Plant Science Instructors' Perceptions of Learning Experiences in Online and Face-to-face Courses

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Abstract

Introductory plant science instructors have several options for course setting; lectures and laboratories can both be held via a face-to-face course, online course, or a hybrid of the two. While online laboratories boast many benefits over their face-to-face counterparts, instructors' preferences for teaching in these settings is unknown. This study utilized a survey approach to describe introductory plant science instructors' perceptions of learning experiences in the three course environments. Findings indicate that instructors offer instruction via face-to-face lectures and laboratories, prefer class sizes under 40 students, and prefer face-to-face learning environments. Instructors also felt that learning could be maximized by offering students a lecture before a follow-up laboratory experience. They primarily offered students abstract conceptualizations through their lectures and concrete experiences through their laboratories. These findings yielded several recommendations, among them being the need for instructors to explore online learning settings to overcome challenges common to face-to-face lecture and laboratory environments.

Introduction

In education, laboratory activities have numerous purposes. Primarily, laboratory work provides students with the conceptual and theoretical knowledge necessary to fully understand scientific concepts and understand the nature of science (Dikmenli, 2009). Additionally, students engaging in laboratory activities apply procedures used by scientists in the field (Dikmenli, 2009). Laboratory activities have also been found to increase students' interest in academic subjects (Tüysüz, 2010). Instructors and educational researchers acknowledge that laboratory work has the potential to foster higher order thinking skills (Ottander and Grelsson, 2006). Dale (1969) posited that learners engaging in hands-on experiences, such as laboratory activities, remember approximately 90% of what they do, compared to 10% of what they read.

Kolb (1984) identified four experiential learning stages in which a student must engage in order for learning to occur, each of which is possible in a laboratory setting. Information grasping activities, through either 1) concrete experiences or 2) abstract conceptualizations, enable the learner to take in new information. Information transforming activities, through either 3) reflective observation or 4) active experimentation, allow the learner to take that new information and use it in a manner that integrates it into the knowledge schema of the learner. Learning can occur regardless of the starting point and order of these stages, provided the learner engages in all four. Laboratory activities have the potential to include all four stages of experiential learning, thereby enhancing the knowledge gained by the student.

However, practitioners have identified several barriers that reduce the use or effectiveness of classroom-based laboratory activities, including the costs of equipment and consumables required for laboratory work, the time required to plan and conduct laboratory activities, the management of large numbers of students in confined laboratory spaces, and a lack of materials or facilities to carry out specific laboratory activities (Tüysüz, 2010). The rise of online education programs has offered laboratory instructors a potential avenue to overcome these barriers; virtual laboratory activities hosted on the internet reduce equipment costs and time requirements, enhance safety by reducing student access to hazardous materials and eliminating crowded laboratory rooms, and reduce the time required by instructors to prepare the laboratories (Kiyici and Yumusak, 2005). Online laboratory experiences also have the ability to maintain standards of educational quality set by face-to-face classroom laboratories; Demirci (2003) found that virtual laboratories allowed students to understand difficult concepts more easily, and Tüysüz (2010) reported that students experiencing virtual laboratories had significantly higher knowledge gains and interest growth than students experiencing a

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traditional laboratory. In Plant Science, the use of virtual laboratories may assist in reversing the widespread challenge of stimulating interest in plants among undergraduates (Vougioukalou et al., 2014).

The quality of the laboratory experience, regardless of delivery format, depends on the views and subsequent actions of the instructor responsible for the laboratory. While laboratory experiences can be utilized for knowledge production through all four stages of the experiential learning cycle (Kolb, 1984), research has shown that instructors "*fail to understand that laboratory activities may provide opportunities for students to produce new knowledge through scientific investigations*" (Dikmenli, 2009, para 3, line 5-7) and view laboratory activities as an opportunity for students to apply what they have already learned (Kang and Wallace, 2005; Shoulders and Myers, 2013). Shoulders and Myers (2013) found that high school agriculture teachers typically omitted at least one stage of the experiential learning cycle when working with students in laboratory settings, and that active experimentation was the stage most frequently omitted from laboratory-based learning activities. Further, there is a gap between undergraduates' and instructors' perceptions of the use of technology in the classroom. While current undergraduates "expect [technology] to support their learning" (International Advisory Board, n.d., p. 4), their instructors have been found to be resistant to new technologies (Pvtel, 2006). Currently, there is a gap in the literature with regard to plant science instructors' perceptions regarding online laboratory environments and how they compare to face-to-face laboratory environments.

