Comparison of Instructional Methods for Teaching Landscape Construction Techniques to Undergraduate Horticulture Students[1]

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Abstract

A software program was created that could be used to familiarize undergraduate horticulture students with common landscape construction techniques. The objective of this study was to evaluate a prototype of this software by comparing its effectiveness to the more traditional type of instruction consisting of lecture and overheads. Students responded to both multiple-choice and graphic response (answer requires graphic representation of technique) questions in a pretest / posttest format. For both types of questions, students in the control (provided information by lecture) and treatment (provided information by software) groups significantly improved their scores on the posttest compared to the pretest. However, there were no significant differences between control and treatment groups on posttest scores. Results of this study indicate that the software program and lecture were equally effective in teaching students about common landscape construction techniques.

Introduction

Landscape construction involves the design, creation, and incorporation of non-plant elements - such as walkways, retaining walls, bridges, and water features - into a landscape (Sauter, 1999). University horticulture programs can find it difficult, for several reasons, to meet the needs of their students with respect to training in landscape construction. Most importantly, courses in landscape construction are expensive to teach since they generally include a lab which requires a substantial input of costly materials and equipment. In addition, it can be hard to find academically trained professionals who have both a strong knowledge base and practical work experience in the field of landscape construction. Teaching the subject is challenging since, in most cases, a number of different approaches and many different types of materials can be used to complete a particular project.

Computer based instruction (CBI) has the potential to be a useful tool in teaching landscape construction, particularly in situations where it is not possible to offer a lab. Graphic capabilities of computers, in conjunction with sophisticated authoring software, allow construction processes to be depicted in a clear, step-by step manner which is difficult to simulate in a traditional lecture format. In addition, there is no doubt that CBI has the potential to be a cost-effective approach when compared to the cost of outdoor lab exercises (Rhodus and Hoskins, 1995).

A project was initiated in 2000 to develop a CD-based software program that could be used to instruct students in landscape construction techniques. The objective of this study was to evaluate a prototype of this software and compare its effectiveness, as a teaching tool, to the more traditional type of instruction consisting of lecture and overheads.

Materials and Methods

Creation of Images

Twenty-six landscape construction projects were selected and categorized under the headings of landforms, pavement, site structures, or water. Projects were selected because of their common use in the landscape construction industry. Elevation and plan views of each project were drawn within a five by five-inch area using a Bruynzeel (Netherlands) design pencil with an H quality lead. Details were drawn to scale and subsequently transferred to Grafix film sheets (Grafix Plastics, Cleveland, OH) using Rapidograph pens and Ultradraw quick drying black India ink. (Chartpak Inc., MA).

Completed drawings were scanned into Adobe Photoshop (Adobe Systems, San Jose, CA) as high-level line art with a resolution of eight hundred dpi (distributed protocol interface). Drawings were subsequently converted to grayscale at a resolution of seventy-two that provided good contrast between black and white areas of the drawings.

Delivery Platform

Macromedia Directory (Macromedia Inc., San Francisco, CA) was chosen as the delivery platform. Scripts detailing each step of the construction process were written for each detail and recorded with a Shure 57 microphone (Shure Inc., Evanston, IL) into a Digi ProTools (Macromedia Inc., San Francisco, CA) system on a Mac G4. Recordings were subse-

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quently cleaned up using a compressor and EQ and taken into SoundEdit 16. (Macromedia Inc., San Francisco, CA). SoundEdit was used to break up the audio into separate steps, convert the audio to Shockwave audio (Macromedia, Inc., San Francisco, CA) and insert the points that trigger the tags in Director. Labels that accompanied drawings were timed to gradually fade in as a particular aspect of a drawing was being discussed on the script.

Data Collection and Analysis

The experimental population consisted of forty-two junior and senior students enrolled in the landscape horticulture program at Southern Illinois University Carbondale. Students were randomly assigned to either a control or treatment group and given two pretests. The first pretest consisted of seventeen multiple choice questions concerning landscape construction techniques (Table 1). For the second pretest (graphic response test), students were given a list of four different landscape features (reinforced concrete wall, bluestone patio, attached shade structure, free-laid bolder wall) and asked to draw and label the various components involved in construction, Both pretests were administered to students before they had been exposed to any classroom information concerning landscape construction techniques.

One week after administration of pretests, students in the control group attended a lecture presentation that discussed construction of the four landscape features the students had previously drawn. The lecture, which included use of overheads, lasted two hours and was given in the same classroom in which the class was normally held. Students in the treatment group were taken to a computer lab on campus and allowed to view (for two hours) the prototype software that covered the same four landscape features. Every effort was made to provide students in the control and treatment groups with identical information. Once students had been exposed to the subject matter, they were given two posttests that were identical to the previously administered pretests.

Multiple choice questions were graded on a correct / incorrect basis. For graphic response questions, students received points (Table 2) for each component of a particular landscape feature that they drew and labeled correctly. Points that a student received were summed and divided by the total points available to get overall score on a percentage basis.

Pretest scores of the control and treatment groups, for both the multiple choice and graphic response questions, were compared using two sample t-tests. Posttest scores were analyzed in a similar manner. Additional t-tests were run to compare 1) pre-and posttest scores for the control group and 2) pre- and posttest scores for the

Table 1. Multiple choice questions used to evaluate student's knowledge of landscape construction techniques.

1. When installing a free-laid boulder wall, what is the purpose of a 30% setback?

   A. for aesthetic purposes
   B. to increase drainage
   C. to keep the wall stationary
   D. to keep the wall level
   E. none of the above

2. Why is the row of base stones buried 1 ft deep or to 1/3 of the stone's size?

   A. for stability
   B. to increase drainage
   C. for aesthetic purposes
   D.To secure the landscape fabric
   E. none of the above

3. What needs to occur before the base row of stones is set in place?

   A. landscape fabric is installed
   B. compact the backfill
   C. finish the base grade
   D. compact the soil base
   E. none of the above

4. When laying a bluestone patio, where should one begin ?

   A. at the house working out
   B. in the center
   C. farthest point from the house
   D. at the lowest point
   E. none of the above

5. Why should the size of the bluestone sections be varied in a bluestone patio?

   A. to increase strength
   B. they only come that way
   C. for a good appearance
   D.are easier to install
   E. none of the above

6. Why should the base of a bluestone patio slope 1-4% away from a structure?

   A. to maintain strength
   B. to follow the soil grade
   C. to keep the bluestone stationary
   D. to direct drainage
   E. none of the above

7. What replaces two or more of the support posts in an attached shade structure?

   A. a beam
   B. a joist
   C. a ledger
   D. a nailing block
   E. none of the above

8. Why are galvanized bolts used in the construction of an outdoor shade structure?

   A. for strength
   B. for increased support
   C. they are cheaper
   D. they are rust resistant
   E. none of the above

9. When building a shade structure, why are the concrete piers for the support posts set on a 1-2% slope?

   A. for support
   B. for increased strength
   C. to prevent water from collecting
   D. to prevent shifting during freezing temperatures
   E. none of the above

10. In a shade structure, how are the beams are connected to the posts?

    A. by galvanized bolts
    B. by galvanized nails
    C. by a galvanized metal post cap
    D. by a copper plated post cap
    E. none of the above

11. What is a toenail?

    A. a type of footing
    B. an attachment method
    C. a galvanized screw
    D. a specific type of metal post cap
    E. none of the above

12. When constructing concrete walls, what dictates the depth of the footing?

    A. the height of the wall
    B. the soil type
    C. the frost line
    D. soil moisture content
    E. none of the above

13. When building a footing for a poured concrete wall, why is a heel incorporated on the bottom of the footing?

    A. to prevent shifting
    B. to support the wall
    C. to keep the wall level
    D. to add strength
    E. none of the above

14. When pouring concrete for a wall, why should only 1" be poured and tamped at a time?

    A. to allow concrete to cure in layers
    B. to allow placement of rebar
    C. to remove excess air space
    D. to permit removal of rebar
    E. none of the above

15. Why are weep holes commonly included as part of a concrete wall?

    A. to allow good air circulation
    B. to allow proper drainage
    C. to support the wall
    D. to keep the wall stationary
    E. none of the above

16. Why are dead men incorporated into a poured concrete wall?

    A. for aesthetic purposes
    B. to add support and strength
    C. to encourage free drainage
    D. to add a brick veneer
    E. none of the above

17. What is a brick veneer?

    A. a type of sealing compound
    B. a type of cement for masonry work
    C. a special type of brick
    D. a façade
    E. none of the above

Table 2. Grading scale used to evaluate student responses to graphic response questions on landscape construction techniques.

Reinforced Concrete Wall	
1) Reinforced concrete wall (must have footing below frost line)	
Footing not represented	0
Footing represented but not below frostline	1
Footing represented and below frost line	2
Footing represented, below frost line, incorporates a heel to prevent shifting	3
2) Reinforcing bars (must be incorporated into concrete wall)	
Reinforcing bars not represented	0
Reinforcing bars represented but not attached with wire connection ties	1
Reinforcing bars represented and attached with wire connection ties	2
3) Drainage protection	
Weep holes not represented	0
Weep holes represented but not in the proper location	1
Weep holes shown, in proper location but not slanted outward	2
Weep holes shown, in proper location, slanted outward but not on 4' centers	3
4) Concrete dead man incorporated	
None shown	0
Shown but not with taper and angled reinforcing bar	1
Shown with taper and angled reinforcing bar	2
Total	____
Bluestone Patio	
5) Bluestone patio (must reflect slope for drainage)	
Slope not represented	0
Slope represented but not away from structure	1
Slope represented, away from structure but not at 1-4%	2
Slope represented, away from structure at 1-4%	3
6) Proper placement of stones	
Inadequate or not shown	0
At least two to the following are shown:	
Staggered seams	
Tight butt joints	
Varied stone size	
Level surface	1
At least three of the above are shown	2
All of the above are shown	3
Total	____
Attached Shade Structure	
7) Method of attachment to house or structure	
No attachment	0
Attachment by use of a ledger	1
Attachment by use of a ledger and lag bolts	2
Attachment by use of a ledger and lag bolts connected to house stud	3
8) Method of support (for portion that is not attached to building or structure)	
No supports of inadequate system	0
Basic structural system logical	1
Structural system logical. includes key elements (footings, posts, beams and joists)	2
Footings shown, meet minimum standards (1-2% slope), includes all of above	3
Footings penetrate the frost line. includes all of above	4
9) Attached Shade structure (fasteners and connectors)	
None shown	0
At least two of the following are shown:	
Lag bolts connecting ledger to house stud	
Galvanized post cap (connecting post to beam)	
Metal connectors(connecting joist to ledger)	
Metal connectors (connecting joists to beams)	1
At least three of the above are shown	2
All four of the above are shown and properly placed	3
Fastenings are indicated as galvanized	4
10) Placement of louvers (on top of shade structure)	
Louvers not shown or noted	0
At least two of the following are shown:	
Louvers are positioned on top of joists	
Louvers are properly spaced at 2"	
Louvers are attached with galvanized nails	
Proper placement of louvers in relation to the joists	1
At least three of the above are shown	2
All four of the above area shown	3
Total	____
Free-Laid Boulder Wall	
11) Free-Laid Boulder Wall	
No specific details included or labeled	0
At least two are included and labeled:	
30% setback	
Largest boulders at base	
Base course buried	
Compacted soil under base course	
Top course level	
Use of landscape fabric	1
At least three of above are included and labeled	2
At least four of above are included and labeled	3
Total	____
Cumulative Total	____

treatment group. All t-tests were conducted at the five percent level of significance.

Following administration of the posttest, a Likert Scale survey (not presented) was given to all students participating in the study. The survey was designed to assess student perceptions (attitudes) about the presentation formats, and did not ask questions specifically about landscape construction. Students were also encouraged to make written comments concerning any aspect of the testing procedure.

Results and Discussion

Multiple Choice Questions

Results of the multiple choice pretest indicated no significant differences between the control and treatment groups on any question (Table 3); overall scores of the two groups were statistically equivalent, averaging 57.4%. Therefore, both groups were considered similar with respect to their knowledge concerning cost estimation prior to receiving instruction on the subject. Low scores were expected on the pretest since the students had not yet been exposed to any information concerning landscape construction techniques.

Results of the posttest indicated no significant differences between the control and treatment groups on any question (Table 3). Overall scores for the multiple-choice questions were statistically equivalent for the control and treatment groups, averaging 79.1%. