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Evaluation of online educational tools in horticulture: An online course and problem-solving software

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Evaluation of online educational tools in horticulture:
An online course and problem-solving software

by

Tigon E.H. Woline

A thesis submitted to the graduate faculty
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Major: Horticulture

Program of Study Committee:
Ann Marie VanDerZanden, Major Professor
    Jeffery Iles
    Dale Niederhauser

Iowa State University
Ames, Iowa
2009

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ABSTRACT

The Internet and online tools have become incredibly ingrained in daily life. Checking email, tracking packages, networking with friends and co-workers, and getting an education can all be done quickly and easily online. Although these types of tools are important in daily life, it is essential to carefully consider how they might be integrated into higher education. A two-pronged research program focused on evaluating teaching horticulture courses online and looked at incorporating a web-based teaching tool that centered on problem-solving, into a traditional face-to-face course. The results of this research have the potential to impact future online course development and to encourage further development and adoption of web-based tools to support problem-based learning within the Department of Horticulture and in other departments at Iowa State University.
CHAPTER 1. GENERAL INTRODUCTION

1.1 Thesis Organization

This thesis contains a general introduction, literature review, one journal article that has been published and a second that has been submitted for publication, general conclusions, and various appendixes on the subjects of online education and the use of online tools to enhance the development of problem-solving skills in higher education within the field of horticulture.

1.2 Introduction and Rationale

The Internet and online tools have become incredibly ingrained in daily life. Checking email, tracking packages, networking with friends and co-workers, and getting an education can all be done quickly and easily online. Although these types of tools are important in daily life, it is essential to carefully consider how they might be integrated into higher education. The popularity of online courses and web-based tools demands a closer examination and evaluation of their appropriate use in education (Allen and Seaman, 2008; Henry and Meadows, 2008; Sikora, 2002). To this end, a two-pronged research program was developed.

The first facet of this research focused on teaching horticulture via an online course. Distance and online education is a growing portion of higher education. This is evidenced by the fact that in the United States between fall 2005 and fall 2007 student enrollment in online courses grew from approximately 3.8 million students to nearly 4 million students (Allen and Seaman, 2006, 2008). According to the Iowa State University course catalog for the 2005 academic year (spring, summer, and fall semesters), 60 online courses were offered in a variety of subject areas, but none in horticulture. In 2007 that number increased to 94 online courses, including one in horticulture (Iowa State University, 2005, 2007).

In order to expand horticulture course offerings online at Iowa State University and to evaluate the efficacy of an online introductory horticulture course, Horticulture 193F was developed. This course was evaluated to determine its role in online education in the
Department of Horticulture. Undergraduate, graduate, continuing education credits, and professional development courses in horticulture could be offered to audiences who are otherwise unable to attend face-to-face on campus courses.

The second facet of this research looked at incorporating a web-based teaching tool that enables instructors to include problem-based learning experiences in a traditional face-to-face course. Problems vary in their degrees of structure, complexity and abstractness from well-defined and well-structured to ill-defined and ill-structured (Jonassen, 2000, 2002). Ill-structured problems have specific contexts, yet elements of the problem may or may not be clearly defined. Further, multiple paths can be followed to multiple solutions all of which could be correct. A horticulture-based example could be determining why a plant is declining without knowing the details of the environmental conditions or cultural practices that have impacted the plant. These are the types of problems that horticulture professionals are faced with in their daily work.

Web-based tools, such as the Problem-Solving Learning Portal (PSLP) can be used to track how students move through the problem-solving process. Creating classroom based problem-solving exercises allows students to develop the skills necessary to solve ill-structured problems without legal and financial ramifications for poor decision-making, and to have instructor guidance when needed. Producing graduates with these skills meets the industry need for technically qualified individuals with highly developed problem-solving and decision-making skills.

1.4 Research Objective: Online Horticulture Course

The objective of the online course research was to evaluate an online horticulture course. The evaluation centered on student demographics, such as classification, as well as how the online environment impacted course delivery, and what aspects of the course contributed to or distracted from student learning. Results from this research will provide background information useful in faculty discussions about developing additional online horticulture courses.
1.5 Description of Horticulture 193F Course

Horticulture 193F, an online one-credit course, had five modules covering the basic horticulture topics of: plant identification and characteristics; plant growth and development; the rooting environment; selecting plants for the landscape; and putting plants in the landscape. Course objectives include: understanding basic plant anatomy, physiology and nomenclature; understanding characteristics of the rooting environments for horticultural crops; identifying characteristics of healthy nursery stock; and developing the ability to determine appropriate site selection criteria and proper planting technique.

Each module included a lecture created in PowerPoint (Microsoft Corp., Redmond, Wash.) with an audio track, a discussion board activity, an assignment, and a quiz. The audio track and PowerPoint lecture slides combined into a presentation using Macromedia Breeze (Macromedia, Adobe Inc., San Jose, Calif.). Module 1 (Plant Identification and Characteristics) and Module 2 (Plant Growth and Development) also had drag-and-drop self-test components which allowed students to test their comprehension of the material. As students completed each module they processed and used information they had learned in multiple ways: quizzes tested their recollection of facts; discussion board activities required application of knowledge; and assignments incorporated previous knowledge with new knowledge through a synthesis question.

The questions and problems posed in each discussion board activity were open ended. In order to complete the activity students needed to research the question or problem using course materials as well as outside resources including websites, gardening books, magazines, and their personal experience. They posted answers to the course website where it was subjected to peer and instructor evaluation. For example, in Module 3 (Rooting Environment), students answer the following question in the discussion board activity:

“Sally Farmer wants to know which locations in her new backyard would be best for her flowers and her vegetable garden. There are two areas she is considering: Area A and Area B. Area A is mostly heavy clay with drainage problems. The area will pool water after a light rain event. Part of
the area gets full sun; the rest of it gets partial sun. Area B is very sandy and is part sun/part shade over the entire area. The plants Sally wants to grow in her garden are listed below.

Your task is to evaluate the two possible locations. Make a decision about where the gardens should go. In your response, explain why Sally should plant her garden in one location or the other.”

Assignments for each module provided an opportunity for students to apply what they learned. Many of the assignments required students to explore their environment and look for examples of horticulture they might not have previously considered. For example, in Module 1 (Plant Identification and Characteristics) students were required to visit their local grocery store to determine how many different types of fruit (as discussed in the PowerPoint and audio lecture) they could identify. All assignments were submitted as a Microsoft Word (Microsoft Corp., Redmond, Wash.) document. Each assignment was reviewed by the teaching assistant, comments were added using the comment insert feature in Microsoft Word, and documents were returned to the student with a grade. Using the comment feature allowed for detailed feedback on assignments.

Quizzes were a combination of multiple choice, fill-in-the-blank, and true-false questions. Each module quiz had fifteen questions that primarily tested the acquisition of key ideas and facts.

After completing the five modules and the corresponding assignments, students completed a final exam covering all five modules. The exam was a combination of multiple choice, true-false, and short essay questions which required students to demonstrate an understanding of key ideas and facts as well as apply and synthesize this information.

1.6 Research Objectives: Problem-Solving Learning Environment

The objectives of the problem-solving skill development research were to (1) evaluate student problem-solving skills before and after completing several horticulture case studies via a web-based teaching tool and to (2) make recommendations for improving the Problem-Solving Learning Portal (a web-based teaching tool) for future, wide-spread adoption at Iowa
State University and in particular adoption within the Department of Horticulture. This research will contribute to the current understanding about problem-solving and improve a teaching tool that may encourage other faculty to implement problem-based instruction in their courses and conduct research about teaching and learning.

1.7 Description of the Problem-Solving Learning Environment Research

The problem-solving research was conducted using the Problem-Solving Learning Portal (PSLP) online environment. This software was initially developed by faculty at Iowa State University in the departments of Industrial and Manufacturing Systems Engineering and Educational Leadership and Policy Studies (Ryan, et al., 2004). Further development of PSLP has been done by faculty in the Physics, Curriculum and Instruction, and Horticulture departments. The software utilizes a database with resource documents such as maps, extension publications, and photographs of injured plants, an Internet-based user-interface, and instructor provided questions to promote higher order problem-solving among students. The nature of the software is such that many disciplines and types of problems, including well-structured and ill-structured problems, can be accommodated.

Through the PSLP software, four case studies related to installation, maintenance, and pests associated with a fictitious residential landscape in USDA hardiness zone 5 were presented to students. A fifth case study was included as an example. The four case studies increased in difficulty as the students progressed through the series. The PSLP environment also included several resources such as a map of the site, a problem description, digital images of affected plants, audio files with transcripts of conversations between the homeowner and contractor, soil test results, and extension publication websites. Groups of four or five students worked through three stages for each of the case studies. First, they were to submit a “Situation Summary” to the instructor for approval. If approval was given, they then progressed to the “Diagnosis” step. If approval was not given, the group was required to reevaluate the data provided about the case and resubmit a modified summary before they were permitted to progress to the diagnosis step. The final step was to articulate a
“Recommendation” for the fictitious homeowners. The students were responsible for completing the case studies outside regular class meeting times.

1.8 References


CHAPTER 2. REVIEW OF LITERATURE

A recent report published by the Pew Internet and American Life Project showed that 60% of children under 18 years of age and 78% of children between 12 and 17 use the Internet on a regular basis (Levin and Arafeh, 2002). These tech-savvy students use the Internet to do research for school assignments, as an extensive reference library, and to communicate with study groups, tutors, and instructors (Levin and Arafeh, 2002). Because students are already using the Internet in so many different ways, and with each succeeding generation students are becoming even more tech-savvy, it is imperative for educators to understand the capabilities and educational potential of the Internet and other technologies in the classroom. This includes both offering online courses, as well as using Internet-based tools such as those used in solving ill-structured problems, in traditional face-to-face classrooms.

2.1 Teaching Online

The population of students who opt to take an online course is steadily growing in higher education. In fall semester 2007, 3.9 million students enrolled at higher education institutions were taking at least one online course. Although undergraduate students make up the majority of this population, there are also a significant number of graduate students and non-traditional students (Allen and Seaman, 2008). A 2002 report published by the National Center for Education stated that 56% of all two- and four-year institutions offered distance education courses during the 2000-2001 academic year (Sikora, 2002). Furthermore, the number of post-secondary students enrolled in an online course during fall term 2005 was 18.2% of the total population of 17 million students (Allen and Seaman, 2006). That number increased to 20% in fall semester 2007 (Allen and Seaman, 2008). Both the number of students taking online courses and the number of institutions offering online courses are growing annually.
2.1.1 Student Perspective

To date, the vast majority of online education research has focused on examining the students’ perspective. Often, student demand for online courses is a major driving force in the development of new online courses and degree programs. When asked why they chose an online course, many students indicate a need to resolve scheduling conflicts, eliminate the need to travel a significant distance to campus, meet an academic requirement, or for a flexible schedule to accommodate their work and family responsibilities (Cavanagh, 2006; Mansour and Mupinga, 2007; Allen and Seaman, 2008). Online courses permit non-traditional students, those who work full-time and/or have family and community responsibilities, to take courses when they have available time.

Online courses are not for all students. The literature supports the idea that students with self-discipline and motivation are best suited to the asynchronous environment (Waschull, 2005). Roval, et al. (2007) suggest that students enrolled in online courses may self-select because they are more intrinsically motivated. The flexibility and less-structured nature of online courses are often cited as attractive features by students, however research shows that the dropout rate is often higher for online courses than similar face-to-face courses. This may be because students who are not self-directed learners feel disconnected from the instructor and the other students or feel abandoned in the vast world of the Internet without guidance (Waschull, 2005; Lee and Nguyen, 2007; Mansour and Mupinga, 2007). Developing and delivering online courses that contain a social presence of the students and instructor, engaging and relevant activities, and a clear interface help insure student success in this learning environment (Palloff and Pratt, 2007; Henry and Meadows, 2008).

2.1.2 Instructor Perspective

Significantly less research has been done from the instructor’s perspective in online education. Some faculty are early adopters and have already developed and taught courses online for over a decade; others have valid concerns about getting into the world of online learning. There are many reasons instructors and institutions are not pursuing online educational opportunities including: fear of the time commitment; intimidation of the
technology; and suspicion of the quality of education (Palloff and Pratt, 2007; Bender, et al., 2004; Lee and Nguyen, 2007).

Many faculty members believe that online courses require a larger time commitment during development and delivery to students (Bender, et al., 2004). Online instructors often write very explicit instructions for assignments, which certainly takes more time than a face-to-face, verbal explanation where students can ask follow-up questions easily. However, once the instructions are written they can be used for future offerings with minor changes. Lee and Nguyen (2007) found that although instructors spent more time preparing for their online courses than they did for traditional courses, anecdotal evidence shows they felt more rewarded by the students’ performance and development into self-motivated learners. Successful online courses are not simple digitization of traditional materials. Content needs to be re-framed to best convey the information while utilizing the range of technology available (Henry and Meadows, 2008). This is another place where a significant time investment is required; without this investment, the course likely will not be a success.

The multitude of technologies available to assist instructors in developing and delivering their online courses can be overwhelming (Henry and Meadows, 2008). Personal communications with numerous instructors indicate that many of them begin by using the services provided by their institution. If they are inclined to branch out beyond the basic services, they will encounter a world of options including everything from open source software to virtual worlds. Knowing which technology provides the most useful features that will enhance the educational experience of both the teacher and the student is challenging because of the variety of options and the speed at which technology changes.

Resistant instructors may cite the perception of the lower quality of online courses as their main reason for not getting involved (Lee and Nguyen, 2007). However, research has shown that online courses are not necessarily inferior to traditional face-to-face equivalent courses (Henry, et al., 2004; Lim, et al., 2006; Summers, et al., 2005). Henry, (2004) found student comprehension of landscape-construction techniques taught through computer-based instruction was comparable to traditional laboratory instruction. In their study comparing online and blended courses, Lim, et al. (2006) found that students enrolled in both types of
courses experienced a significant increase in both self-perceived and actual learning. Further, Summers, et al. (2005) found that students enrolled in an online, distance statistics course learned as much as their counterparts enrolled in an equivalent face-to-face statistics course.

One final issue many online instructors face is the lack of tangible contact with students. Palloff and Pratt (2007) recognize that the prospect of teaching in an environment where you cannot see, hear, or touch those with whom you are communicating is a daunting one. The physical, emotional and mental challenges that accompany online education mainly revolve around the development of a social presence (Palloff and Pratt, 2007; Henry and Meadows, 2008). The instructor’s social presence in the online environment is the key feature that keeps students motivated and feeling connected during the course. However, Palloff and Pratt (2007) also cite examples of how instructors were asked by students to stay out of their discussions because it was distracting. The students were teaching each other and themselves about the content through deep discussions and debates. They felt that the instructor was meddling, and not helping their learning. Instructors must develop a balance between directing student learning and facilitating student learning.

Although many instructors may have reservations about teaching online, purposeful use of technology combined with a willingness to commit to the initial investment of time to develop the course, can result in a quality learning experience for students.

2.2 Problem-based Learning and Case Studies

Problems encountered in life range from well- to ill-structured. Well-structured problems require the application of a limited number of concepts or information, and the goal or path toward the solution is clear. For example, these types of problems are often found in textbook algebra problems where students are required to replace equation variables with the values from the problem to get the correct solution. Ill-structured problems typically have elements that are missing or are not well defined. The problem is situated in a specific context and the path toward a solution is unclear. There may be multiple solutions that could satisfy the problem. Ill-structured problems are more common than well-defined problems outside academia (Jonassen, 1997). However, as Jonassen (2000) argues, students are not
being adequately prepared to solve these problems because they are rarely exposed to them during their education or training.

