Teaching Methods

An Experiential Learning Activity in a Landscape Irrigation Undergraduate Course

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SUMMARY. In the Fall 1999 semester, the Department of Horticulture, Forestry, and Recreation Resources at Kansas State University introduced a 3-credit-hour irrigation system principles and installation course with experiential learning as the core of the instructional format. The experiential learning component of the course is the multiweek installation of a residential irrigation system during the laboratory sections that allows students to learn the procedural skills necessary to properly install an irrigation system. To assess the influence that this experiential learning activity may have on students' confidence to perform specific irrigation installation skills, a survey was administered to 70 undergraduates enrolled in the course (HORT 550: Landscape Irrigation Systems) during the Fall 2006 and 2007 semesters before and after the completion of the irrigation system. Using a Likert scale, students responded to two questions pertaining to 10 specific irrigation skills used during the installation project: 1) whether they actually performed the particular skill during the installation (coded 0 = did not assist, 1 = did assist); and 2) how confident they were to perform that aspect of installation on their own (on a 9-point Likert scale with 1 = not at all confident to 9 = extremely confident). The correlation between whether students actually performed the particular skill during the installation and how confident they were that they could actually do it on their own was significant ($r = 0.46$, $P < 0.0001$). During the Fall 2006 semester, 44 students were asked to compare their actual experience installing the system to what they learned during lecture and by reading the textbook; participants said that installing the system greatly increased their understanding (mean = 7.84, $SD = 1.41$) and increased their confidence to perform particular skills ($m = 7.84$, $SD = 1.03$). As documented in the survey, students benefitted significantly from this experiential learning activity.

It is estimated that as much as 3.5 billion gallons (13.25 million cubic meters) of landscape

irrigation water is lost or wasted due to evaporation, wind, or improper irrigation system design, installation, and maintenance in the United States each year. In an overall effort to improve irrigation water efficiency, the U.S. Environmental Protection Agency is sponsoring the program WaterSense® as a means to label certification programs for landscape irrigation professionals that support the principles of efficient irrigation. To earn a WaterSense® label, contractors are required to undergo rigorous

testing and achieve certification to validate their competency in designing, installing, maintaining, and auditing irrigation systems. This process also confirms their ability to evaluate soil–water–plant relationships and the resulting impacts on irrigation system efficiency. Consequently, irrigation contractors and certain golf course superintendents (Schlossberg et al., 2004) across the United States seek employees that have the combined understanding of soil–plant–water relations and the technical expertise required to create efficient irrigation systems that unite water-saving designs with correct installation practices (Reaves, 1999).

In response to this concern, Kansas State University (KSU), specifically, the Department of Horticulture, Forestry, and Recreation Resources was the first institution of higher education to integrate Irrigation Association® (IA; Falls Church, VA) professional educational training materials into a course for undergraduate students (Reaves, 1999). Founded in 1949, IA is the leading membership organization for over 2000 corporate and individual members from irrigation equipment and system manufacturers, dealers, distributors, designers, consultants, contractors, and end users worldwide.

The course, HORT 550: Landscape Irrigation Systems, was introduced in the Fall 1999 with experiential learning as the core of the instructional format. An overarching goal of this course is to increase students' understanding of fundamental irrigation concepts by bringing relevance and context to the lecture topics by providing students the opportunity to install a residential irrigation system. This experiential learning project allows students to further process the lecture information while striving to enhance their comprehension and confidence to perform the skills required during an irrigation system installation.

The term "experiential learning" describes students' "learning by doing or participating" through experiences such as community service, field work, internships, independent study, and research projects (McKeachie, 2002). Early in the 20th century, Dewey (1938) described the important connection between education and personal experience. Experiential learning

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offers the learner an opportunity to intertwine theoretical concepts with action. Work by Rogers (1969) describes the qualities of experiential learning as one of involvement by the learner that is self-initiated, self-evaluated, and has significant effects on the learner.

Experiential learning has long served as the foundation of agricultural teaching, referred to as field experience or cooperative education (Bliss, 1952; Cheek et al., 1994; Knobloch, 2003; McKeachie, 2002; Roberts, 2006), and many university and college agricultural programs employ creative methods of using experiential learning activities (Barkley, 2003; Davis, 1999; Davis and Gilman, 1995; McLean and Camp, 2000; Robinson and Torres, 2007; Sanchez and Craig, 2007; Stearns, 1995; Wiebold and Slaughter, 1986). Experiential learning activities offer the learner relatively immediate feedback and may serve as a predictor of self-efficacy; i.e., a person's confidence to complete a job successfully (Mosca et al., 2007).

