When evaluating students' college experiences, it is best to begin with the introductory course. Introductory science courses provide college students with their first scientific impression and experience in a college classroom. Labov (2004) stated that for many students:

> Introductory science courses often give undergraduates their first and, for many students, their last formal exposure to a deeper understanding of science. Thus, introductory courses might be the only opportunity to provide a basic level of scientific literacy for the educated lay public. (p. 212)

Students should be engaged to learn science within these courses. Kuh, Cruce, Shoup and Kinzie (2008) found that educationally purposeful activities that engage students are positively related to academic outcomes such as first-year student grades and persistence between the first and second year of college. If professors are one of the greatest influences on learning (Umbach & Wawrzynski, 2005), it is imperative to understand how professors think about the content and the methods they use to help students learn content and concepts in specific domains. Bok (2005) criticized higher education because there is little to no discussion about how professors teach. Current teaching practices in higher education rely heavily upon the transmission of knowledge by an expert at the front of the class (Conti, 2004), and is a method that higher education faculty learned well through observing the teachers they had while sitting in classes as a student (Lortie, 1975).

Conceptual Framework

The conceptual framework for this study was informed by two foundational educational theories; Lortie's theory of apprenticeship of observation (1975) and Schön's theory of reflective practice (1987). Lortie states that unlike many other occupations, teachers' socialization into the profession starts when they are students. Many faculty have the mindset 'teaching is lecture' so embedded in their schema that it becomes difficult to perceive any other method of instruction. As a result, not only do faculty 'do what they were taught to do' but they continue the cycle by training their STEM undergraduate and graduate students, and future faculty members in this same instructional paradigm. In addition, Schön (1987) posits that examining teaching reflectively is a means of developmental insight and can provide a basis for professional development. If faculty members can reflect upon their own beliefs about teaching and learning it could lead to faculty awareness of a need for further development.

We chose to look specifically at three contexts within the life sciences as a means to better understand how faculty facilitate learning in introductory courses in animal science, food science, and plant science. We were particularly interested in how these introductory life science courses might help students learn in contextualized STEM learning experiences. Cruce et al. (2006) suggested that their findings on the impact of effective educational practices "may be particularly important for those students who enter postsecondary education with the least educational capital" (p. 379).

Post-secondary Emphasis on Teaching and Reflection

Faculty who teach in U.S. colleges and universities, typically, are not pedagogically prepared and they begin teaching as untenured faculty without prior experiences or formal training in teaching and learning (Academy of Distinguished Teachers, 2002; Murray, 1987; Scarlett, 2004; Whaley & Wickler, 1992). Some faculty do not see the need to improve their teaching, and the professional climate that is informed by rewards and promotion does not place teaching quality on the same level as research and publications (Scarlett, 2004). However, there is more emphasis on improving the undergraduate student experience as universities are responding to stakeholder pressures of accountability (Menges & Austin, 2001). As such, some faculty consider teaching an important activity of their careers (Altbach & Lewis, 1997), and reflect on their teaching as they engage in faculty development activities (Hubball, Collins & Pratt, 2005). The development of teaching capacity is highly personal, contextual, and experiential (Kreber, 2002). As such, a person's beliefs, values, and motivations play an important role in developing teachers (Pryor, Sloan, & Amobi, 2007), and reflection plays an important role in that development (Scanlon, Care, & Udod, 2002; Schön, 1987).

Teaching Within the Agrisciences

Teaching plays an important role in academic institutions, yet research overshadows teaching in many universities. A limited number of studies have investigated teaching faculty's perceptions in agricultural disciplines in higher education (Davis & Beyrouty, 1995; Dooley & Murphy, 2000; Wardlow & Johnson, 1999). Davis and Beyrouty (1995) found that agriculture faculty believed teaching was a major mission of the university, were not adequately prepared to teach, and agreed they needed to change their teaching techniques. Wardlow and Johnson (1999, p. 53) found that agriculture faculty rated their abilities to teach using "more traditional activities such as lecture, demonstration, preparing teaching materials, and motivating students" as good to excellent, whereas they felt less capable in teaching using active learning strategies. Dooley and Murphy (2000) found that College of Agriculture faculty were more confident in their technical abilities than their methodological abilities to teach using educational technologies. Although a majority of the faculty did not understand how to use these technologies to teach, they valued the technologies and could see that they will be important to use in their teaching. In 2009, Harder, Roberts, Stedman, Thoron and Myers found that agriculture faculty were interested in faculty development programs to learn how to engage students in learning, teach critical thinking, lecture effectively, use effective questioning techniques, and use active learning strategies.

In summary, the literature identifies introductory courses as vital to student success and interest in moving forward (Kuh, Cruce, Shoup & Kinzie, 2008). The significance of this study is that it focuses on critically important introductory courses in the STEM pipeline and asks the question 'if these courses are so critical, how are they being taught?' The study further adds to the knowledge base as no study was found in the literature that investigated faculty beliefs and experiences about their teaching from a qualitative approach.

Purpose and Research Questions

The purpose of this study was to investigate the origins of teaching practice for university faculty engaged in teaching introductory contextualized life science courses. The specific research questions were: (1) How did university faculty learn to teach college students in introductory animal science, food science and plant science courses? (2) What teaching methods did university faculty communicate that they use in teaching college students in introductory courses in animal science, food science, and plant science?

Methods and Procedures

This nested qualitative case study (Yin, 2009) involved seven, university faculty who taught introductory courses in one of three domains (animal science, food science or plant science) at two land-grant universities in two different states. The purposive sample consisted of the seven faculty members representing the entirety of faculty at the two, respective universities engaged in teaching introductory courses in animal science at one university, and food science and plant science at the second university (Patton, 2002). Universities were chosen because of their focus on STEM in agricultural contexts. Faculty who taught introductory courses in the three domains were chosen to participate in this study as part of a large curriculum development grant project. Faculty participants had achieved various stages within their academic careers from ranks of assistant professor to full professor. Lastly, two of the participants were recipients of teaching awards both institutionally and nationally.

A team of researchers with expertise in teacher professional development and educational research developed an interview protocol. Eighteen questions were developed to engage faculty in a semi-structured interview and help them reflect on their teaching beliefs and experiences (Patton, 2002). The protocol was field tested with faculty who were not participants in the study and minor edits were made based on feedback. The Institutional Review Boards approved the human subject protocol at each campus. Unique identifiers were assigned to faculty for confidentiality. Table 1 provides selected demographic variables for the faculty participating in the study.

Table 1

Selected Demographic Information for Faculty Teaching Introductory Life Science Courses

Course Domain	ID Code	Gender	Race	Tenure Status & Rank
Animal Science	A1	F	White	Untenured/Asst.
	A2	M	White	Tenured/Prof.
Food Science	F1	F	White	Untenured/Asst.
	F2	F	Black	Untenured/Asst.
Plant Science	P1	F	White	Tenured/Assoc.
	P2	F	White	Tenured/Assoc.
	P3	M	White	Untenured/Asst.

Note: Asst. = Assistant Professor; Assoc.=Associate Professor; Prof.=Professor

Individual, face-to-face interviews were conducted with each faculty member in their office utilizing the semi-structured interview guide. One researcher conducted all interviews to maintain consistency. Interviews were audio recorded and lasted approximately 60 minutes. Audio recordings were then transcribed, and participants (aka, members) checked transcripts for accuracy and completeness, and confirmed the results when edits were completed (Gall, Gall & Borg, 2003). Transcripts were analyzed by the team of researchers using open and axial coding (Patton, 2002). Next, central concepts, main ideas, and related responses were analyzed to create thematic categories and eventually assertions (Glesne, 2011). Subjectivity was minimized as peer debriefing was conducted throughout the entire coding process, enhancing inter-rater reliability (Patton, 2002). Trustworthiness and confirmability were established by continuously returning to the original data and clarifying responses from faculty participants (Denzin, 1984).

Researcher Perceptivity, Bias and Limitations

In qualitative studies it is important to communicate the perspectives from which the researchers approached the investigation (Creswell, 2009) and to articulate potential researcher bias and limitations of the study (Patton, 2002). In this case, the authors are considered experts in the teaching and learning phenomenon possessing Ph.D. degrees in education and having been engaged in classroom teaching, teacher education, and teacher professional development for their professional careers. In addition, the authors possess their Ph. D. degrees in the subject matter context of the study (agricultural life science education). Five of the seven, university faculty involved in the study have been colleagues and collaborators with one or more of the authors on other teaching and learning activities or university related educational projects. Lastly, it can be argued that the authors were biased in their assessment of agricultural life science instruction at the university level based upon their education and experiences. There are three mitigating factors refuting this claim. First, the faculty participants involved in the study had the opportunity to read and review the transcripted interviews for accuracy. Second, authors conducted regular peer debriefing sessions to monitor potential biases and challenge assumptions. And third, the authors maintain that there are several studies, referenced in the introduction, calling for improved teaching in university STEM courses. It is from this perspective that the researchers conducted this study.

