

# Summary Lecture versus Web-based Method for Instruction of Site Planning for Protected Environment Structures<sup>1</sup>

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## Abstract

This study compared student learning outcomes from two teaching methodologies about site planning for protected environment structures (PES): a traditional summary lecture presentation and an asynchronous web-based method that included a case study ([www.hightunnels.org/planning/casestudy.htm](http://www.hightunnels.org/planning/casestudy.htm)) followed by an all-class discussion. Students were divided into two groups and each experienced both methodologies; however, the order in which the groups received the methodologies was reversed. A quiz was given after each method, and questions were designed to assess knowledge gained, higher-order learning, and student perception of how confident they would be in solving actual site planning scenarios. Overall quiz scores improved after both quizzes for both groups. When questions were categorized as lower-order versus higher-order learning, a greater increase in scores was observed in higher-order learning. Although students' perceived confidence was not influenced by which method was received first, their confidence increased after experiencing both methods. Rather than one teaching method being superior to the other, this study suggests that it is beneficial to use both. Interestingly, while students overwhelmingly preferred to receive the summary lecture before the web-based method, no significant difference in test scores occurred between the two orders, suggesting that neither order offered any advantage.

## Introduction

The demand for electronically accessible materials that supplement or replace conventional lectures has grown substantially in recent years. While some propose that the addition of on-line course materials enhances the learning process (Sistrunk, 1998), little information is available to support these claims. Likewise, concepts such as development of higher-order cognitive skills and problem-based learning have become established in educational theory, but little has been translated into practice for horticulture and related curricula. One example of a problem-

based learning method, characterized by a cognitive process focusing on unsettled questions, is the case study (Turgeon, 1997). The work that has been done relating to horticultural education is observational and little data exists to back up observations (Zimmerman, 2002). Therefore, a need exists to assess effectiveness of teaching methodologies and their impact on development of higher-order cognitive skills in horticulture education.

Many recognize the benefits of electronically-accessible materials: they are easily updated and widely accessible (Sistrunk, 1998); students can access material at their own pace and preferred order (Turgeon, 1997); the current curriculum can be enriched and extended by providing access to materials that otherwise could not be brought into the classroom (Dyrli and Kinnaman, 1996); and online discussions can be used to post information, exchange ideas and discuss problems (Lea-Cox et al., 2002). These combined benefits create an environment that is more interesting to the student; this interest-based learning empowers students, encourages creativity, maximizes engagement, and increases productivity (Amabile, 1983). However, most recognize that technology is not a panacea for teaching and educational needs, and many instructors in the contemporary classroom are struggling to find a place for web-based methods to fit into the current curricula and conventional synchronous teaching methods.

Critical evaluation of methods that assess learning is becoming a concern for educators in all fields of study. All too often, assessment of learning reverts to delivery and testing of material by rote memorization of facts due to instructors' comfort, lack of preparation time, and/or tradition. Educators recognize this and have long been concerned that most tests measure trivial, isolated fragments of knowledge involving memorization of facts (Haladyna, 1997). This rote memorization is the first level of learning in Bloom's Taxonomy, a six step hierarchy of learning. The levels: Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation are a progression, and mastery of one

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## Summary Lecture

level is necessary before advancing to the next level (Bloom et al., 1956). With this hierarchy that was proposed almost 50 years ago, the possibility of teaching to accomplish higher-order learning objectives was raised (Krathwohl et al., 2001). While knowledge gain is an important building block in the learning process, students often miss experiencing problem-solving situations during classroom instruction similar to what they will encounter in a real-world setting.

Assessment is most commonly accomplished through written tests in various formats, including multiple choice, short answer, essay, matching and true/false. The purpose of any test item is to obtain a student response to make an inference about the student's knowledge or mental skill or ability (Haladyna, 1997). To this end, it is also possible to write test items that measure both lower-order cognitive skills such as memorization and recall and higher-order cognitive skills such as problem-solving and application. Therefore, in an effort to assess levels of learning that occur via the summary lecture versus a web-based method with a case study and all-group discussion, test items were written to assess lower-order and higher-order learning.

Specifically, this study was designed to address 1) if one method produced better understanding of key principles than the other; 2) whether one method contributed to higher-order learning more so than the other; 3) whether students became more confident about their ability to apply acquired knowledge after learning the material via one method more so than the other; and 4) if the order in which students experienced the different methods influenced their learning and confidence outcomes.

## Materials and Methods

The two methods evaluated in this research were a summary lecture and a web-based method with a case study followed by an all-class discussion. The summary lecture presentation involved a synchronous learning environment where an instructor's lecture to a class was supported with a digital, image-rich presentation and text handouts; this could be considered a traditional, conventional or classical lecture format (Klein et al., 2003). The web-based method occurred in an asynchronous learning environment where students worked through interactive material in a time-independent and place-independent manner (Klein et al., 2003); this

method has also been referred to as an independent web-based method (Teolis et al., 2003). In our study, the asynchronous web-based method was followed by an all-group discussion to reveal the case study solution. The content covered via both methods was site planning for protected environment structures (PES), which include greenhouses, glasshouses, hothouses, high tunnels, hoophouses and cold-frames. The website content, in the form of education modules located at [www.hightunnels.org](http://www.hightunnels.org), includes a case study on site planning designed to promote higher-order learning and problem solving skills (Spaw and Williams, 2004). The experiment reported here provides assessment of the two presentation methods to evaluate the assumptions of higher-order learning and the roles of summary lectures and web-based materials in today's agriculture classrooms.

The 21 participants involved in the study were students enrolled in HORT 570 Greenhouse Operations Management during the Fall 2003 semester at Kansas State University (Manhattan, KS.). This is an upper-level undergraduate course and included two students classified as sophomores, eight students as juniors and eleven students as seniors; all were majoring in horticulture.

During the first day of class, information was gathered via a pre-survey. Questions included

**Table 1. Undergraduate student responses (as a % of all students in the class) in a greenhouse management class based on their personal interest in Protected Environment Structures (PES) and related topics on a Pre-survey given during the first class period.**

	Not at all Interested					
	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	Very Interested 6 (%)
Site planning for horticulture production operations	0	9.5	14.3	23.8	28.6	23.8
Constructing a greenhouse or other PES	0	0	14.3	4.8	33.3	47.6
Flower and/or vegetable production in a PES	0	0	0	9.5	9.5	81.0
Flower and/or vegetable production in the field	0	4.8	0	19.0	23.8	47.6
How to manage greenhouse crop nutrition	0	0	4.8	9.5	47.6	38.1
	Strongly Disagree					
	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	Strongly Agree 6 (%)
I have participated in the site planning process for a Protected Environment Structure (PES) for a specific parcel of land	66.7	9.5	9.5	14.3	0	0
I have participated in the construction of a PES	57.1	9.5	0	0	14.3	19.0
In the future, I intend to construct a PES	0	0	9.5	19.0	42.9	28.6
I am familiar with the factors to consider when planning the site for a PES on a specific parcel of land	9.5	42.9	9.5	33.3	4.8	0
I am interested in learning more about the factors involved in planning the site for a PES	0	0	0	4.8	23.8	71.4

students' area of specialization within horticulture and previous work experience. Forty-three percent of students' specialization was Greenhouse Management with the remaining specializing in: Horticulture Science, Horticulture Therapy, Landscape Design or Nursery Management. Forty-three percent of the students reported one to three years previous work experience related to horticulture. Fifty-two percent of the students reported less than one year work experience in a greenhouse or PES with the majority of the remainder (43%) having less than three years experience in a greenhouse or PES. In addition, questions were asked to ascertain personal interest in PES topics and interest in constructing a PES (Table 1) as well as confidence about making site planning decisions for PES (five questions; Table 2).

The experiment was designed as follows: the subjects were randomly split into two groups. Group 1 received the asynchronous web-based method first while Group 2 received the summary lecture presentation first. The following day, Group 1 participated in an in-class discussion and then both groups were given a short quiz (Time 1). One week later, the groups switched and received the treatment they did not receive previously. The following day, the

identical quiz was given again (Time 2) after Group 2 participated in a discussion. Students had been told that they would be tested on the content of PES site planning, but they did not know that the quiz would be identical during Time 1 and Time 2. This design allowed for both between and within subject comparisons.

Students using the asynchronous web-based learning resources with a case study were given one class period, 50 minutes in duration, to work through the site planning material which consisted of four educational modules (Site Selection, Orientation & Structural Considerations, Materials & Construction, and Case Study: Site Planning for High Tunnel Construction) in a department-sponsored computer lab. Students were given the assignment of reviewing the information and making a definitive decision about where to place the PES in the site plan case study. They were encouraged to work as much as they wanted after the class period was officially over, either on a home or lab computer of their choice. The next day, these students participated in a group discussion about their decisions on PES placement for the site. The 30 min. discussion was facilitated each week by the primary author of this paper and concluded by revealing the grower's solution.

**Table 2. Mean and standard deviation (SD) of perceived student confidence regarding site planning for a Protected Environment Structures (PES) for Group 1, which received the asynchronous web-based method first, and Group 2, which received the summary lecture presentation first, during the Pre-survey, Time 1 and Time 2<sup>z</sup>.**

Questions	Pre-Survey		Time 1		Time 2 <sup>y</sup>	
	Mean <sup>x</sup>	SD	Mean <sup>x</sup>	SD	Mean <sup>x</sup>	SD
I feel confident about choosing the best site for a PES on a given parcel of land.	2.5	1.2	4.4	1.0	4.6	.82
I feel confident about choosing the best orientation for a PES on a given parcel of land.	2.5	1.2	4.4	1.0	4.7	.75
I feel confident that I know the factors to consider when planning the site for a PES.	2.6	1.0	4.7	.86	5.0	.86
I feel that incorporating all the necessary factors is consider when making site planning decisions is fairly straight forward.	3.6	1.0	4.1	1.1	4.3	1.1
I feel that determining the best site for a PES is fairly straight forward.	3.5	1.2	4.1	1.2	4.4	.88

<sup>z</sup> Pre-survey given during the first class period, Time 1 was after a teaching methodology was received the first time, and Time 2 was after groups switched and received the method they had not received previously, one week after Time 1.

<sup>y</sup> Student confidence was borderline significant (p=0.065) at Time 1 and Time 2 when all questions were combined.

<sup>x</sup> Scale: 1=Strongly Disagree; 2= Disagree; 3= Somewhat Disagree; 4=Somewhat Agree; 5=Agree; 6=Strongly Agree

## Summary Lecture

The summary lecture presentation contained complimentary information, but had no case study. Along with unique content to each method, key principles were repeated in both methods but in different formats. The summary lecture consisted of a lecture via a text and image-rich PowerPoint (Microsoft Corp., Redmond, Wash.) presentation supplemented with a text handout. The lecture period was 50 min. long. While students were encouraged to review the information in preparation for the quiz, no class discussion was held the following day.

The quiz consisted of 20 questions: Seven designed to assess lower-order cognitive skills of knowledge and comprehension (Table 3), eight designed to assess higher-order cognitive skills of application, analysis, synthesis, and evaluation (Table 4), and the same five “perception of confidence” questions contained in the pre-survey (Table 2). The test item format consisted of 13 multiple choice and two short answer questions. The quiz assessed key principles that were presented via both teaching methodologies. A pilot quiz had been taken by a horticulture student not enrolled in the course prior to the study and it required 19 min. to complete. For the 21 participants, the quiz required less than 30 min. to complete, and they were given as much time as they preferred. After the quiz at Time 2, a short post-survey was given to obtain feedback about student preferences regarding these teaching formats.

Short-answer questions were scored using consistent criteria. Data were analyzed using SPSS

confidence questions. Non-parametric Chi-square tests and frequencies were determined on the pre-survey and post-survey questions.

## Result and Discussion

A between-group comparison of quiz scores was made at Time 1 to determine if one method produced a better understanding of key principles than the other. Overall quiz scores were not different (Table 5). This outcome is comparable to the results of a study that compared whether the lecture or case study method is more effective for instruction of business management concepts (Watson, 1975). However, a within-subject comparison of overall quiz scores, expressed as a percentage, did indicate that they increased at Time 2 for both groups ( $p=0.03$ ; Table 5). This result suggests that the delivery of complimentary information reinforced learning, as key principles along with unique information were presented via different pedagogies. Even so, overall scores still averaged only 70% at Time 2 (Table 5).

When performance was analyzed based on the category of question, scores for higher-order questions improved at Time 2 ( $p=0.04$ ), but no significant increase occurred for the lower-order questions that reflected knowledge gain ( $p=0.11$ ; Table 5). The repetition of material via a different format likely contributed to the increase observed in higher-order learning as much as the use of a case study. For the purposes of this study, the amount of class time allotted to the subject of site planning for PES was doubled compared to what would normally be allocated to this topic. While it is not feasible to

allot extra in-class time to one subject over others to reap the benefits of repetition, an advantage of asynchronous web-based materials is that they can be assigned outside of class. For example, future instruction of this topic at Kansas State University will include the in-class summary lecture, assignment of the web-based case study to be completed outside of class, and an in-class discussion of the case study solution. Therefore, the benefits of using both pedagogies can be accomplished without allocating a disproportionate amount of in-class time to the single topic.

The order in which the teaching methodologies were administered did not influence overall quiz scores ( $p=0.93$ ), lower-order ( $p=0.98$ ) or higher-order learning ( $p=0.88$ ; Table 5). Therefore in this study, the order in which the students experienced the teaching methods did not influence overall quiz

**Table 3. Quiz questions designed to assess lower-order learning about site planning for Protected Environment Structures (PES) by undergraduate students in a greenhouse management class at Time 1 and Time 2<sup>2</sup>. Correct responses are in bold. Instructions for questions 1-3 are to select only one response, questions 4-6 are to choose all that apply, and question 7 is short answer.**

1. What two characteristics of a windbreak interact with each other to determine wind speed reduction?  
a) Height and density   b) Height and length   c) Length and orientation   d) Length and density
2. A structure's orientation as it relates to light transmittance is most critical during which season?  
a) Spring   b) Summer   c) Fall   d) Winter
3. What latitude does most of Kansas fall between?  
a) 30°N - 34°N   b) 35°N - 39°N   c) 40°N - 44°N   d) 45°N - 50°N
4. What is an example(s) of a live load?  
a) Snow   b) Wind   c) Hanging Basket   d) Portable Temporary Heater   e) Permanent Fan
5. What factor(s) should you consider when deciding on the placement of a PES on a specific site?  
a) Topography   b) Wind Load   c) Water Supply   d) Strength of Structure   e) Light Intensity
6. What characteristic(s) of a windbreak affect the area protected downwind?  
a) Height   b) Length   c) Width   d) Density   e) Orientation
7. List five structures and/or features that a temporary PES should be located near to facilitate labor efficiency:

<sup>2</sup>Time 1 was after a teaching methodology, summary lecture or web-based method, was received the first time, and Time 2 was after groups switched and received the method they had not received previously, one week after Time 1.

Base ver. 10.0 (SPSS Inc., Chicago, Ill.). Descriptive statistics as well as analysis of variance were run for within-subject and between-subject factors for overall percent scores, indexed higher-order questions, indexed lower-order questions and

**Table 4. Quiz questions designed to assess higher-order learning about site planning for Protected Environment Structures (PES) by undergraduate students in a greenhouse management class at Time 1 and Time 2<sup>1</sup>. Correct responses are in bold. Instruction for question 1 is to choose all that apply; questions 2-7 are to select only one response per multiple choice question; and question 8 is short answer. Questions 4-8 are to be answered after reading the scenario that preceded the questions.**

1. For a PES at 40°N Latitude the best orientation may include:  
a) North : South   b) East : West   c) Northeast : Southwest   d) Other
  2. An angle of incidence of 70° at 40°N latitude through glass glazing material of a PES:  
a) has virtually no effect on light transmittance through glazing material   b) results in very low light transmittance through the glazing material   c) results in maximum amount of light transmittance through the glazing material   d) at this latitude, a 70° angle of incidence is not possible
  3. A grower is planning to build gutter-connected greenhouses in upstate New York. For maximum light transmittance it would be best to orient the high tunnel with the ridges running:  
a) North : South   b) East : West   c) Northeast : Southwest   d) Does not really matter at this location
- For two years a grower north of Lincoln, Nebraska supplied local restaurants year round with fresh herbs and lettuce greens. Most of the production occurred in a minimally heated high tunnel. While the first year of production went relatively smoothly, the second year proved disastrous. After several days of heavy snow accumulation in January, temperatures rose well above freezing one day. The next morning when the grower entered the structure to remove the row-covers, the inside of the high tunnel was a sheet of ice, what the grower dubbed a "skating rink" effect.
- The high tunnel is 20 feet wide by 30 feet long and has 3 foot sidewalls. The ribs are constructed of PVC and attached to wood hip boards and base boards. The base boards are made of treated lumber because they set directly on the soil, flush with the ground. The structure is covered with a single-layer of polyethylene. The site is relatively level, however, one portion features almost a 20% slope. The high tunnel structure is protected by a mature windbreak that is supplemented with additional plastic fencing. The high tunnel is oriented in a North : South direction (see diagram).
4. Why do you suppose the North : South orientation was selected for this structure?  
a) To avoid accumulation of heavy snow loads   b) To avoid damage from heavy wind loads   c) To Increase light transmittance in the summer   d) To Increase light transmittance in the winter
  5. What do you predict would happen if the structure was replaced with a heated, permanent, wood-framed, glass-covered greenhouse at the same location and orientation on this site?  
a) Summer production may be hindered because of very low light intensity   b) Winter production may be hindered because of very low light intensity   c) Wind loads would become more critical to determine   d) Snow loads would become more critical to determine
  6. Given that previous production occurred in frigid winter conditions (snow, freezing temperatures, etc.) what is the primary cause of the sheet of ice that formed on that particular January night?  
a) High tunnel placement on site   b) Quality of the soil   c) Heavy wind load   d) Heavy snow load
  7. This windbreak is protecting this high tunnel from prevailing winds primarily during which season?  
a) Spring   b) Summer   c) Fall   d) Winter
  8. What further information do you need to know to evaluate the effectiveness of the tree line depicted in the diagram as a windbreak? State five pieces of information.

<sup>1</sup>Time 1 was after a teaching methodology, summary lecture or web-based method, was received the first time, and Time 2 was after groups switched and received the method they had not received previously, one week after Time 1.

confidence was observed between Time 1 and Time 2 ( $p=0.23$ ) regardless of which method the participants received first.

For both groups combined, students became more confident about their ability to apply acquired knowledge over time. Confidence about making site planning decisions was extremely low at the pre-survey (Table 2). In tandem with survey questions about their work experience (Table 1), this verified that students' previous experiences did not skew results of this study. Although students' perceived confidence is not influenced by which method is received first ( $p=0.23$ ), perceived confidence increased after Time 2 compared to Time 1 ( $p=0.06$ ). The order of experiencing the two teaching methodologies did not make a difference in perceived student confidence.

Interestingly, most students (86%) preferred to experience the traditional lecture presentation before the web-based method. Intuitively, this is a logical order: establish a base of knowledge and then expand it with problem-solving skills. To solve the case study presented via the web-based method, students had to acquire the knowledge necessary to make a competent decision by reading information in the education modules. It is likely that students are more comfortable with receiving information in the straight forward manner of the summary lecture and did not recognize the process

of retrieving information from the web-based modules as establishing a knowledge base. Therefore, they perceived that it would be more beneficial to receive the summary lecture first.

All 21 students indicated that they thought it was worthwhile to complete both methods. Repetition that occurs in a different context and allows students to explore the content further without contributing to boredom appears to be an ideal way to encourage

**Table 5. Student performance based on order of teaching methodology (web-based method with class discussion or summary lecture) for both groups combined, on lower-order questions, higher-order questions and average overall quiz scores (%) at Time 1 and Time 2.<sup>2</sup>**

	Lower-order			Higher-order			Overall Quiz Score		
	Time 1 (%)	Time 2 (%)	Significance <sup>3</sup>	Time 1 (%)	Time 2 (%)	Significance <sup>3</sup>	Time 1 (%)	Time 2 (%)	Significance <sup>3</sup>
Web-based method received first (Group 1)	84.7	84.3	NS	46.4	57.9	NS	63.4	70.4	NS
Summary lecture method received first (Group 2)	80.5	88.3	NS	49.1	53.4	NS	64.8	70.0	NS
Significance <sup>4</sup>	NS	NS		NS	NS		NS	NS	
Both Groups Combined	82.5	86.4	NS	47.8	56.0	*	64.1	70.0	*

<sup>2</sup>Time 1 was after a teaching methodology, summary lecture or web-based method, was received the first time, and Time 2 was after groups switched and received the method they had not received previously, one week after Time 1.  
<sup>3</sup>NS, \*Nonsignificant or significant at  $P<0.05$ , based on Time 1 and Time 2.  
<sup>4</sup>NS based on method received first.

scores at Time 1 or Time 2, and order did not influence overall improvement over time ( $p=0.64$ ).

The method by which the students received the material did not influence their confidence about their ability to apply acquired knowledge. Confidence was measured at three points in time: pre-survey, Time 1 and Time 2. Confidence was different between the three times ( $p=0.05$ ). However, when the pre-survey was dropped because confidence scores were extremely low, as expected, no difference in

## Summary Lecture

the development of problem-solving skills. The two methodologies work together to encourage a positive learning environment that is appealing to students and ultimately may be contributing to increased quiz scores over time.

Seventy percent of the 21 students in this study indicated a preference for the web-based method with a case study over the summary lecture. In fact, when asked which method they would prefer if only one were to be used, 62% still selected the web-based method. It is unclear whether the asynchronous web-based component contributed to this preference or whether other factors, such as the inclusion of a synchronous group discussion, influenced their opinions. The learning climate could be perceived as better when students were actively involved in a group discussion, and this could have contributed to the preference for the web-based method with a case study (Watson, 1975). However, this study was not designed to evaluate the impact of the discussion component. Regardless, students' preference for the web-based component encourages the continued integration of web-based technologies into current curricula.

## Summary

The use of both teaching methods--a summary lecture presentation and a web-based method with a case study followed by a group discussion--increased test scores and student confidence on the subject of site planning for PES. In addition, while students preferred that the summary lecture be experienced first, quiz performance was not affected by the order in which the teaching formats were experienced. It would be interesting to explore these results with further study via replication of this study in similar courses at multiple universities and/or over several years at the same university.

This study indicates many advantages of merging web-based information with a case study into current horticulture curricula. This format is interactive and allows for repetition of key concepts in a way that students find relatively interesting. Web-based content was well received by the students, and students' test scores increased when both teaching methods were used in tandem. With careful planning by the instructor, web-based methodologies can be integrated into current curricula to augment or even replace a traditional summary lecture.

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