Current trends in pedagogy emphasize student-centered learning and increasingly involve problem-based learning (Jonassen, 2000). Recently, many medical schools have modified their curricula to include, or to be entirely based in, problem-based learning (Jolliffe, et al., 2005). Practitioners of medicine must address ill-structured problems like recognizing patterns and traits of a disease without all of the related information. Similarly, horticulture professionals must become adept at solving ill-structured problems such as determining why a tree or shrub is showing signs of decline without knowing the details of the environmental conditions or cultural practices that have impacted the plant. The use of problem-based learning in this manner, builds content knowledge as well as confidence in the students’ ability to function in the roles representative of their future profession (McAlpine and Dudley, 2001). Problem-based learning experiences promote the development of higher-order thinking skills, like those identified in Bloom’s taxonomy (Jolliffe, et al., 2005; Jonassen, 1997; VanDerZanden, 2005).

Case studies are an example of a pedagogical technique that fits under the umbrella category of problem-based learning, and they have become a popular method of teaching problem-solving skills. The flexibility and variety of case study methods make them appropriate for subjects from law, medicine, and business to biology, engineering, and horticulture. However, the complex nature of case studies requires substantial time investments by instructors to create and assess learning. Most all case studies are interdisciplinary to some extent and therefore instructors may need to be versed in several relevant content areas (Chin and Chia, 2006). Case studies provide valuable problem-based learning experiences for students, especially when hands-on experiences are not feasible. Many professionals, including horticulturists, use personal experiences to develop case studies. In the workplace, stories and personal experiences are used to reflect on, interpret, and share information among employees as they solve problems (Jonassen and Hernandez-Serrano, 2002). Incorporating case studies in undergraduate curriculum can provide opportunities for students to develop problem-solving skills relevant to their future careers.
2.2.1 Concerns, barriers, and benefits to developing ill-structured problem-based learning experiences

In order for large-scale problem-based learning programs to be successful, training and orientation sessions are essential for instructors, students and support staff (Riseman, et al., 2005). These training and orientation sessions provide the necessary framework for the process and explain evaluation criteria (Riseman, et al., 2005). Research has shown that although students initially struggle with ill-structured problems (Chin and Chia, 2006); they gain confidence in their ability to solve them and an appreciation for the nature of the problems as they progress through the work (Akinoğlu and Tandoğan, 2007). Problem-based learning is as much about the content as the problem-solving process. Concept understanding and academic achievement are improved through the use of problem-based learning (Akinoğlu and Tandoğan, 2007).

2.2.2 Using Online Tools to Facilitate Problem-Based Learning

Many challenges that previously prevented instructors from using case studies and problem-based learning can be addressed with the assistance of computer technology (Henry, et al., 2004). The combination of case-based problem solving and computer-based instruction has the potential to meet educational goals and limit financial and time restrictions without compromising the students’ learning. Ryan, et al. (2004) found that by engaging in realistic engineering problems, undergraduate students developed a deeper understanding of content and it helped them develop higher order thinking skills.

The use of a web-based interface allows researchers and instructors to monitor and track student behavior and progress. Teaching assistants and instructors are also able to provide prompt feedback in the electronic environment, even in large lecture courses where hundreds of students are participating (Ryan, et al., 2004). Case studies often include features, such as maps, images, and resources that may be difficult or costly to replicate in print. However, the Internet makes the distribution of these features to students easier and allows instructors to incorporate other materials (e.g. video, audio, color images) which may not have been feasible before.
Current software packages that support student learning through problem-based activities, such as case studies, are constantly evolving and one such example is the PSLP software developed at Iowa State University (Ryan, et al., 2004).

### 2.3 Conclusions: Combining Technology and Pedagogy

Including technology in education does not automatically mean student learning is improved. Using all the features of a tool may prove to be more distracting than helpful to student learning (Henry and Meadows, 2008). It is only through the judicious and purposeful inclusion of technology that education can be positively impacted. Henry and Meadows (2008) describe nine principles for excellent web-based teaching. They further note that poorly selected technology can ruin great teaching in an online course, but great technology can not save poor teaching. It is the combination of sound pedagogy and appropriate technology that creates excellence in the online classroom (Henry and Meadows, 2008). Technological pedagogical content knowledge (TPCK) forms a foundation of good teaching and centers around understanding four important concepts:

1. how technology can enhance the representation of concepts;
2. how pedagogical techniques can utilize technology effectively;
3. how technology can help students overcome learning challenges;
4. how technology can build on students’ previous knowledge and epistemologies and build new knowledge and epistemologies (Mishra and Koehler, 2006).

The critical question of how useful the technology is in the learning process must be answered before the technology is widely adopted.

Literature reviewed here suggests the significant use of technology in daily life and in higher education requires a close examination of each new tool to accurately assess its advantages and challenges. This was the broad umbrella under which the objectives of this research were developed. The objectives of this research were to: (1) evaluate an online horticulture course to provide background and data to assist faculty in future online course development; (2) to evaluate student problem-solving skills prior to and following the completion of a series of case studies in an online problem-solving environment (PSLP); (3)
and to make recommendations for improving the online problem-solving environment for further, wide-spread adoption at Iowa State University.

### 2.4 References


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CHAPTER 3. STUDENT PERCEPTIONS OF AN ONLINE INTRODUCTORY HORTICULTURE COURSE

Modified from a paper published in the NACTA Journal
Ann Marie VanDerZanden¹,² and Tigon Woline¹

Abstract

The number of distance education courses available in American higher education has increased substantially over the past decade. The number of higher education students enrolled in an online course during fall term 2005 was close to 17% of the total population of 17 million students. The objective of this research was to develop and evaluate a one credit introductory horticulture course delivered exclusively online. This course has five modules covering the basic horticulture topics of: plant identification and characteristics; plant growth and development; the rooting environment; selecting plants for the landscape; and putting plants in the landscape. Eleven graduate students (37.9%), nine undergraduate seniors (31.0%) and nine adult learners (31.0%) have completed the course from fall 2006 to summer 2007 (includes four distinct offerings). Evaluations revealed an overall course rating of 3.90 (scale: 1=poor; 5= excellent). When asked what aspects contributed most to their learning, three themes were prevalent: the assignments (40.5%), the lectures (27.0%) and the asynchronous environment (10.8%). When asked what distracted them from their learning four themes were evident: difficulty of the assignments and format (17.5%), wanting more in the lectures (15.0%), technical problems (15.0%) and problems with assignment feedback and grading (10.0%).

Introduction

The number of distance education courses available in American higher education has increased substantially over the past decade. A report from the National Center for Education (Sikora, 2003) stated that 56% of all two and four year institutions offered distance education

¹ Associate Professor and Graduate Research Assistant, respectively.
² Author for correspondence.
courses during the 2000-2001 academic year. Further, the number of higher education students enrolled in an online course during fall term 2005 was close to 17% of the total population of 17 million students (Allen and Seaman, 2006). Student demographics in online courses include undergraduate and graduate students, as well as adult learners and high school students. When asked why they chose an online course, many students cited needing to resolve scheduling conflicts or to meet an academic requirement (Cavanagh, 2006; Mansour and Mupinga, 2007). Although many students are enrolling in online courses, the literature supports the idea that students with self-discipline and motivation are better suited to the asynchronous environment (Waschull, 2005). Rovai, et al. (2007) suggest that students enrolled in online courses may self-select because they are more intrinsically motivated than their traditional face-to-face counterparts.

After reviewing the literature on distance education courses and analyzing current distance course offerings at Iowa State University, a one credit introductory horticulture course to be delivered exclusively online was developed. The objective of this research was to evaluate this online horticulture course. The evaluation centered on student demographics, as well as how the online environment impacted course delivery, and what aspects of the course contributed or distracted the most from student learning.

**Course Description**

The online one-credit course, HORT 193F, had five modules covering the following basic horticulture topics: plant identification and characteristics; plant growth and development; the rooting environment; selecting plants for the landscape; and putting plants in the landscape (Figure 3.1). The course objectives included: understanding basic plant anatomy, physiology and nomenclature; understanding characteristics of rooting environments for horticultural crops; identifying characteristics of healthy nursery stock; and developing the ability to determine appropriate site selection criteria and proper planting technique.

Each module included a lecture created in PowerPoint (Microsoft Corp., Redmond, Wash.) with an audio track (Figure 3.2), a discussion board activity, an assignment, and a quiz. The audio track that accompany the PowerPoint lecture slides were recorded with a
headset microphone using Audacity software. The audio files were synched with the lecture slides using Breeze (Macromedia, Adobe Inc., San Jose, Calif.). Module 1 (Plant Identification and Characteristics) and Module 2 (Plant Growth and Development) also had drag and drop self-test components (Figure 3.3) which allowed students to test their comprehension of the material. As students completed each module they processed and used information they have learned in multiple ways: the quizzes tested their recollection of facts; the discussion board activities required application of the knowledge; and the assignments incorporated previous knowledge with new knowledge in a synthesis question.

The questions and problems posed in each discussion board activity were open ended. In order to complete the activity students needed to research the question or problem using course materials as well as outside resources such as websites, magazines, books, and personal experience to develop a recommendation. They posted the recommendation to the course website where it was subjected to peer evaluation as well as instructor evaluation. For example, in the Rooting Environment module (Module 3), students answered the following question in the discussion board activity:

Sally Farmer wants to know which locations in her new backyard would be best for her flowers and her vegetable garden. There are two areas she is considering: Area A and Area B. Area A is mostly heavy clay with drainage problems. The area will pool water after a light rain event. Part of the area gets full sun; the rest of it gets partial sun. Area B is very sandy and is part sun/part shade over the entire area. The plants Sally wants to grow in her garden are listed below.

Your task is to evaluate the two possible locations. Make a decision about where the gardens should go. In your response, explain why Sally should plant her garden in one location or the other.

The assignments for each module provided an opportunity for students to apply what they had learned. Many of the assignments required students to explore their environment, looking for examples of horticulture they might not have considered before. For example, in the Plant Identification and Characteristics module, students were required to visit their local
grocery store to determine how many different types of fruit discussed in the module, they can identify. In all cases, assignments were submitted as a Microsoft Word (Microsoft Corp., Redmond, Wash.) document. Each assignment was reviewed, comments were added using the comment insert feature in Microsoft Word, and the documents were returned to the student with a grade. Using the comment feature allowed the instructors to provide detailed feedback on assignments.

The quizzes were a combination of multiple choice, fill-in-the-blank, and true-false questions. Each module quiz had fifteen questions that primarily tested the acquisition of key ideas and facts.

After completing the five modules and the corresponding assignments, students completed a final exam covering all five modules. The exam was a combination of multiple choice, true-false, and short essay questions and required students to demonstrate an understanding of key ideas and facts as well as application and synthesis of the information.

Materials and Methods

Using a modified Iowa State University course evaluation, a 27-question evaluation was developed for this course. Questions were designed to gather information on student attitudes and perceptions of the online course. The evaluation consisted of 23 closed-ended and four open-ended questions. The closed-end questions were formatted into a 5-point Likert-type scale where respondents specified their level of satisfaction with a statement. The 23 questions were grouped into six categories; student information (6), general course information (8), learner engagement (1), assessment and measurement (1), course technology (5) and learner support (2). The four open-ended questions asked students to describe: aspects of the course that contributed most to their learning; aspects that distracted from their learning; improvements that should be made to the course; and other horticultural topics they would be interested in learning about in this distance delivery format. The evaluation was distributed electronically to the 38 students enrolled in four sections of the course between September 1, 2006 and August 15, 2007. Data was entered using Excel (Microsoft Corp., Redmond, Wash.) and descriptive statistics, such as mean and standard deviation, were computed.
Results and Discussion

Across the four course offerings, 29 evaluations were returned and useable for a 76% response rate. Eleven graduate students (37.9%), nine undergraduate seniors (31.0%) and nine adult learners (31.0%) completed the course evaluation questionnaire. A majority (52.9%) of students did not reside in Iowa and only 17.6% were enrolled in a degree program at Iowa State University. The location of both the graduate students and adult learners were widespread across the country.

Respondents ranked their prior experience in the horticulture field as 2.5 (5=high; 1=low), however, they had a relatively high interest in the subject area (3.8). After completing the course, 58.6% of respondents reported they would take another horticulture course online.

Table 3.1 summarizes responses to questions on general course information, learner engagement, and assessment and measurement. Respondents rated all 14 of the questions between good (3) and very good (4).

Respondents ranked their comfort level with learning via a web-based format as 3.9, and overall found the course format and technology used to create the course content valuable in their learning. Respondents felt the online format was an effective way to present the course information (4.1), that the navigation of the individual modules was clear (3.9), and that the interactive format of the course aided in their learning (3.7). Further, they gave the audio clips associated with the PowerPoint slide lectures a rating of 3.8. Interestingly, although respondents gave this course an overall rating of 3.9, they only rated their preference for a web-based format to a traditional learning environment as 3.2. Lee and Nguyen (2007) reported that students who enroll in online courses often cite being distracted by family, feeling alone and the faster pace of online learning as drawbacks. This may explain in part why students in this study rated their preference for online learning relatively low.

Responses to the open-ended questions about what aspects contributed most, or distracted the most, from their learning were categorized by theme. The percent of total responses to the question are listed by theme in parentheses. When asked what aspects
contributed most to their learning, three themes were prevalent: the assignments (40.5%), the lectures (27.0%) and the asynchronous environment (10.8%). Examples of responses to this question included: “The assignments forced me to look back at the lecture material and really helped me gain a better understanding of the course content.” And, “The audio lecture was extremely beneficial and a great teaching tool.” And the “Freedom to choose the best time to learn the material.” Lee and Nguyen (2007) also reported that an advantage to online learning is the flexibility and convenience as compared with traditional classrooms.

When asked what aspects distracted most from their learning, four themes were evident including: the difficulty of the assignments and the format (17.5%), wanting more images and printable versions of the lectures (15.0%), technical problems (15.0%) and issues with assignment feedback and grading (10.0%). Examples of responses to this question included: “Possibly have a printable notes sections.” And “I found the feedback from instructors on assignments was lacking. Nice examples, good work; types of answers don’t tell the student much.” And “Assignments were more extensive than the information presented within the modules; I had a hard time with the assignments that were at a higher level of horticulture than what this class represented.”

Respondents provided valuable feedback on how the course could be improved. Again responses were grouped by theme and the three most common themes were: wanting more in depth content information in the lectures (23.5%), wanting fewer technical/server problems (17.6%), and inclusion of additional credible resources or tips on how to find credible resources for the outside research (11.8%). The technical and server problems reported in this study are similar to Mansour and Mupinga’s study (2007) where they reported that computers and course management software distracted students from learning. One major difference between responses to this study and other published results has to do with the online learning community. For example, many studies report students feeling disconnected from other learners and the instructor (Lee and Nguyen, 2007; Lim, et al., 2006; Mansour and Mupinga, 2007). That issue was not listed as a limitation or something that needed to be improved for this course.
Another difference is in the workload associated with the course. Lim, et al. (2006) reported that the workload in online courses is more than what students expect, yet respondents in this study did not report an excessive workload and reported wanting more information which could increase the workload.

The comments have been helpful in refining the original course. To provide more interaction between students and with the instructor, the discussion board activities were modified to include a portion that requires students to evaluate and respond to a peer’s posting for the assignment. Evaluation rubrics were developed and shared with students so they understand how they are being evaluated. Summers, et al. (2005) suggest that students in the online environment may require a detailed explanation of evaluation and grading methodology to better understand what is expected; whereas face-to-face students are able to ask questions to supplement the written assignments. Modifications have also been made on how students receive feedback on assignments including a PDF with the assignment and associated instructor comments.

References


Table 3.1. Online course evaluation of an introductory horticulture course

Student responses to online course evaluation for HORT 193F from fall 2006 through summer 2007. (n=29)

<table>
<thead>
<tr>
<th>Category</th>
<th>Statement</th>
<th>Average Response</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General Course Information</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clarity of student responsibilities and requirements was:</td>
<td>3.9</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>The organization of the course material was:</td>
<td>4.2</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>The course content was:</td>
<td>3.9</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>The time allowed to complete each modules and its assignments, quiz and activities was:</td>
<td>4.1</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>The reading materials were:</td>
<td>3.3</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>Readability of the content was:</td>
<td>4.1</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>The amount of information presented in the modules was:</td>
<td>4.0</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td><strong>Learner Engagement</strong></td>
<td>The course’s ability to stimulate my thinking more deeply about the subject was:</td>
<td>3.7</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Assessment and Measurement</strong></td>
<td>Evaluation and grading techniques (tests, papers, projects, etc.) were:</td>
<td>3.9</td>
<td>1.2</td>
</tr>
<tr>
<td>Navigation of the teaching tools was:</td>
<td>3.9</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>The audio clips associated with the modules were:</td>
<td>3.8</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td><strong>Course Technology</strong></td>
<td>This tool is an effective was to deliver information.</td>
<td>4.1</td>
<td>0.8</td>
</tr>
<tr>
<td>The interactive format of this tool aided my learning.</td>
<td>3.7</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>I prefer this web-based format to traditional learning environments.</td>
<td>3.2</td>
<td>1.4</td>
<td></td>
</tr>
</tbody>
</table>

* Responses measured on a scale of 1=poor, 2=fair, 3=good, 4=very good, 5=excellent.
Figure 3.1. Online introductory horticulture course module index

Online introductory horticulture course, HORT 193F, course module index site in course management system (WebCT Vista) combined all module related activities, including lecture presentation with audio, PDF lecture notes, assignment, quiz, and discussion board activity, in a single location.
Figure 3.2. Online introductory horticulture course sample lecture

Online introductory horticulture course, HORT 193F, contained slide lectures with accompanying audio track and written script to address different learning styles while presenting pertinent course content.
Figure 3.3 Online introductory horticulture course self-test

Online introductory horticulture course, HORT 193F, incorporated drag-and-drop self-tests for modules which included a large number of new vocabulary terms to enable students to test their knowledge before taking a quiz.
CHAPTER 4. STUDENT PERCEPTIONS OF PROBLEM-SOLVING SKILLS AND EVALUATION OF WEB-BASED SOFTWARE FOR CASE-STUDY WORK

Modified from a paper submitted to HortTechnology for publication

Tigon Woline¹ Ann Marie VanDerZanden² Jeffery K. Iles³, and Dale Niederhauser⁴

Abstract

Problem-based learning has become a popular pedagogical strategy for teaching problem-solving skills as well as subject content. Ill-structured problems, like those typically found in case studies, provide a realistic simulation of real-world problem-solving. However, the implementation of this strategy is time consuming for educators. Use of the Internet and computer software could aide the creation, use, and maintenance of these teaching tools encouraging more educators to use them. Our objectives were to (1) determine how juniors and seniors perceive their own problem-solving skills in relation to an ill-structured problem presented as an online case-study and the importance of problem-solving skills in general; (2) and evaluate a software package to support online case studies. Iowa State University students enrolled in HORT 342, Landscape Installation and Maintenance, were asked to participate in this study. Students were assigned a series of four ill-structured case study problems based in a fictitious yet realistic residential landscape. Data were collected via three questionnaires and a group discussion. Results indicated students understood the need for developing problem-solving skills, especially as they relate to future employment opportunities. However, students were concerned with obtaining the right answer to a specific problem, not with developing a strategy for solving problems. The software package was adequate for supporting the use of case studies as a teaching tool. Problems with the

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software included difficulty connecting to the site and software errors that resulted in lost student work. Students liked the variety of resources available and that case information was consolidated in a single location.

**Introduction**

Problems encountered in life range from well- to ill-structured. Well-structured problems require the application of a limited number of concepts or information, and the goal or path toward the solution is clear. These types of problems are often found in textbook algebra problems where students are required to replace equation variables with the values from the problem to get the correct solution. Ill-structured problems have elements that are missing or not defined. The problem is situated in a specific context, but the path toward the solution is unclear. There may be multiple solutions that could satisfy the problem outside academia. Ill-structured problems are more common than well-defined problems (Jonassen, 1997). However, Jonassen (2000) argues that students are inadequately prepared to solve ill-structured problems because they rarely are required to do so during their education or training.

Current trends in pedagogy emphasize student-centered learning and increasingly involve problem-based learning (Jonassen, 2000). Recently, many medical schools have modified their curricula to include, or to be entirely based in, problem-based learning (Jolliffe, et al., 2005). Medical practitioners must recognize patterns and traits of a disease without all the related information. These are ill-structured problems. Similarly, horticulture professionals must become adept at solving ill-structured problems such as determining why a tree or shrub is showing signs of decline without knowing the details of the environmental conditions or cultural practices that may have impacted the plant. Initially students struggle the ill-structured nature of the problems (Chin and Chia, 2006), but students gain confidence in their ability to solve them and an appreciation for the nature of the problems as they progress through the problem (Akinoğlu and Tandoğan, 2007). Concept understanding and academic achievement are improved through the use of problem-based learning (Akinoğlu and Tandoğan, 2007).
Case studies are an example of a pedagogical technique that falls under the broad category of problem-based learning. Case studies provide valuable problem-based learning experiences for students, especially when hands-on experiences are not feasible. Jonassen and Hernandez-Serrano (2002) state that stories, like those used to develop case studies, play an important role in the workplace. Stories are used to reflect on, interpret, and share information among employees as they solve problems (Jonassen and Hernandez-Serrano, 2002). Problem-based learning experiences promote development of higher-order thinking skills, like those identified in Bloom’s taxonomy (Jonassen, 1997; VanDerZanden, 2005). Unfortunately, these types of real-world-based, ill-structured problems require substantial time investments to create and assess learning. They also present class scheduling difficulties because students work through problems at different rates (Akinoğlu and Tandoğan, 2007; Chin and Chia, 2006).

With the assistance of computer technology, many challenges that previously prevented instructors from using case studies and problem-based learning can be addressed (Henry, et al., 2004). The combination of case-based problem solving and computer-based instruction has the potential to meet educational goals and limit financial and time restrictions. Henry, et al. (2004) found landscape-construction techniques taught through computer-based instruction were comparable to traditional laboratory instruction. Unfortunately, current computer software packages for online course management do not support pedagogy required in problem-based learning. Consequently, existing software must be supplemented or new software must be developed that supports problem-based learning (Jonassen, 2002).

The Problem-Solving Learning Portal (PSLP) online environment was developed by faculty in the Departments of Industrial and Manufacturing Systems Engineering and Educational Leadership and Policy Studies at Iowa State University (Ryan, et al., 2004). The environment includes a database with resource documents, an Internet interface, and instructor-provided questions to promote higher-order problem-solving among students. Currently, instructors in Industrial and Manufacturing Systems Engineering, Physics, and Curriculum and Instruction use this software tool in several courses. The PSLP environment
is flexible enough to accommodate well-structured problems from physics and the ill-structured problems from horticulture. Personal communication with the instructor of a large physics course that used the software showed that the PSLP environment was successful. This inspired further research into what other subjects could benefit from using the software. One of the additional subject areas was horticulture. The problem-based learning environment must be structured in a manner that accommodates the problem type and the context surrounding it (Jonassen, 2002).

Our understanding of problem-solving activities is limited making it difficult for educators to engage and assist students in learning problem-solving skills (Jonassen, 2000). The objectives of this study were to (1) learn how junior- and senior-level horticulture students perceive their problem-solving skills and (2) to evaluate the PSLP online software for use in solving four ill-structured horticulture case studies online.

**Materials and Methods**

**CASE STUDIES**

The four case studies used in this course were developed by faculty and graduate students in the Iowa State University Department of Horticulture. Content was related to installation, maintenance, and pests associated with a fictitious, yet realistic, residential landscape plan in USDA hardiness zone 5. A fifth case study, titled Perennial Garden, was used as an example. The four case studies increased in difficulty as the students progressed through the series. The cases, in order from simplest to most complex, were titled: White Pines, Sugar Maples, Hawthorn, and Swamp White Oak.

Students were provided a map of the site, a problem description, and several resource documents to use in solving the problem. Resources for all four case studies included digital images of affected plants, audio files with transcripts of conversations between the homeowner and contractor, soil test results, and extension publication websites. All resources were loaded into a database and made available to students through a password-protected website. Faculty in the College of Engineering at Iowa State University developed the web-based software used to deliver the case studies (Ryan, et al., 2004).
Students were guided through the case studies by a series of steps. First the student groups were required to submit a Situation Summary (Figure 4.1) where they were to summarize the problem and hypothesize a number of plausible preliminary diagnoses that may or may not be substantiated by the resource data. This step was submitted to the course instructor for evaluation. The instructor would permit the students to progress to the next step if their work was thorough. If their work was not satisfactory, the instructor would require the students to resubmit the Situation Summary until she was satisfied with their work. The second step was the Diagnosis (Figure 4.2). In this step the students’ preliminary diagnoses were automatically transferred to the final diagnosis column. In this step the students returned to the resource documents to find evidence for the diagnosis and a cause or causal agent. At this stage, it was expected that some diagnoses would not have evidence in the resources to support the claim. The final step was the Recommendation (Figure 4.3). Here the students were required to articulate the actions the client needed to take in order to manage the problem. The recommendations included both short term and long term actions and differentiated which actions were required and optional. Providing this variety and depth of information for the recommendation step mimics the types of realistic client needs.

IMPLEMENTATION AND DATA COLLECTION

Students enrolled in HORT 342, Landscape Installation and Establishment, during the fall semesters of 2007 and 2008 participated in this study. This course is generally populated by juniors and seniors. All students were required to complete the case studies, but participation in the problem-solving research study was optional. Three questionnaires were developed in consultation with the Iowa State University Institutional Review Board. The questionnaires included Likert-type and short-answer questions and were distributed to students in a paper format. Students also participated in small-group discussions moderated by a graduate student. Further, student actions while completing the online case studies were collected by the software. Students worked in assigned groups of four to complete each of the four case studies. Individually, they were asked about their perceptions of their own problem-solving skills, attitudes about problem-solving, and previous experience with solving problems both before and after they began working on the case studies. Students were
surveyed after completing the Swamp White Oak case study for more specific information on their problem-solving process for that case. The Swamp White Oak case study was selected because it was the last and most challenging in the series of case studies. Questions were specific to their problem-solving process for that case study, not about problem-solving in general.

Finally, students participated in an in-class group discussion that focused on the web-based software interface. As small-groups, students discussed several questions about the software interface. Then each group reported their ideas to the larger group. During this discussion, students also completed an individual assessment of the software tool. Student-reported data were compared with user data collected by the software package. Data were entered by using Excel (Microsoft Corp., Redmond, WA.) Descriptive statistics, including frequencies, means, and standard deviation, were computed.

Results

DEMOGRAPHICS

A total of 45 students were enrolled in the course during the fall 2007 and 2008 semesters. Of those who participated, 78.1% were men and 21.9% women and the average age of the participants was 21.8 years. Study participants were from a variety of horticulture options including environmental horticulture, greenhouse and nursery production, turfgrass management, and planting design and installation. A few students were from majors outside the horticulture program. Participants categorized their previous job experience that required problem-solving as follows: design/installation (28.6%), retail/customer service (16.6%), nonhorticulture related (14.3%), golf course/sports turf (14.3%), education/school (9.5%), farming/field work (7.1%), nursery/garden center (7.1%), and public gardens (2.4%).

STUDENT PERCEPTIONS ABOUT PROBLEM-SOLVING

Student demographics and undergraduate option were similar for 2007 and 2008. As a result data from 2007 and 2008 have been combined for reporting purposes. Initially, when asked to rate nine steps in a generic problem-solving sequence on a scale from 1 = not at all important to 5 = very important, 81.8% of the participants rated the statement “Determining what the problem to be solved is” as 5 (very important) in the precase questionnaire (Figure
In the postcase questionnaire, 78.9% of the respondents rated the same statement as very important. When asked about the importance of “determining the best solution,” 97.0% and 92.1% (precase and postcase, respectively) of respondents rated the statement either 4 or 5. In the precase questionnaire, 72.7% of respondents rated the statement regarding the determination of “what standards and judgment criteria the solution should meet” either 4 or 5. In the postcase questionnaire, 81.6% of respondents rated the same statement 4 or 5. The percent of respondents who rated the statement concerning the use of their “standards and judgment criteria to determine the pros and cons of each possible solution” 4 or 5 was 84.8% and 81.6% (precase and postcase, respectively). When asked to rate the statement “putting the decision into action,” 72.7% of respondents in the precase questionnaire rated the statement as very important. That number decreased to 57.9% in the postcase questionnaire. Interestingly, a larger percentage of respondents rated the statement “evaluating the outcome of your decision and action steps” a 4 or 5 (72.7% and 86.8%; precase and postcase, respectively).

On the precase questionnaire, students were also asked to rate nine statements about decision-making on the job on a scale of 1 = not at all important and 5 = very important (Figure 4.5). Thirty-three students provided responses. A majority of respondents felt it was “very important” that the solution to a problem be valuable to the customer or client (72.7%). They also felt it was important to consider the cost of implementation, including both time and money resources (57.6%). Interestingly, only 27.3% of respondents felt it was “very important” to consider the time to completely implement a solution when solving a problem in a workplace setting. Respondents were similarly concerned about the importance of considering how well the cause of the problem is addressed by this solution and the potential negative consequences of that solution (54.5% and 51.5%, respectively). Respondents were less concerned with the support and opposition of others to the solution.

During the group discussion, students reported using knowledge from previous coursework in plant pathology, woody and herbaceous plant identification, agronomy, biology, turfgrass, and communications to solve problems. Students also relied on work
experience such as retail sales and customer interactions, landscape design-build jobs, machine-operation skills, and working as part of a team to inform their problem solving.

EVALUATION OF WEB-BASED INTERFACE

After completing the four case studies in the PSLP environment, students were asked to evaluate the web-based environment itself. The data for the environment evaluation has been combined from both 2007 and 2008 for reporting purposes and are presented in Figure 4.6. Participants where asked to rate a series of Likert-type statements about their overall experience on four different scales. On the scale of 1 = terrible, 5 = wonderful, 61.1% of respondents rated their overall experience a 3. When the scale was 1 = frustrating, 5 = satisfying, 33.3% rated their experience as 1, 30.6% rated it as 3, and 22.2% rated it as 2. On the scale of 1 = dull, 5 = stimulating, 41.7% rated their experience as 3. These feelings mirror what the students said in the group discussion. Students were frustrated by a variety of technical problems including: inability or difficulty connecting to the site when off-campus, computer errors that lost students’ answers and assignments, and using certain computer platforms and Internet browsers during the fall 2008 semester. Helpful items included: having a consistent layout and navigation, consolidated information and resources, and resource documents in various forms (text, images, and audio files). Some students felt the experience was not necessary for their formal education or that they had already learned these skills from their work experiences. Some students felt that the exercise was not worthwhile and repetitive. This was especially true for the fall 2008 group of students. The group discussion also revealed many students felt the case studies involved an overwhelming amount of work.

The respondents were more satisfied (ratings of 4 or 5) with the links (80.6%), the appearance of text (80.6%), locating resources (72.2%), and the feedback they received (66.7%). There were a number of aspects of the environment that respondents were dissatisfied (ratings of 1 or 2) with including: the ability to go back and change an answer (66.7%) and using the shared workspace (55.6%). During the group discussion, students openly shared what frustrated them about the environment. In addition to the technical problems some experienced and the opinion that the assignment was not valuable to their
educational experience, students felt that the instructor needed to know more about the environment to assist them with troubleshooting problems. Many of the groups did not know that some features, such as the collaborative workspace, existed in the environment. They commented that the instructor needed to take class time to demonstrate how to use the environment. Interestingly, the instructor did take time to walk through the web-based environment before the students were assigned the case studies.

When asked what other resources would be helpful in solving the case studies, 28.9% of the responses indicated all necessary resources were provided. Those who felt more resources were needed requested more details on assignment setup and guided assistance with the problem-solving processes (15.8%), more pictures of the plants (15.8%), and additional external web links (13.2%). Respondents stated they relied on web searches, previous coursework, and personal experience to make diagnoses.

When asked how much time each group spent working on the four case-study assignments, respondents reported a mean of 4.6 h. Total hours reported on other assignments for class, not including the case studies, was 5.6 h. Other assignments included one set of landscape calculation problems, three other written assignments, and three oral presentations spread throughout the 15-week semester.

**Discussion**

Students perceive problem-solving as an important skill and they are concerned with finding the best solution to problems. The best solution will minimize any negative impacts and maximize the positive impacts for all parties involved. In the work environment, the best solution is the one that resolves the problem and meets the needs of the client. In an academic situation, students often think the best solution is the correct solution as determined by the teacher. The students rated finding the best solution, in either context, among the more important aspects of problem-solving (Figures 4.4 and 4.5). This indicates that students understand how their problem-solving impacts the people they are trying to satisfy, in either an academic or a business situation. It might also be indicative of their ability to apply problem-solving skills they learn in college to the problems they encounter in the workplace.
4.4), respondents increased their rating from 72.7% giving a rating of 4 or 5 in the precase questionnaire to 81.6% than in the postcase questionnaire. However, when asked about using their standards and judgment criteria, the change decreased from the precase (84.8% rating it 4 or 5) to the postcase (81.6%) questionnaire. Perhaps this indicates that students do not think abstractly about their problem-solving method and how they personally determine the appropriateness of a possible solution. In the workplace, the standard for judging the appropriateness of a potential solution is a balance between the value to the client and the cost to the company. This is supported by the responses related to the importance of the solution being of value to the client (Figure 4.5). These student responses show that there may not be as large a discrepancy between school-taught problem-solving skills and workplace application as Jonassen (2000) suggested.

Jonassen (2002) states the online environments that support problem-solving need engaged learners in solving the problems and to support their intellectual and social activities. The environment also needs to put solving the problem ahead of concept retention. The concepts are what provide the intellectual support to the students. With these criteria in mind, the software platform developed at Iowa State University can be used to facilitate student problem-solving in horticulture. In general, students felt the software was capable of facilitating the case studies (Figure 4.6), but from the group discussion, we found students were frustrated. The frustration stemmed mainly from technology problems, which would not support learning. Frustration with technology could be solved by creating a technical support group to assist both instructors and students. Jolliffe, et al. (2005) recommended having experienced tutors guide students and instructors through development and use of case studies. Some students felt instructors were not familiar enough with the software to help them solve their problems, but having a support group could resolve that. Additionally, a detailed in-class demonstration of the software might help students feel more comfortable and allow them time to resolve problems or ask questions.

From an instructor perspective, it was difficult to get help with technical problems and trouble-shooting because there was not a centralized support person or group for this software. Inadequate technical support could become a barrier to widespread adoption of this
software. However, this product is relatively new and many of those challenges are being addressed. Current work on this project is moving towards a more user oriented interface that would allow instructors to create, manage, assess and gather data on their cases without depending on a limited support staff. The software is also being integrated with other ill-structured problem-solving software systems being used on campus. In future courses, adoption and use of the software could be much smoother than this research reflects.

References


Figure 4.1. Problem-Solving Learning Portal sample case: Situation summary

Student groups were first required to submit a Situation Summary where they were to summarize the problem and hypothesize a number of plausible preliminary diagnoses that may or may not be substantiated by the resource data. This step was submitted to the course instructor for evaluation. The instructor would permit the students to progress to the next step if their work was thorough. If their work was not satisfactory, the instructor would require the students to resubmit the Situation Summary until she was satisfied with their work.
Figure 4.2. Problem-Solving Learning Portal sample case: Diagnosis

Building on preliminary diagnoses created in the Situation Summary stage, students completed stage two, the Diagnosis. Diagnosis stage included describing the cause or causal agent for the diagnoses and listing pertinent evidence from the resources.
Figure 4.3. Problem-Solving Learning Portal sample case: Recommendation

The final stage was the Recommendation. Here the students were required to articulate the actions the client needed to take in order to manage the problem. The recommendations included both short term and long term actions and differentiated which actions were required and optional.
Juniors and seniors in an upper-level horticulture course during fall 2007 and fall 2008 were asked to rate these statements both before and after completing four case studies in an online environment. (n = 33 precase; n = 38 postcase)

[Figure 4.4: Student self-evaluation of problem-solving skills]

Scale 1 = unimportant to 5 = very important.
Juniors and seniors in an upper-level horticulture course during fall 2007 and fall 2008 were asked to rate these statements about their on-the-job problem-solving experience before completing four case studies in a web-based problem-solving environment. (n = 33)

Scale 1 = unimportant to 5 = very important.
Figure 4.6. Problem-Solving Learning Portal usability evaluation

Juniors and seniors in upper-level horticulture course during fall 2007 and fall 2008 were asked to rate the following statements about the usability of a web-base problem-solving environment. (n=36)

<table>
<thead>
<tr>
<th>Statement being rated</th>
<th>Participant responses to evaluation questionnaire of Problem-solving Learning Portal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which of the following best describes your overall experience with the case studies in PSLP?</td>
<td>5: 5, 4: 1, 3: 0, 2: 0, 1: 0</td>
</tr>
<tr>
<td>Which of the following best describes your overall experience with the case studies in PSLP?</td>
<td>5: 5, 4: 2, 3: 1, 2: 0, 1: 0</td>
</tr>
<tr>
<td>Which of the following best describes your overall experience with the case studies in PSLP?</td>
<td>5: 5, 4: 2, 3: 1, 2: 0, 1: 0</td>
</tr>
<tr>
<td>Which of the following best describes your overall experience with the case studies in PSLP?</td>
<td>5: 5, 4: 2, 3: 1, 2: 0, 1: 0</td>
</tr>
</tbody>
</table>

1. Scale 1 = terrible, 5 = wonderful
2. Scale 1 = frustrating, 5 = satisfying
3. Scale 1 = dull, 5 = stimulating
4. Scale 1 = routine, 5 = educational
5. Scale 1 = terrible, 5 = appropriate
6. Scale 1 = hard to find, 5 = easy to find
7. Scale 1 = annoying, 5 = helpful
8. Scale 1 = confusing, 5 = logical
9. Scale 1 = hard, 5 = easy
10. Scale 1 = insufficient, 5 = sufficient
11. Scale 1 = difficult, 5 = easy
12. Scale 1 = difficult, 5 = easy
13. Scale 1 = unclear, 5 = clear
Figure 4.6. Problem-Solving Learning Portal usability evaluation continued

Participant responses to evaluation questionnaire of Problem-solving Learning Portal

- The appearance of text on the screen:
  - 5
  - 4
  - 3
  - 2
  - 1

- Links were:
  - 5
  - 4
  - 3
  - 2
  - 1

- Pop-up windows were:
  - 5
  - 4
  - 3
  - 2
  - 1

- How the information was displayed on the page was:
  - 5
  - 4
  - 3
  - 2
  - 1
Figure 4.6. Problem-Solving Learning Portal usability evaluation continued

Participant responses to evaluation questionnaire of Problem-solving Learning Portal

<table>
<thead>
<tr>
<th>Statement being rated</th>
<th>Percentage of participants by response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locating task and problem statements was: 1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Locating resources was: 1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Information provided on task pages was: 1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Going back and changing answers was:</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>
Figure 4.6. Problem-Solving Learning Portal usability evaluation continued

Participant responses to evaluation questionnaire of Problem-solving Learning Portal

<table>
<thead>
<tr>
<th>Statement being rated</th>
<th>Percentage of participants by response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submit button on task pages was</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Overall navigation of the case studies within PSLP was</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Feedback you received on completion of a task was</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Using the shared workspace to save and share solutions was</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Competing the approval process was</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER 5. SUMMARY AND DISCUSSION

Research in the scholarship of teaching and learning has resulted in a growing body of knowledge that strives to understand how best to prepare students for their careers. Undeniably, the Internet and computer technologies will continue to play a larger and larger role in educational and professional endeavors. This may mean that educators will need to integrate the Internet and technology in their courses more to meet the growing demand from employers and alumni. Online course offerings and other web-based, collaborative learning environments will help prepare students for their future careers.

5.1 Online Horticulture Course Evaluation

The introductory horticulture course has been offered nine times since the beginning of this research and continues to be offered. During the course of this research, 70 students were enrolled in the course; 53 students completed the course evaluation providing the data for this research. The feedback from the students enrolled in HORT 193F indicates that there is an audience for this type of course within the state of Iowa and beyond. Undergraduate students, graduate students, and adult learners participated in the course. The two largest groups of students were adult learners (37.7%) and undergraduate seniors (32.1%). During the course introduction activity, students told their classmates where they live; responses included anywhere from Iowa to Oregon to New York. A majority of students did not reside in Iowa (52.9%). Some of the adult learners were taking the course as part of a professional development program through their employer. Respondents felt comfortable (4.1 out of 5.0) using and learning in a web-based format and that the format was effective in teaching basic horticulture concepts (4.1 out of 5.0). Although respondents reported having little previous experience with horticulture (2.6; scale 1 = poor, 5 = excellent), by the end of the course 75.5% reported they would be interested in taking another horticulture course in this online format.

Although the students generally rated this course high (4.0; scale 1 = poor, 5 = excellent), they did not overwhelmingly prefer the online environment to a traditional face-to-face environment (3.4; scale 1 = poor, 5 = excellent). These results are similar to what
other researchers have reported. Successful online students tend to be self-directed, intrinsically motivated and able to manage their time commitments, which may explain why the majority of students were seniors, graduate students and adult learners.

The results of this study indicate that future online horticulture courses would be equally successful. Respondents in this study suggested the following additional topics be taught online: propagation, plant materials, and landscape design. The course materials developed for the introductory horticulture course have been adapted and expanded to become the Iowa Nursery and Landscape Association’s Certified Nursery Professional online training program. Future online course development could continue to meet the needs of industry professionals as well as students.

Future research into online educational tools is needed. This study raised important questions about how effective a particular activity or tool is, especially compared to traditional pedagogical techniques. Further research is needed to fully understand how online courses can be incorporated into current horticulture curricula.

5.2 Problem-Solving Learning Portal Evaluation

Online environments to support student problem-solving have very different requirements from other educational web-based environments. Jonassen (2002) believes that environments specifically designed for problem-solving need to engage the learners in the process of solving the problems and support them with content resources as well as avenues for social activities such as communication. The web-based Problem-Solving Learning Portal (PSLP) has several of those characteristics, but its execution and usefulness may not be enough to effectively support the development of problem-solving skills for undergraduate students. Setting up the environment to best support students was cumbersome. The lack of a dedicated, central technical support group meant that interested faculty relied on one fellow faculty member to make changes and troubleshoot problems. There are collaboration and communication tools incorporated into the environment. However, when asked, students found those tools difficult to use. During the group discussion, the students reported not understanding how to use the tools in the PSLP environment and suggested that the instructor
needed to show them how to use it. Interestingly, they had forgotten that the instructor had walked them through the environment in class before they were assigned the first case study.

This research did not investigate how the students’ perceptions of their problem-solving skills related to their actual performance. Anecdotal evidence suggests that students are over-confident in their assessment of their problem-solving abilities because their grades on the case study assignments were not as high as the assumed. Further research into how to adequately assess student problem-solving skills is needed in order to then create effective learning environments and pedagogy. Additional work has been done with the Problem-Solving Learning Portal and future plans include tools that would allow instructors to create and manage their own content. Also, this problem-solving environment may be combined with other similar environments on campus to create a palette of tools from which instructors could select the tools that best fit their content and objectives.

5.3 General Conclusions

Online courses and web-based teaching tools hold great potential for many types of courses, many types of subjects and many styles of learners. Students already use technology in their daily lives, perhaps not regularly in their education. This is likely to change in the future, especially as teachers strive to incorporate technology to support their teaching endeavors. Further research is needed to understand how student learning changes through the medium of technology.

5.4 Reference

**APPENDIX ADDITIONAL MATERIAL**

Table 5.1. Online course evaluation of an introductory horticulture course, HORT 193F

This table shows the mean responses to an online introductory horticulture course evaluation for nine offerings of the course from fall 2006 to fall 2008. (n = 53)

<table>
<thead>
<tr>
<th>Evaluation Statement</th>
<th>Average Response&lt;sup&gt;z&lt;/sup&gt;</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>My interest in this course was:</td>
<td>4.0</td>
<td>0.4</td>
</tr>
<tr>
<td>The relevance and usefulness of the course content were:</td>
<td>3.9</td>
<td>0.4</td>
</tr>
<tr>
<td>My previous experience with horticulture was:</td>
<td>2.6</td>
<td>0.5</td>
</tr>
<tr>
<td>I felt comfortable using this web-based format.</td>
<td>4.1</td>
<td>0.4</td>
</tr>
<tr>
<td>Clarity of student responsibilities and requirements was:</td>
<td>3.9</td>
<td>0.6</td>
</tr>
<tr>
<td>The organization of the course material was:</td>
<td>4.2</td>
<td>0.4</td>
</tr>
<tr>
<td>The course content was:</td>
<td>4.0</td>
<td>0.5</td>
</tr>
<tr>
<td>Evaluative and grading techniques (tests, papers, projects, etc.) were:</td>
<td>3.8</td>
<td>0.5</td>
</tr>
<tr>
<td>The reading materials were:</td>
<td>3.5</td>
<td>0.3</td>
</tr>
<tr>
<td>The course's ability to stimulate my thinking more deeply about the subject was:</td>
<td>3.8</td>
<td>0.4</td>
</tr>
<tr>
<td>Navigation of the teaching tools was:</td>
<td>4.0</td>
<td>0.4</td>
</tr>
<tr>
<td>Readability of the content was:</td>
<td>4.2</td>
<td>0.2</td>
</tr>
<tr>
<td>The audio clips associated with the modules were:</td>
<td>3.9</td>
<td>0.2</td>
</tr>
</tbody>
</table>

<sup>z</sup> Scale of 1=poor, 2=fair, 3=good, 4=very good and 5=excellent.
Table 5.1. Online course evaluation of an introductory horticulture course, HORT 193F continued

<table>
<thead>
<tr>
<th>Evaluation Statement</th>
<th>Average Response</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>The amount of information presented in the modules was:</td>
<td>4.1</td>
<td>0.3</td>
</tr>
<tr>
<td>This tool is an effective way to deliver information.</td>
<td>4.1</td>
<td>0.4</td>
</tr>
<tr>
<td>The interactive format of this tool aided my learning.</td>
<td>3.7</td>
<td>0.4</td>
</tr>
<tr>
<td>I prefer this web-based format to traditional learning environments.</td>
<td>3.4</td>
<td>0.5</td>
</tr>
<tr>
<td>The time allowed to complete each module and its assignments, quiz and activities was:</td>
<td>4.2</td>
<td>0.4</td>
</tr>
<tr>
<td>The overall rating of this course was:</td>
<td>4.0</td>
<td>0.5</td>
</tr>
<tr>
<td>Instructor's responsiveness to questions was:</td>
<td>3.7</td>
<td>0.5</td>
</tr>
<tr>
<td>Instructor's availability for extra help when needed was:</td>
<td>2.7</td>
<td>1.0</td>
</tr>
</tbody>
</table>
Figure 5.1. Problem-Solving Learning Portal homepage

This is the homepage the students see every time they logged into the online problem-solving learning environment. From this location students are able to navigate to the problem description, the situation summary, the diagnosis, the recommendation, and all the provided resources.
ACKNOWLEDGEMENTS

I would like to thank those who have helped me reach this milestone in my life. First, I would like to thank Dr. Ann Marie VanDerZanden without whom I would not have pursued a graduate degree and further developed my passion for horticulture and innovative educational techniques. I would also like to thank the other members of my committee – Dr. Jeffery Iles and Dr. Dale Niederhauser. Their guidance and patience have been priceless. I would also like to thank my family who prepared me to meet the challenges of life and set my sights high. Finally, I would like to thank my husband Ben who has been incredibly understanding and supportive.