This study has obvious limitations consistent with qualitative approaches for collecting data through observations and interviews. Interview data, while collected in the respective faculty offices, represented a point in time. The nature of interview data has limitations of its own including "recall error, reactivity of the interviewee to the interviewer, and self-serving responses" (Patton, 2002, p. 306).

In addition, no classroom or laboratory observations were conducted in this study. This is a limitation as we relied upon the perception of the faculty to tell us the allocation of their time devoted to various teaching techniques. And finally, no data were collected from students or teaching assistants engaged in the courses.

Results, Findings, and Discussion

Research Question One: How Do Faculty Learn Instructional Methods?

Our initial research question assessed how university faculty learned to teach first year college students in introductory animal science, food science and plant science courses. Upon completion of analysis, we were able to assert: *All participants professed having limited or no formal educational training regarding teaching practices*. This assertion was supported by three axial categories derived from the data. Supporting categories included: 1) Informal observation; 2) Class inheritance; 3) Intuitive instruction. The quotes contained herein are representative of a larger data set.

Informal observation. Several participants indicated they learned methods of instruction through informal observation; however, the context for observation varied among faculty. Many faculty credited their current teaching practice to methods observed and experienced during their undergraduate and graduate education. Two faculty discussed implementing methods that they believed to be beneficial to them during their undergraduate training, *"I found useful some things I learned as a student from the instructors I had related to well"* (A2). And another added similarly, *"Largely they're the methods that were used by my previous professors that I found to be effective"* (P3). Finally, one instructor implied lecture as being the traditional method for instruction within her discipline, *"Lecture is how I was taught"* (P1).

Student-instructor observation at the university was not the only method of informal learning. Two faculty utilized their peers as observational resources after becoming established in their academic roles, *"When we [my former department] moved agricultural education into the department, voilà! Look, I have all these people who know how to teach, would you teach me something?"* (P1). And a second faculty member stated *"It's mostly just watching others or what I think is good to pick from them"* (A2). In the absence of formal training, informal observation seemed to have the greatest influence on participant teaching methods.

Class inheritance. Aside from informal teaching observation, two faculty members described being thrown into their instructional roles suddenly and unexpectedly. In each case, participants surprisingly inherited their course(s) from a previous instructor. They described their teaching experiences as being a "trial by fire" in that, *"The class was given to me as 'here's your pile of PowerPoint™ slides"* (P1). Another participant mimicked the instructional methods of their graduate faculty mentor, *"I was asked to teach a 300 student lecture course because my former supervisor was going on sabbatical ... I tried to follow some of what I saw in him"* (F2). And, the same individual indicated when their supervisor permanently left the university *"He said here are my overheads—the course is yours"* (F2). Each response indicated lecture as being the primary educational method, leaving the new instructor with limited instructional preparation and/or guidance.

Intuitive instruction. During analysis, a third category emerged as participants began discussing innate feelings toward their teaching practice. This "intuitive ability" was best summarized using one instructor's response, *"I do some things that more or less come to me* *naturally, or that are kind of easy for me, and seem to work well"* (A2). Intuitive instruction emerged from two sub-categories, self-taught and trial and error. The following faculty responses support this finding.

Self-taught. Motivated by an inner desire to improve their educational practice, one participant used literary sources to ascertain diverse instructional methods, *"bringing in the case studies, the activities, the discussion, a lot of that had been self taught from reading methods articles"* (P1). In addition, membership in professional societies and reading peer-reviewed journals were found to be helpful, *"one of the big professional development things has been the National Science Teachers Association. They have some great books. They have the Journal of College Science Teaching, looking at some of that stuff"* (P1). It is important to note that while several instructors used observation as their primary source for instructional training, this faculty member used multiple sources to enhance her instructional delivery.

Trial and error. Throughout the interview, faculty discussed how they tested their instructional practice through trial and error. One instructor expressed being surprised by his students' response when he implemented a question and answer component to his class for the first time, *"That was my first experience of having people ask me questions and you'd just go, 'Wow, this is great, I'm having people ask me questions … I know exactly what you were wondering … and now I'm able to help you"* (P3). Another instructor spoke of being inspired by others at professional workshops then returning to her classroom to implement different methods, *"going to … workshops and hearing some of the cool things some people are doing and then trying to bring that back to try it out"* (P1). Overall, however, faculty were not ambitious in trying new teaching techniques and they seemed to lack the confidence to try new methods.

Research Question Two: What Methods do Science Faculty use in Introductory Courses?

We developed our second research question to gain a deeper understanding of instructional methods used by university faculty to teach introductory courses. Two assertions developed as faculty discussed their beliefs and practices regarding their teaching methods. The first assertion: *Educational environment influenced instruction*, was emphasized by beliefs that the lecture hall was used for delivering traditional lectures, and no other teaching methods really took place there. In fact, the majority of participants viewed the lecture hall as both a location and an instructional practice. Moreover, "hands-on" or "active learning" teaching methods were restricted to the lab section for each course.

The majority of faculty believed they differentiated their instruction using both teacher-centered and student-centered techniques. However, after discussing their instructional practice, we were able to assert that: The majority of instructional practices described were teacher-centered. The following axial categories further illustrate and support our assertion that the majority of teaching methods used are teacher-centered.

The lecture hall as a location and method of teaching. The first thematic category encapsulates faculty perceptions of the lecture hall as being an educational environment, location and teaching method. One participant best articulated the belief that the physical aspects of a "lecture hall" mandate the instructional method "lecture":

> *I am in a large auditorium. Not a very stimulating environment and [there is] no aisle way in the center so I cannot get in and out toward the students. In there I am stuck behind the podium and I have slides. And so it is basic, traditional lecture.* (A1)

Another instructor described her use of lecture using PowerPoint™ as a variant to her counterpart's traditional lecture within the lecture hall:

> *I use primarily lecture. I still do PowerPoint™. Dr. … has thrown the PowerPoint™ slides in the trash and just lectures … but he just got tired of the whole thing, the whining and the fussing and the whole thing. I haven't been brave enough to do that yet.* (P1).

We found her perspective to be particularly interesting in that she viewed traditional lecture instruction to be more bold than her lecture using PowerPoint™ hybrid instruction.

Another faculty participant further emphasized the belief that lecture-based instruction was practiced within the lecture hall. As part of his practice, he was able to enhance his lecture instruction by infusing animations within his lecture using PowerPoint™. Moreover, he hoped to engage his students by providing incomplete PowerPoint™ notes for his students:

> *In the lecture portion I have a set of PowerPoint™ slides that I use. The students get those handouts a week before that particular lecture. Not all of the information is on the particular slide so I use a tablet PC to write the information on ... I can advance through a set of slides to make an animation happen that diffuses a complex topic that breaks it down into these simple steps that they can then grasp.* (P3)

Instructional diversification within the lecture hall. In an effort to diversify instruction within the lecture hall, faculty members voiced their use of a variety of instructional techniques. The first included question and answer and classroom discussion:

> *I keep the classroom very dialogue based. My class is very vocal and will converse with me. I walk around the lecture hall. I'm not in any one particular location. The students converse with me regularly, even up in the cheap seats; they'll still answer questions.* (P3)

The second category of instructional variance included the use of case studies and/or current events, one faculty member stated, *"I have a couple of very specific activities that I do with them every semester. I do the biotech case studies ... right before Thanksgiving"* (P1). Other faculty discussed the use of current events as relevant cases or examples for their instructional content:

> *We talk about current events, especially when we talk about microbes. In some of the cases you see with peanut butter, with the salmonella, I try to bring some of those things and ask "what have you heard about this?" You know, "how does this relate to what you've heard in the news with the salmonella outbreak in peanut butter?* (F1)

The use of current events as a method of instruction was echoed by another faculty participant:

> *We have a discussion going on about something that came out in the newspaper. Let's say that it's a controversy about high fructose corn syrup, or about a food additive, or food irradiation is bad for you and things like that.* (F2)

Distinct from her peers, one faculty member indicated how she infused her international experiences into her lectures in the form of storytelling and/or case studies, *"I have written a few examples internationally from different experiences in agronomy, and I would bring those examples in as a project in the course, as part of something they would do"* (P2).

With a desire to get her students moving in class, one instructor revealed her method for physically engaging her students within the lecture hall through an active learning technique:

> *I actually have an activity where I make them do a seed necklace. They get their little seed in a plastic bag on Tuesday and I say you bring it back to class on Thursday and draw it on your quiz and you'll get extra credit. What better way to learn about seed germination than to have it in your hand, looking at what happens?* (P1)

We found it noteworthy that this instructor, who sought out multiple teaching method sources, also implemented multiple engaging methods within her lecture.

Another participant designed a scholarly poster session where students applied what they learned in lecture to a practical context. The session included a question and answer time with peers and faculty experts within their department:

> *They have to work on that topic and make a poster ... at the end of the semester and the last week of classes, I bring poster boards downstairs in the main floor, and all of the students come. And then I invite everyone from the food science department. It's like a poster session. And I have other faculty go in and ask them questions about their topic and a lot of the posters are very creative.* (F2)

Finally, faculty viewed field trips as an extension of the lecture educational environment.

They perceived the location of the field trip as being a place where lecture meets real world application:

> *[I] take them to places for field trips, to a meat packing plant with animals being slaughtered, food being processed ... It is like "boom" this is where our food comes from. So it is a very rude awakening but we all get on the bus together and we talk about it on our way in and talk about what we saw on the way back - to process it a little bit.* (A1)

A second faculty member reiterated this thought by providing that:

> *We do field trips. I take them to (a local processor) where they take them through the whole processing plant. They get to see everything!* (F1)

It is evident that participants viewed "lecture" as having several meanings. First, it was viewed as a physical location where their course was taught. Next, faculty perceived lecture as an educational environment that influenced their instructional practice. This was the case with the physical lecture hall layout as well as the educational extension of field trips. Lastly, participants viewed lecture as a method for instruction.

As part of their instruction many faculty described using a variety of methods to enhance their lecture. These methods included technological enhancement, discussion or question and answer, case studies or current events, storytelling, active learning, and scholarly presentations. While many of these methods assist in further engaging the learner, they are often considered to be more teacher-centered than student-centered.

The laboratory setting as a location and teaching method. The second thematic category summarized faculty perceptions of the laboratory. As previously discussed, the majority defined the lab as an educational environment, location and teaching method. However, the instructional methods used in the laboratory varied. A majority of participants professed using the laboratory as a venue to teach students technical skills, specifically using direct instruction. Such skills included calibrating microscopes, dissection techniques, experiment preparation, and DNA extraction:

> *We do microscope work and they grow plants, they look at plants, they measure plants, they do experiments with different pot sizes and different soil volume. We have a mineral and nutrition experiment where we take nutrients away, we give them too much and they have to observe and see what happens. We have one with growth regulators, when we spray them. I ask them 'do they get big? Do they get small? Can I shrink the plant by spraying it with something?' We don't shrink plants, we're not magicians, what really happens?* (P1)

Another faculty participant added similarly:

> *They're using microscopes, dissecting plants, doing experiments, running gels, extracting DNA, so it's very much an active process.* (P3)

In an effort to enhance instructional variability, animal science faculty discussed using both demonstration and problem-solving instruction as part of their instructional practice:

> *With the labs I will typically make a few open remarks where the students will come up front and stand around the table in front of the chalkboard. We will go through the skeleton and let's say we dissect the digestive tract. I will dissect the pig's digestive tract on the big table first, and they are all around and they see how I go through the parts systematically. That then gives them the base knowledge to go back and work with the ruminant tract, and be able to see how it is different as they go through all those different parts.* (A2)
>
> Adding further evidence to this approach, the other animal science faculty participant added:
>
> *When I get them in the lab, I do not give them too much information up front. Then they have to cut it open and figure it out and go back to the references. Some of the kids get carried away and want to go find the eye bones and the tongue bones.* (A1)

The hybrid demonstration or problem-solving technique seemed to enhance student learning on two fronts. First, students had to solve a problem by transferring their digestive knowledge from that of a pig to a ruminant system in a systematic way. Second, a few students seemed to be motivated by the opportunity to apply their knowledge gained in lecture as they explored anatomy beyond the scope of the assignment.

Faculty in food science also used problem-solving techniques utilizing ice cream as the educational context. One faculty member described how they manipulated the laboratory environment to create multiple problems that students needed to work through and evaluate.

> *I have one group go through the normal process of making ice cream the way it's supposed to be, and then I'll have one lab that uses half-and-half milk instead of whole milk so now the fat content has changed. As far as processing I might say, well the normal procedure uses x amount of sugar, I modify it and add three times as much sugar. What does that do to the freezing process? How does that affect the freezing time? It depresses it, right? Because it's going to take longer to freeze since there's more sugar. So they get to see the impact of ingredients and processing methods on the final product quality.* (F1)

Other faculty provided less structure in their laboratory instructional practice. One plant science instructor used inquiry-based instruction, further shifting the responsibility of learning to the students:

> *On homework, where they have a problem situation and they have to identify that problem, maybe there is no right answer so that they feel they can think through and logically tell me what they are thinking. So I know if their logic goes closer to the reality of the problem or further away.* (P2)

It is important to note that not only did the instructor use inquiry-based learning to focus on the scientific process with her students; she also used it to evaluate the base knowledge and learner process of her students.

Teaching methods outside of the classroom. During data analysis, a third category emerged. This category was distinct in that it did not include teaching methods used in either the lecture or laboratory component of participant courses. This thematic category includes the promotion of student learning outside the confines of the previously described educational settings. Methods implemented by faculty within this category included small group work and virtual workgroups:

> *I use online virtual work groups using Blackboard Vista™ ... we may have a discussion going on about something that came out in the newspaper… I put the students in random groups so I don't select who goes into which group. In real life you don't choose who you get to work with so I make them do that.* (F2)

Providing evidence of their use of small groups, one faculty member added:

> *I use group [small group] study. I have them do a group assignment that was part of the photosynthesis and respiration homework. I tell them that they can work in groups, however, they have to independently turn in the assignment so that they can learn from each other.* (P2)

Faculty implemented both virtual and face-to-face group work assignments as they identified a need for students to socialize and learn from each other. More specifically, the food science professor used group work to prepare students for situations they may face in their respective professions.

Most of the teaching methods were deemed to be teacher-centered. Even though participants viewed their educational practice as being more "hands on" in the laboratory, the faculty members involved were more concerned with what they were teaching as opposed to what students were learning. Comments from faculty throughout the interviews focused mostly on what they were doing in the classroom relative to teaching. Little or no time was spent focusing on the activities of the learners in their classes. Table 2 provides a brief summary of the emergent themes for each research question.

Table 2

Summary of Themes For Each Research Question

Research Question	Emergent Themes
1. How Do Faculty Learn Instructional Methods?	a. Informal observation b. Class inheritance c. Intuitive instruction – self-taught, trial-and-error
2. What Methods Do Science Faculty Use in Introductory Courses?	a. The lecture hall as a location and method of teaching b. Instructional diversification within the lecture hall c. The laboratory setting as a location and teaching method d. Teaching methods outside of the classroom

Conclusions and Recommendations

In our quest to examine how agricultural life science faculty learned to teach and then apply instructional methods, we were able to identify three conclusions (i.e., assertions). First, we concluded participants had little or no formal training in educational teaching methods. This assertion substantiated what has been known for decades—faculty are not prepared to teach and they learn to teach by trial and error (Academy of Distinguished Teachers, 2002; Davis & Beyrouty, 1995; Murray, 1987; Scarlett, 2004; Whaley & Wickler, 1992). In lieu of formal instruction, faculty professed acquiring instructional methods through informal observations. However, the foci of their observations varied. Several participants replicated teaching methods experienced from their undergraduate and graduate education. This conclusion supported Lortie's theory of apprenticeship of observation (1975). Yet, one participant took her training one step further by individually exploring several literary sources, professional organizations, peers who were formally trained in educational delivery, and educational workshops. Overall, faculty expressed a sense of pride in surviving the "trial by fire" approach to learning effective teaching strategies and exhibited motivation that teaching was an important role as a professor (Altbach & Lewis, 1997; Davis & Beyrouty, 1995).

Results indicated faculty had limited to no access to resources concerning instructional training. Therefore, it is recommended that instructional programming for both current and future faculty consisting of elements of learner-centered instruction be developed using contextualized examples rather than broad-based pedagogical application. More specifically, programs concentrating on faculty instructional development could adapt the practices modeled, and as they are experienced, within the plant, animal and food science courses. Finally, faculty development specialists should consider the developmental stage of the participating faculty (inexperienced, reflective practitioner, other). In this way, instructional strategies could vary for graduate teaching assistants, novice faculty, and veteran professors.

Our second conclusion pertained to *participants' perception of lecture and laboratory as a location, educational environment and teaching practice*. Participants assumed that all instruction within the lecture hall, whether discussion-based, question and answer, or case studies was considered "lecture." Similarly, the laboratory setting was the location to deliver "hands-on" teaching techniques, which applied lecture content to practical context. Even if the technique was a demonstration, the fact that it occurs in the laboratory made it a "lab." This way of thinking demonstrated by the participants supports the proposition that teaching is a highly contextualized experience (Kreber, 2002). As such, faculty considered "lecture and laboratory" as their teaching experience—location, environment, and practice.

Little distinction was given to the specific teaching methodology in the minds of the participating faculty, it was based upon the location where the instruction took place that gave a technique its designation. To further illustrate, during interviews, participants had to be prompted to think of specific teaching methods that they used other than lecture while in the lecture hall. Even though they were aware of techniques such as using current events, problem solving, and discussion, they were unable to articulate these as being different than lecture since they occurred in the lecture hall. The same was true for the laboratory setting. This may suggest that faculty in this study were not as reflective about their practice as informed by scholarly teaching (Hubball, Collins & Pratt, 2005).

It was evident that epistemological and linguistic barriers exist between educational disciplines and science educational practice at the collegiate level. Further research is needed to gain a deeper understanding of the mental frameworks that inform how life science faculty teach, which is supported by Pryor, Sloan, and Amobi (2007). This includes a broader examination of faculty knowledge and understanding of educational delivery and practice.

Finally, data revealed that the *majority of instruction described was teacher-centered*. In all but one case, faculty viewed their teaching strategies through the lens of their own challenges in getting their course information taught, while focusing heavily on the ease of content delivery (i.e., lecture). This conclusion supported Conti's (2004) assertion that lecture is "currently the dominant approach throughout all levels of education in North America" (p.77), and Liu, Qiao, and Liu's (2006) finding that 80% of graduate teaching assistants were teacher-centered. Further, Wardlow and Johnson (1999) found that faculty in a college of agriculture felt most comfortable with traditional teaching methods such as lecture and discussion. Consistent with Lortie's theory of apprenticeship of observation (1975), the teaching strategies employed by the faculty were largely influenced by the 'way they were taught.' This theory has important implications when applied to university faculty, many with no formal education in the teaching and learning process and who were trained in a heavily lecture based educational system (Estes, 2004).

Regardless of the teaching method used, faculty viewed student reactions to their teaching as secondary to what was comfortable or what allowed them to cover the course material efficiently. While there was some variability in instructional delivery in both the lecture and laboratory portions of their courses, the majority of instructional practice described was deemed to be teacher-centered when transposed along a teacher-centered/student-centered continuum (Conti, 2004). Faculty play a major role in what students experience in classrooms (Umbach & Wawrzynski, 2005), and this is particularly important for introductory college courses that serve as gateways for students pursuing STEM majors and careers (Labov, 2004) and particularly for students who may be least prepared to pursue STEM careers (Cruce, Wolniak, Seifert, & Pascarella, 2006).

In an effort to enhance the effectiveness of participant instructional delivery, we recommend faculty be taught to apply several student learning theories with a specified course in mind. Although faculty used multiple teaching methods in their introductory science courses, faculty struggled to articulate an understanding for how each of the methods contributed to their students' comprehension of course material. Reflection plays an important role in teacher development (Scanlon, Care, & Udod, 2002; Schön, 1987) and exploration of these theories may assist faculty in associating student-learning processes with content delivery. Life science faculty and education faculty should collaboratively engage in discussions surrounding the responsibilities associated with student learning. Venues and discussions such as these could be fruitful in developing philosophies and practices pertaining to the teacher-centered/student-centered continuum (O'Neill & McMahon, 2005). This recommendation is supported by Harder et al. (2009) who found that agriculture faculty were interested in faculty development programs to learn how to engage students in learning and use active learning strategies.

When considering the importance of STEM education nationally, it is evident that an emphasis on faculty development in the understanding and use of learner-centered teaching strategies is needed. Faculty engaged in teaching students enrolled in university introductory science courses need to be equipped with the knowledge and skills to effectively facilitate student learning in STEM fields. In order to accomplish this, further study is needed to understand difficult science concepts in introductory courses that are challenging for students to learn and for teachers to teach in order to better comprehend the cognitive activities involved in this process.

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