Kolb's (1984) model of experiential learning asserts that learning can be enhanced by concrete experience, reflective observation, abstract conceptualization, and active experimentation. An experiential learning activity such the installation of a residential irrigation system can serve as an ideal venue to practice Chickering and Gamson's (1999) seven principles of good practice for undergraduate education: student-faculty contact, cooperation among students, encouraging active learning, giving prompt feedback, emphasizing time on task, communicating high expectations, and respecting diverse talents and ways of learning.

In two studies (Enderlin and Osborne, 1992; Rothenberger and Stewart, 1995), horticultural students who were taught using experiential learning activities scored higher on knowledge exams when compared with students taught using lectures exclusively. Real-life learning activities provide students the opportunity to physically and mentally put into action the concepts learned in the classroom (Robinson and Torres, 2007; Scales et al., 2006). Additionally, this style of learning can also promote communication skills, creativity, self-directness, and confidence (Grayson, 1999; Mosca et al., 2007;

Pennington, 2004; Sanchez and Craig, 2007), all characteristics desired by employers, even more so than job-specific skills (Beidler et al., 2006; Berle, 2007; Norwood and Henneberry, 2006). Learning as a behavior is a function of the interaction a person has with their environment, the particular circumstances, and other people (Bandura, 1977). Learning is considered a social event (Merriam and Caffarella, 1999), therefore activities that involve opportunities for interaction with faculty and fellow students in a positive working environment can be beneficial to the understanding and learning process.

Students like to "see, feel, and experience" while they are learning or gaining new skills (Lavis, 2005). Purposeful group activities encourage students to apply concepts. From the students' perspective, any interaction or activity that requires the application of information gives significance to their learning; if they think it is worthwhile, they put more effort into learning (Beidler et al., 2006; Norwood and Henneberry, 2006; Lavis, 2005). A bonus to such activities is that when problems arise or things do not go according to plan, what seemed so theoretical in the classroom becomes authentic.

While the learning theory literature abounds regarding the value of experiential learning, there is relatively little information to support the influence of experiential learning on student confidence gained as a result of in-class experiences. However, in one of the few tests of this relationship, a pre- and post-course study by LaVan and Carley (1981) found that students' confidence in their knowledge increased significantly from the beginning of the semester to the end of the semester as a result of experiential learning.

Self-confidence surveys can be used to discover how students rate their self-perceived confidence of course topics before the learning experience (Angelo and Cross, 1993). Self-confidence and knowledge surveys can be useful tools to determine the effect of class projects, particularly when the aim is to teach new skills or increase skill levels (Angelo and Cross, 1993). The implication of such information is that the instructor can focus on these specific skills during

the experiential learning activity to promote ways to avoid anxiety in students who have low confidence in their abilities to perform such skills. Self-confidence surveys can also be helpful to the student because a well-designed survey helps them to focus on the skills that they need to learn or become more comfortable performing (Angelo and Cross, 1993).

Therefore, the objectives of this study were to describe this experiential learning activity, the installation of a residential irrigation system, with instructors who may want to develop a similar course that includes the potential for students to pursue the IA-Certified Landscape Irrigation Auditor (CLIA) certification, and to evaluate the influence that this learning experience had on student confidence to perform specific irrigation skills that are taught during this course.

The course, HORT 550: Landscape Irrigation Systems, includes two weekly lectures (50 min each) and one weekly laboratory section (115 min). This is a required course with an enrollment of 40 to 45 students who are majoring in horticulture with specializations in golf course management, sports turf operations management, and landscape management. Students specializing in landscape design, greenhouse and nursery management, fruit and vegetable production, and horticultural therapy typically choose this course as a horticultural elective.

During the lectures, basic, yet essential, irrigation principles and practices are introduced. The lecture topics include irrigation components, correct installation procedures, system auditing, and fundamentals of hydraulics, system winterization, and electrical and mechanical troubleshooting (Table 1). A primary portion of the laboratory (5–7 weeks) includes the installation of a residential irrigation system; the students continue using this system to learn other important irrigation principles such as how to perform 1) a follow-up site visit with the homeowner, 2) an irrigation audit, 3) electrical and mechanical troubleshooting, and 4) winterization practices.

In addition to the students gaining irrigation installation skills, they learn how to perform an irrigation audit using the system they built. An audit is an effective tool for maximizing water use efficiency as well as exposing

Table 1. Tentative (weather-permitting) weekly discussions of lecture and laboratory activities in an upper-level undergraduate course on landscape irrigation systems.

Week no.	Lecture topics	Laboratory projects
1	<ul style="list-style-type: none"> • Irrigation system overview • Preview to irrigation components 	<ul style="list-style-type: none"> • Introductions and laboratory protocol • Introduction to the tools and equipment used for installation
2	<ul style="list-style-type: none"> • Performing the site inspection • Reading blueprints and specifications • Learning to use a scale 	<ul style="list-style-type: none"> • Performing pre-installation inspection and gather data • Practice reading design using a scale • Flag site for installation
3	<ul style="list-style-type: none"> • Installing the point-of-connection (POC) • Introduction to backflow devices • Introduction to piping and fittings • Solvent welding pipe • Joining polyethylene using barbed fittings • Introduction to automatic drains 	<ul style="list-style-type: none"> • View and discuss the POC and backflow device as installed by the contractor • Students solvent weld polyvinylchloride pipe • Students work with the contractor to pull the piping using a vibratory plow • Install of automatic drains
4	<ul style="list-style-type: none"> • Introduction to field wiring • Splicing wire • Introduction to electric control valves 	<ul style="list-style-type: none"> • Install system master valve • Install zone valves • Wire the valves • Set valve boxes • Make flex pipe swing joints
5	<ul style="list-style-type: none"> • Sprinkler selection, installation, adjustment, and repair • Introduction to sprinkler precipitation rates 	<ul style="list-style-type: none"> • Install sprinklers • Install drip valves • Install drip system • Install weather based controller • Install weather station • Run system, adjust sprinklers • Consult with homeowner • Perform audit on site
6	<ul style="list-style-type: none"> • Introduction to drip irrigation 	<ul style="list-style-type: none"> • Diagnosing electrical problems using electrical simulator (inside laboratory) • Faults and meter readings
7	<ul style="list-style-type: none"> • Introduction to controllers • Introduction to other irrigation sensors 	<ul style="list-style-type: none"> • On-site work reading faults and meters • Learning the steps of electrical troubleshooting • Hydraulics and pipe sizing • Using friction loss charts • Pressure demonstrations showing the influence of pressure changes in flow and operation of sprinklers
9	<ul style="list-style-type: none"> • Learning to perform an audit 	<ul style="list-style-type: none"> • Site visit to local golf course to see pump house
10	<ul style="list-style-type: none"> • Introduction to electrical troubleshooting • Electrical terminology • Using multimeters 	<ul style="list-style-type: none"> • Students assist winterizing system
11	<ul style="list-style-type: none"> • Finish electrical problems • Discuss mechanical problems 	
12	<ul style="list-style-type: none"> • Introduction to hydraulics • Introduction to friction loss charts 	
13	<ul style="list-style-type: none"> • Introduction to pumps • Introduction to pump charts 	
14	<ul style="list-style-type: none"> • Introduction to winterization using compressed air 	

students to the critical concepts of water conservation. An audit consists of three activities: site inspection, performance testing, and irrigation scheduling. As the students work through each of the three activities, they are able to distinguish the difference between a good and bad system or the right and wrong method of performing a skill, and how to make these determinations. Auditing drives home the point that proper installation and system maintenance are directly related to distribution uniformity and irrigation efficiency. Over time, even an efficient system breaks down, so knowing how

to perform an audit is important and may be useful in students' future careers, especially with the growing concern of water shortages and the water monitoring requirements of many municipalities already in place. An additional bonus to learning auditing procedures is that students are prepared to take and successfully pass the CLIA exam or the HYDROLogic® select Hc3® certification (HYDROLogic®, Minneapolis, MN). Of the KSU students who have taken the IA certification exam between 1999 and 2008, all have passed. Recently, eight students have also chosen to pursue the

HYDROLogic® Hc3® certification, another top-notch irrigation teaching tool offered by industry.

The logistics of the Irrigation Installation Project

The uniqueness of this experiential learning project is the interaction between the local irrigation contractor, a homeowner, and the students. "Your course with the field lab gives students a more real life experience than any other program that I am aware of. Many colleges will do a landscape/irrigation design for a residential

property, but to my knowledge they have not undertaken the challenges of actually building or installing an irrigation system in the same way that this course does. The fact that you collaborate with industry, you carefully select the customer getting the sprinkler system, and the personal attention you provide the customer and give to the students has made your program unique" (B. Mecham, personal communication).

Six local irrigation contractors have enthusiastically agreed to help with this project on a rotational basis. This rotational method allows each contractor the opportunity every 6 years to assist with the initial portions of the installation (e.g., installing the backflow device and piping). The contractor typically acquires a new client for seasonal maintenance or service as a result. Each installation project is influenced by the willingness of the homeowner to have their property in disarray for ≈ 5 to 6 weeks and by the immediate proximity to campus (within 10 min) because each laboratory section is only 115 min. With the round-trip drive taking ≈ 20 min, that allows about 95 min for instructions, demonstrations, and productive work (Table 1). There are three laboratory sections weekly, and within each, there are ≈ 12 to 15 students. Each of these laboratory sections are synchronized so that each crew experiences and practices, for the most part, every aspect of the installation. For example, each crew will make and install sprinkler swing joints, wire and install an electric control valve, and insert sprinkler nozzles.

During the first lecture of the semester, students are asked to fill out a short questionnaire that responds to the questions: 1) Do you have any previous irrigation experience, and if so, briefly describe this experience; 2) what is your class ranking (e.g., sophomore, junior); and 3) what horticultural specialization/curriculum are you pursuing (e.g., landscape design, golf course management, etc.), or if not horticulture, what degree program are you pursuing? Using this information, students are assigned to a working crew of three to four, as this group size has been determined to generally be the most effective (Lehman, 2007; Lewin, 1935; Marzano et al., 2001). Groups of this size allow for productive communication (Murano and

Knight, 1999) that may encourage a higher-level of thinking (Johnson and Johnson, 1999; McCormick and Whittington, 2000) because members are able to work together to problem solve and reflect upon the task at hand (Hansen, 2006; McCormick and Whittington, 2000). A common complaint about group work is freeloading (Lou et al., 1996); for that reason, the crews are given guidelines to encourage accountability. Additionally, each student rotates into a different working position each laboratory meeting; for example, one week they are the crew leader, the next week the "hole-digger," then perhaps the observer, or the person who gets the needed irrigation supplies organized, and so forth. This positive interdependence silently enforces "a sense of sink or swim" strategy within the group (Lou et al., 1996).

During the first laboratory meeting, students are given a comprehensive overview of the project, including the agreement between the contractor, the homeowner, and the course instructor, and they recognize they are the labor force for the project. The contractor delivers all the necessary irrigation components to the site. The contractor performs the following initial stages of the project: 1) makes the mechanical point-of-connection (POC) to the domestic water supply, 2) installs the backflow device as governed by local codes, and 3) with the students' help, installs the irrigation piping using a vibratory plow. Upon completion of the irrigation system, the contractor invoices the homeowner for all irrigation components and any labor. The homeowner makes a donation of 15% of the total amount paid to the contractor to the instructor's teaching account. The money is used to support this experiential learning project.

The Irrigation Installation Procedure

The project begins with the initial site visit during the first laboratory of the semester; this visit has multiple objectives, including allowing students to become at ease on the property. Although this is not an irrigation design course per se, the students are introduced to the pieces of information (e.g., pressure and flow, meter size) required to design an efficient

irrigation system because this information is important to their overall understanding of an entire irrigation installation project. The instructor points out that the underground utility service lines have been marked as a result of calling the underground utility notification center 48 h in advance of any digging. The residential water meter is located, and the students learn how to determine the meter and water service line size. Students are shown how to verify the site's static water pressure and the flow rate. The instructor demonstrates how to read the irrigation plan and use an engineer's scale. Students then work in their crews to flag or take notice of where the backflow device, sprinklers, electric control valves, and all mainline and lateral piping will be located. The site is now ready for the contractor to install the piping using a vibratory plow.

An important experiential learning component of the project is observing and assisting with the installation of the irrigation piping using a vibratory plow. The plow pulls the pipe into the ground behind a vibrating vertical steel shank that moves horizontally at a fixed vertical depth. In order for the students to appreciate how the vibratory plow operates, all students are required to attend this one-time event. On the first day of the semester, students are given the date that the 50-min lecture will actually occur on site rather than in the classroom so they may see the piece of equipment and how it pulls the pipe into the ground. This requires careful curriculum scheduling of the weekly meeting days and times for the lecture and laboratory sections. For example, one laboratory section is scheduled to immediately follow a lecture (e.g., 8:30–9:20 AM lecture, 9:30–11:20 AM laboratory section). The laboratory section that remains will work with the contractor to install the polyvinylchloride (PVC) pipe system mainline, along with the underground electrical wire, and the polyethylene (PE) pipe for the laterals. The instructor coordinates rides with two additional faculty members to drive vans to the site to get those students who have classes immediately following this class back to campus for their next class.

When all the components have been installed in the ground, students

work alongside an irrigation industry representative to mount the weather-based controller, often referred to as smart water controllers. Weather-based or sensor-based controllers automatically adjust irrigation run times in response to local environmental changes rather than following the same watering schedule day in and day out. These controllers incorporate site data such as soil texture, plant type, slope, sun, or shade with data received from soil moisture sensors, on-site weather sensors, or virtual weather sources. Using this data, these devices calculate evapotranspiration (ET) on a daily basis to automatically adjust irrigation schedules.

Once the weather-based controller has been wired and programmed according to the site and environmental conditions, students will introduce water into the system to flush out any debris that may have entered during installation. At the same time, the system is checked for any leaks or other potential issues. Students then install and adjust the sprinkler nozzles, and perform any other necessary adjustments and modifications to the system.

Once the system is operational, one of the laboratory sections meets for the final site visit with the homeowner. The students have compiled a notebook that contains useful information about the irrigation system. Each crew is required to assemble an assigned section for the notebook, for example, the as-built plan or information on the controller. During this final visit, students discuss the contents of the notebook and demonstrate system operation while addressing any questions or concerns of the homeowner.

Student survey

At the end of the Fall 2006 and 2007 semesters, a survey was administered to 70 students enrolled in the course to determine if the irrigation installation would increase their confidence to perform certain skills. Surveys were anonymous, and students were not required to participate. The survey took approximately 10 min to complete.

The survey was composed of questions pertaining to the following 10 irrigation installation skills: solvent-welding PVC pipe, installing barb fittings into PE pipe, installing nozzles,

making and installing sprinkler swing joints, adjusting rotor-type sprinklers, installing a drip-zone valve, wiring an electric-control valve, mounting and wiring the controller, and installing the on-site weather station. Participants were asked two questions about each of the 10 installation skills: 1) whether they actually helped with the aspect of the installation (e.g., "Did you or your crew assist with installing the nozzles into the sprinkler?"), and 2) how confident they were that they could perform that aspect of the installation on their own (e.g., "How confident are you that you can install nozzles into sprinklers?"; 1 = not at all confident to 9 = extremely confident, Likert scale). They were also asked how difficult they thought each aspect of the installation was (on a 9-point Likert scale with 1 = not at all difficult to 9 = extremely difficult). In addition, the Fall 2006 participants (N = 44) were given an additional survey asking them about their perceptions of their laboratory experience.

Results

DATA ANALYSES. Data were analyzed using SPSS (version 12.0 for Windows; SPSS, Chicago). Correlations were performed to examine the relationship between the student's actual involvement in performing the

installation skill and their self-rated perception of their confidence to perform specific irrigation installation skills. Additionally, during the Fall 2006 semester, students were asked to respond to specific questions regarding their perception of how beneficial the laboratory experience was to the in-class experience.

CORRELATIONS BETWEEN ACTUAL INVOLVEMENT IN PERFORMING THE INSTALLATION TASK AND CONFIDENCE. Correlations were performed between whether students assisted with various aspects of the installation (coded 0 = did not assist, 1 = did assist) and how confident they were that they could do it themselves (on a 9-point Likert scale with 1 = not at all confident to 9 = extremely confident). Collapsing across all 10 aspects of an installation for both semesters (70 participants total), the correlation between whether students actually assisted with an aspect of the installation and how confident they were that they could actually do it on their own was significant ($r = 0.46$, $P < 0.0001$).

As shown in Table 2, when the individual aspects of the installation were examined separately, the correlation between whether students actually assisted with an aspect of the installation and how confident they

Table 2. Effect of participating in an irrigation installation task on confidence and perceived difficulty of each task (N = 70).

Irrigation installation task	Correlation of actual installation and confidence ^a		Perceived difficulty ^b mean $\pm$ SD
	Coefficient	P > r	
Installing the irrigation controller	0.24	0.046	5.14 $\pm$ 1.64
Installing the on-site weather station	0.36	0.002	4.36 $\pm$ 2.01
Wiring the irrigation controller	0.38	0.001	4.04 $\pm$ 2.04
Installing a drip zone valve	0.35	0.003	3.28 $\pm$ 1.72
Connecting polyethylene pipe to barb fittings	0.80	0.001	2.14 $\pm$ 1.56 3.79 $\pm$ 1.31
Installing sprinkler nozzles	0.17	0.165	2.10 $\pm$ 1.28
Making and installing a sprinkler swing joint	0.16	0.180	3.07 $\pm$ 1.61
Adjusting arc and radius rotor sprinklers	0.11	0.356	3.24 $\pm$ 1.92
Wiring an irrigation zone valve	-0.02	0.855	3.06 $\pm$ 1.94
Solvent welding polyvinylchloride pipe/fittings	0.05	0.700	1.67 $\pm$ 1.04 2.63 $\pm$ 1.23

^aCorrelations are based on responses to two questions: "Did you or your crew assist with [name of task]?" (0 = did not assist, 1 = did assist); "How confident are you that you can [name of task]?" (0 = not at all confident to 9 = extremely confident).

^bDifficulty ratings were in response to the question: "How difficult do you think [name of task] was or would be?" (0 = not at all difficult to 9 = extremely difficult).

were that they could actually do it by themselves was significant for five installation processes: having direct experience installing the controller and the weather station, wiring the controller, installing a drip valve, and connecting PE pipe to barb fittings. On the other hand, actually installing sprinkler nozzles, making and installing sprinkler flex pipe swing joints, adjusting the rotor sprinklers to ensure the proper arc and radius of spray, wiring a zone valve, and solvent-welding PVC pipe/fittings did not lead to significantly greater confidence in participants' ability to perform that aspect of the installation.

In general, it appears that the greatest increase in confidence came when participants were engaged in what they perceived to be the more difficult or unfamiliar aspects of the installation. Actual involvement in performing the installation skill did not seem to be as critical when participants were engaged in what they perceived to be the easier or familiar aspects of the installation. Although the difficulty ratings were not extremely high for any of the tasks, the

difficulty ratings tended to be higher when the correlations between involvement and confidence were significant ($t = 10.76, P < 0.0001$).

PARTICIPANTS' RATINGS OF THE INSTALLATION EXPERIENCE. During the Fall 2006 semester, participants ($N = 44$) were given an additional survey asking them about their perceptions of their laboratory experience (all items on a 1 to 9-point Likert scale) after the installation was complete. As shown in Table 3, in general, regardless of whether students learned the skills required to install a sprinkler system through class participation or from previous work-related experience, participants thought that it was important that they know how to install a sprinkler system and that knowing how to perform the skills required to do so was important for their future career. However, they thought that having the actual experience of helping install a system was particularly beneficial for their future career. When directly asked "if you had a choice between taking an irrigation system installation course or

similar courses with or without a lab component, would you prefer a lab component or not?" participants strongly preferred a laboratory component. When asked to compare their direct experience with installing a system to what they learned during lecture and by reading the textbook, participants said that installing the system greatly increased their understanding and increased their confidence. Participants also stated that performing the installation was more interesting than what they learned from lecture and the textbook, as well as more beneficial. In terms of their long-term career goals, participants stated that actually performing various aspects of the installation was more beneficial than what they learned from lecture and the textbook (Table 3).

Discussion

The results from the surveys indicate that students do gain confidence in their ability to perform particular irrigation installation skills after participating in the installation of a residential system. As revealed in the questionnaire given to the students during the first class meeting of the semester, the majority of students stated they did not have any previous irrigation experience. Of those students who did indicate previous irrigation experience, their experiences were primarily involved with adjusting rotor arc and radius, wiring electric zone valves, or solvent-welding PVC to fix breaks. The students who indicated the most previous irrigation experience had worked on golf courses assisting the irrigation technician with repairing broken pipe or sprinklers. Very few of the students indicated that they had any experience wiring a controller or installing drip irrigation, and none of the students had ever worked with weather-based controller. Consequently, the students may consider these skills, wiring a controller, installing a drip zone valve, and installing a weather-based controller with a weather station more challenging or perhaps just more intimidating because they are not familiar.

Another skill students said they gained the most confidence with was using the barb-fittings with the PE pipe. In many parts of the United States, PVC is used exclusively for

Table 3. Student responses to opinion questions on their irrigation installation experiences ($N = 44$).

Question	Response ^a mean $\pm$ SD
In general, how important do you think it is that you know how to install an irrigation system?	7.34 $\pm$ 1.62
How important is it <u>for your future career</u> that you know how to install an irrigation system?	6.95 $\pm$ 2.14
Overall, how beneficial do you think having helped install an irrigation system will be <u>for your future career</u> ?	7.26 $\pm$ 1.80
If you had a choice between taking an irrigation system installation course or similar courses with or without a laboratory component, would you prefer a laboratory component?	8.53 $\pm$ 1.13
How much do you think actually installing parts of the system contributed to your understanding of how to perform an installation (compared with what you learned from lecture and the textbook)?	7.84 $\pm$ 1.41
How much do you think actually installing parts of the system influenced your confidence in your ability to perform an installation (compared with what you expected based upon lecture and the textbook)?	7.84 $\pm$ 1.03
How interesting was performing various aspects of the installation compared with what you learned in lecture and from the textbook?	7.45 $\pm$ 1.67
How beneficial do you think actually performing various aspects of the installation was compared with what you learned in lecture and from the textbook?	7.92 $\pm$ 1.26
How beneficial do you think actually performing various aspects of the installation were <u>for your future career</u> compared with what you learned in lecture and from the textbook?	6.76 $\pm$ 2.15

^aAll questions were answered on a 9-point Likert scale (1 = "not at all" to 9 = "extremely").

landscape irrigation systems, therefore many students may not have had the opportunity to work with PE piping and barb-fittings. Similarly, many contractors have been slow to subscribe to using drip irrigation or microirrigation, thus the opportunity to install a drip zone valve may be isolated. The difference between a drip zone valve and a zone valve is a matter of the additional components, a filter and a pressure regulator; these may have appeared more confusing or challenging to put together and install compared with the one-piece electric zone valves used for the sprinkler zones. Therefore, it may not be that any of these aspects of the installation are any more challenging to perform (although they were rated as being slightly more difficult than the other tasks, $m = 3.8$ compared with $m = 2.6$), merely that they may be unfamiliar. Either way, although it appears that actually installing a system increases confidence in general, the benefits of experience seem to be greatest when the task is unfamiliar or perceived to be relatively difficult. This study focused on the effect of in-class experience on confidence level and did not examine the influence of previous experience on confidence to perform a skill.

A student's ability to achieve is strongly related to their perception of how difficult a skill or concept is and how confident they are in performing it (Cross and Steadman, 1996). A key to successful experiential learning in small groups is to be aware of those students who declare high-self confidence in performing skills (Baldwin et al., 1999; Lavis, 2005). These students can be the most challenging to teach, as they tend to "take-over" the project, and may pose a threat to those students who lack experience. How well an individual thinks he/she can perform is strongly influenced by social comparison or how he/she compare him/herself to another (Bandura, 1977), and as a result, selection of student groups is critical to achieve positive outcomes (Lou et al., 1996). Additionally, the instructor should demonstrate how a skill should be done; individual students may then feel more comfortable performing the skill, particularly in front of their peers, which should help avoid potential intimidation or threat to an individual's self-efficacy and motivation (Ames, 1992; Lou et al., 1996).

Students may actually feel more comfortable working together as they learn new concepts or skills as Baldwin et al. (1999) determined when biology students actively worked in small groups; there was an effective overall influence on student's self-efficacy. Outcome variables, including changes in student confidence, interest, and future career plans, were positively correlated with self-efficacy gained from collaborative engagement in physics (Fenci and Scheel, 2005) and chemistry (Scheel et al., 2002).

The opportunity for students to perform real-life activities such as the installation of an irrigation system and then see the system working can be an advantageous experiential learning tool. This type of situation provides students with the opportunity to learn from each other, builds confidence within the individual to learn new skills, offers occasions to interact with the instructor, homeowner, and contractor, and offers time for problem-solving and reflection (Rothenberger and Stewart, 1995; Sanchez and Craig, 2007). Experiential learning allows the student to have significant opportunities to connect the knowledge introduced during lecture to the skill or technique (Slavkin, 2004), and the retention of information is increased (Lou et al., 1996).

The following written comment is from the Fall 2006 instructor course evaluation, and it summarizes the benefit of this experiential learning experience: "By doing this installation I now understand how an irrigation system is installed and I even like to investigate the various irrigation product catalogs to compare what each offers. This was a great learning experience."

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