Methods

The purpose of this study was to describe plant science instructors' perceptions of face-to-face and online education. In order to achieve this purpose, the following objectives were developed:

1. to describe introductory plant science courses' learning environments;
2. to describe introductory plant science instructors' preferences with regard to learning environment;
3. to describe introductory plant science instructors' preferences with regard to class size based on their courses' learning environments;
4. to describe introductory plant science instructors' expectations of student participation based on their courses' learning environments; and
5. to describe introductory plant science instructors' perceptions of their use of experiential learning stages based on their courses' learning environments.

This study used a survey design to achieve its purpose. The population consisted of all introductory plant science instructors teaching at land-grant institutions in the US, and a census was sought after. The University of [State] Institutional Review Board deemed this study exempt, as it surveyed adults over 18. Because no comprehensive database exists for this population, the researchers reviewed institutional websites and made contacts in order to identify at least one introductory plant science instructor at each institution (N = 120). The sampling frame presents a limitation of the study, as the researchers may not have identified all introductory plant science instructors. Instructors without available email addresses (n = 28) were removed from the study, leading to an accessible population of 92.

In the absence of a validated survey designed to meet the study's objectives, the researchers developed a survey consisting of 50 multiple choice and Likert-type items. Instructors were presented with items only pertaining to the lecture and laboratory settings to which they had access. A panel of experts in plant science and online education reviewed the survey for face and content validity; edits were made based on the panel's recommendations. Reliability was established using the test-retest method (Huck, 2008). Eight professors of agricultural education completed the survey two times at the beginning and end of a two-week period, yielding a reliability score of 0.805.

Dillman et al. (2009) recommend multiple contacts with potential respondents in order to maximize response rate. Members of the sample were contact once weekly for a four-week period. After the four weeks, 41 responses were collected. Of those respondents, 15 indicated that they were not responsible for teaching an introductory plant science course. They were removed from the sampling frame, leading to a final response rate of 33.8% (n = 26). Nonresponse error was addressed via double dipping (Miller and Smith, 1983). No significant differences were found on responses to any item between respondents and nonrespondents ($p = 0.433 - 0.715$). Therefore, findings were generalized to all members of the accessible population.

Results and Discussion

Description of Plant Science Courses' Learning Environments

The majority (n = 20) of respondents described their learning environments as being a face-to-face lecture setting (Table 1). No instructors reported delivering instruction via an online or hybrid face-to-face/online laboratory. Sixteen respondents said they taught in a face-to-face lab setting, four utilized a hybrid face-to-face/online lecture format, and one respondent used an online-only lecture format. Most (n = 14) instructors reported their face-to-face lecture was required to be taken with a lab course, while all 16 respondents reported a face-to-face lab is required when taking the lecture. More (n = 13) instructors reported their face-to-face laboratories reinforced information introduced in the lecture, as opposed to eight respondents stating their face-to-face lecture supplemented information from the laboratory. Eleven respondents (68.9%) indicated that the face-to-face lab grade is not separate from the lecture grade, indicating that in most settings, the lecture and lab are closely linked.

Table 1. Plant Science Courses' Learning Environments

Learning Environment	f	%
Face-to-face lecture	20	83
Face-to-face lab	16	67
Online lecture	1	4
Online lab	0	0
Hybrid face-to-face/online lecture	4	17
Hybrid face-to-face/online lab	0	0

Table 1. Plant Science Courses' Learning Environments

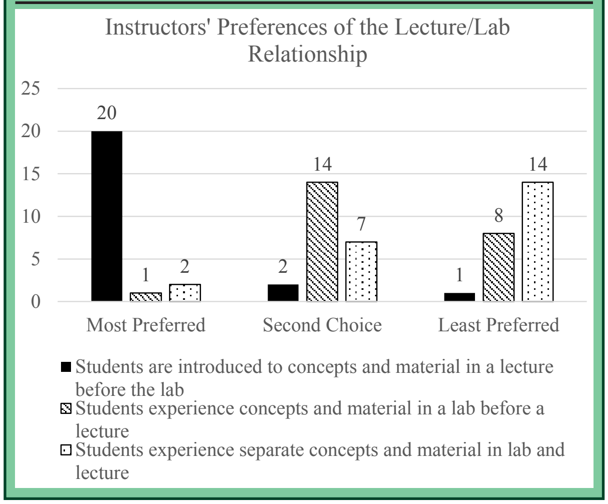


Figure 2. Instructors' perceptions regarding student learning based on lecture/lab relationship.

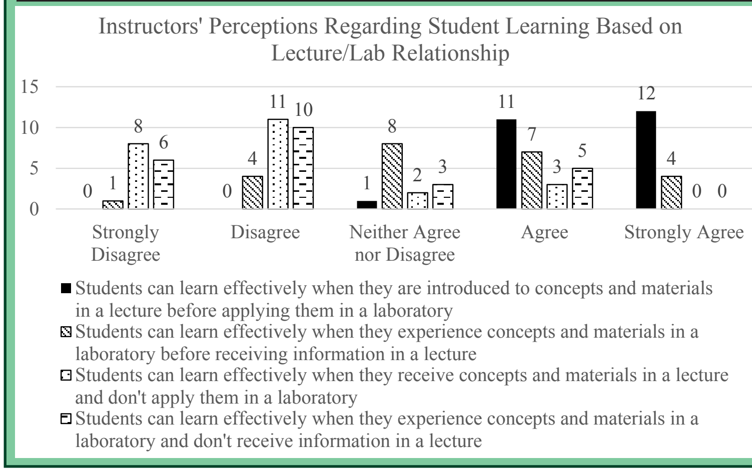


Figure 3. Instructors' preferred class sizes based on learning environment.

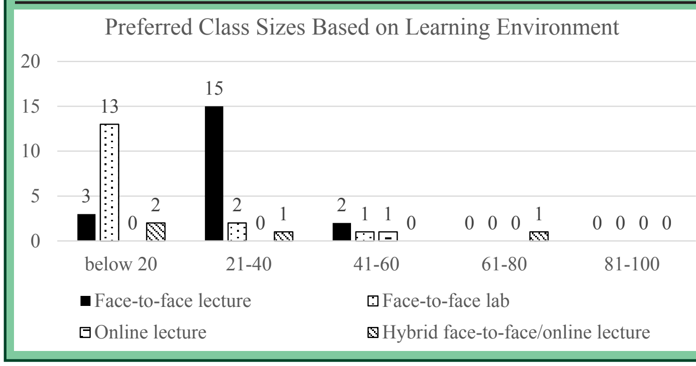


Figure 4. Instructors requiring verbal participation based on learning environment.

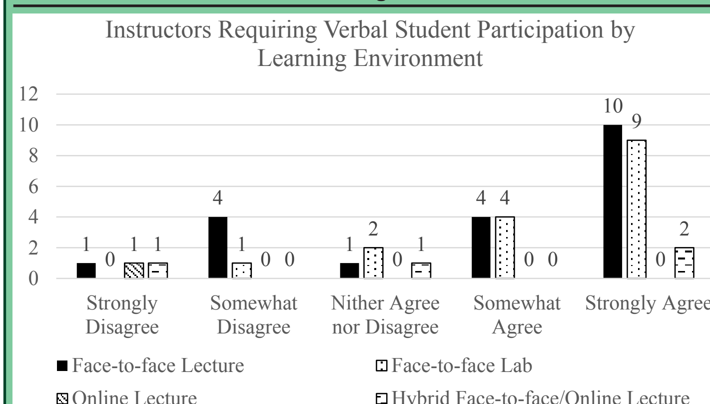
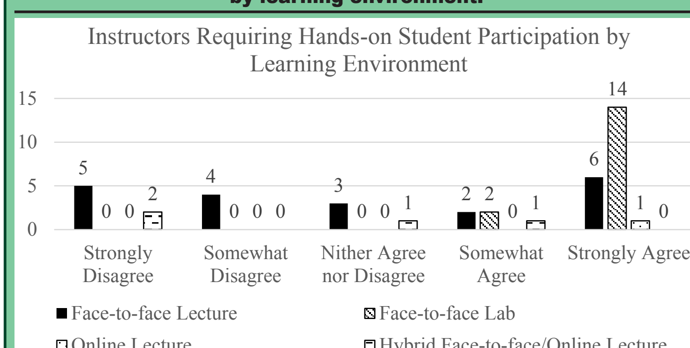


Figure 5. Instructors requiring hands-on participation by learning environment.



Description of Plant Science Instructors' Preferences with Regard to Learning Environment

A majority (n = 20) of instructors ranked a face-to-face learning environment as their most preferred setting for lectures, and 19 listed an online environment as their least preferred for lectures. Similarly, most respondents (n = 22) indicated that a face-to-face lab environment is their most preferred for a lab and online as their least preferred laboratory environment (n = 20). Most instructors (n = 20) preferred to introduce concepts to students in a lecture setting before introducing those concepts in a lab and least preferred the lab and lecture focusing on separate concepts (n = 14) (Figure 1). The majority of respondents (n = 23) agreed or strongly agreed that students learn effectively when they are introduced to concepts and materials in a lecture before applying them in a laboratory. The majority of respondents disagreed that students can effectively learn when they engage in either the lecture or laboratory without the other (Figure 2).

Description of Introductory Plant Science Instructors' Preferences with Regard to Class Size Based on Their Courses' Learning Environments

Most instructors (n = 15) preferred a class size of 21-40 in a face-to-face lecture setting, and fewer than 20 students in a face-to-face lab setting (n = 13) (Figure 3).

Instructors in a hybrid lecture format indicated that fewer than 20 students was also their preferred class size. No respondents indicated a preference for any type of class with more than 80 students.

Figure 6. Instructors' Perceptions of the Experiential Learning Stage Intended when they Instruct Students

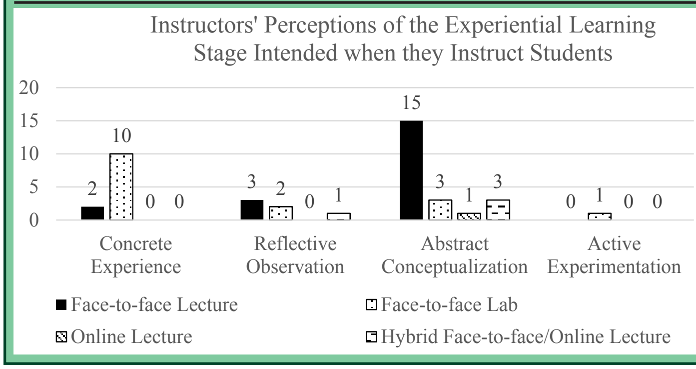


Figure 7. Instructors' Perceptions of the Experiential Learning Stage they Intend when they Design the Purpose of their Class

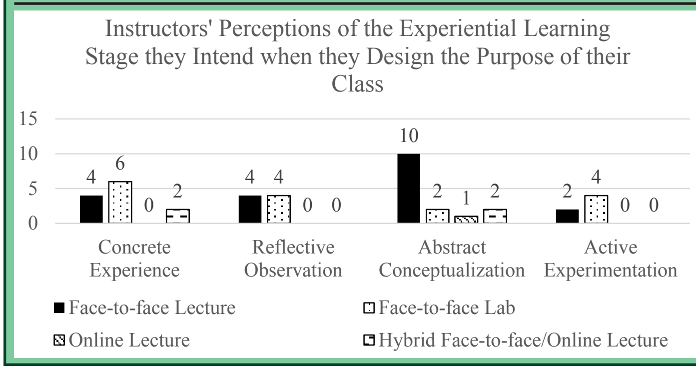


Figure 8. Instructors' Perceptions of the Experiential Learning Stage they Intend when they Design Objectives for Students

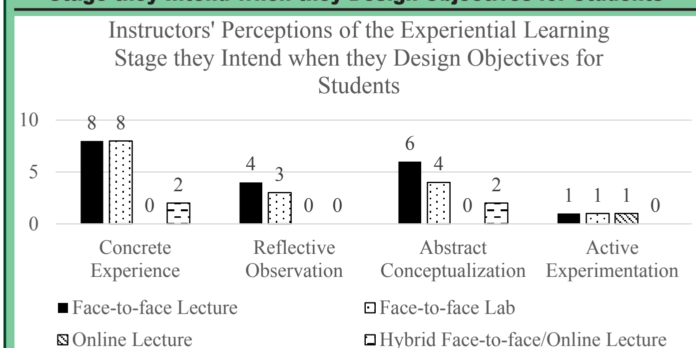
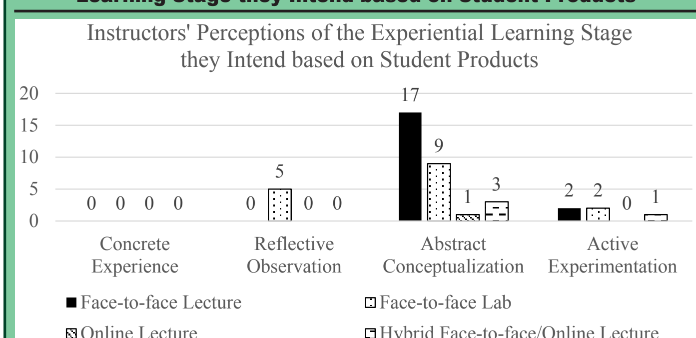


Figure 9. Instructors' Perceptions of the Experiential Learning Stage they Intend based on Student Products



Description of Introductory Plant Science Instructors' Expectations of Student Participation Based on Their Courses' Learning Environments

A majority of instructors in face-to-face lecture, lab, and hybrid environments strongly agreed that students were required to participate verbally (Figure 4).

A single respondent strongly disagreed that such a requirement was present in an online lecture environment. Respondents displayed differing expectations with regard to whether hands-on student participation is required in a face-to-face lecture environment; nine respondents disagreed with the statement while eight agreed (Figure 5). Instructors in face-to-face labs placed high emphasis on hands-on student participation, as did the online lecture respondent. However, among those who taught a hybrid lecture model, hands-on participation was not a stringent requirement.

Description of Introductory Plant Science Instructors' Perceptions of Their Use of Experiential Learning Stages Based on Their Courses' Learning Environments

Most instructors in any type of lecture setting, be it face-to-face (n = 15; 75%), online (n = 1; 100%), or a hybrid of the two (n = 3; 75%), intended for students to achieve abstract conceptualization, whereas the majority of instructors of face-to-face labs (n = 10; 63%) aimed to create a concrete experience for the student (Figure 6). The values were more widespread when examining the learning stage intended by the instructor when designing the purpose of the class (Figure 7). A majority of face-to-face lecture instructors (n = 10) still indicated that abstract conceptualization was their goal of instruction, but smaller factions also indicated that concrete experience (n = 4) and reflective observation (n = 4) were intended outcomes. The intentions of lab instructors were also spread across the range of choices, with concrete experience, reflective observation, and active experimentation receiving nearly equal responses. Respondents indicated the experiential learning stages in which they intended for students to engage when they design learning objectives (Figure 8). Instructors perceived student learning objectives for face-to-face lecture and lab as focused more on concrete experience, followed by abstract conceptualization and reflective observation. Hybrid learning environments were split evenly between experience and conceptualization, and three instructors in three different learning environments reported a focus on active experimentation. Instructors were more unanimous in their perceptions of learning stage displayed in student products (Figure 9). Most lecture and lab instructors reported abstract conceptualization as an intended goal, with a minority saying that active experimentation was the goal.

The majority of introductory plant science instructors taught in face-to-face lectures and laboratories. This follows national trends at land-grant institutions in that the majority of courses are held on campus via face-to-face means. However, the instructional needs and expectations of the technology-oriented millennial generation may benefit from an increase in online course offerings, especially in introductory courses with high enrollment numbers (International Advisory Board, n.d.). Most of the respondents reported the face-to-face environment as most preferred for both laboratories and lectures, and reported online lectures and labs as least preferred, aligning with Pvtel's (2006) position that instructors are resistant to new technologies and prefer to continue using familiar practices. Land-grant institutions should encourage instructors to engage in professional development that familiarizes them with the benefits and best practices of teaching online courses.

Instructors perceived that students can learn most effectively when engaging in both a lecture and a laboratory, but felt that learning was maximized when students experienced the lecture before the laboratory. These findings suggest that instructors' perceptions regarding learning align with the tenets of experiential learning theory, but they may not fully embrace the notion that learners can experience information grasping and transforming activities in any order (Kolb, 1984). Because students' schedules may not allow for a lecture to be experienced before a lab, instructors should become more adept at altering lecture experiences to accommodate students who have already experienced the lab.

All instructors preferred courses with fewer than 80 students, with the vast majority preferring lectures with fewer than 40 students and labs with fewer than 20 students. Universities generate funds through student tuition, making courses with high enrollments more lucrative. Online lectures and laboratories overcome enrollment-related barriers, such as room space and cost of consumables (Kiyici and Yumusak, 2005). Training instructors to feel comfortable in online lecture and lab environments may reduce the challenges they perceive with larger student numbers, enabling universities to bring in more tuition dollars via higher student enrollments in online plant science lectures and labs.

Instructors were similar in their requirements for verbal participation from students in face-to-face lectures, face-to-face laboratories, and hybrid lectures. However, their requirements for hands-on participation varied; only instructors of face-to-face laboratories unanimously required hands-on participation. Experiential learning theory states that students must engage in active experimentation and concrete experiences, both of which require hands-on participation (Kolb, 1984). Instructors should be encouraged to reconsider opportunities for hands-on learning experiences in all learning environments.

Instructors primarily utilized their face-to-face lectures for abstract conceptualization and their face-to-face labs for concrete experiences. Fewer than half of the instructors indicated they use their labs for active experimentation, which would enable students to develop higher order thinking skills (Ottander and Grelsson, 2006). This finding corroborates previous research which found that instructors utilize laboratories as a vehicle for application of knowledge previously learned (Kang and Wallace, 2005; Shoulders and Myers, 2013). Instructors should be encouraged to design laboratory activities that require active experimentation and theory development and testing in order to develop students' higher order thinking skills.

Because few instructors reported teaching lectures or labs in online settings, no comparisons can be made between the use of face-to-face and online lecture and lab settings. If the recommendations within this study are acted upon and instructors begin to offer more online introductory plant science lectures and laboratories, researchers should investigate the similarities and differences in the learning experiences offered to students in these different settings.

Summary

The world of technology moves ever-forward; online learning is a component of students' educational expectations for the foreseeable future. Online laboratories have the potential to benefit introductory plant science students, but few opportunities exist for students to engage in online plant science courses. This study provides introductory plant science instructors a snapshot of the nation's introductory plant science courses, with results that encourage them to explore expanding online offerings and pursue professional development to increase their comfort in online educational methods.

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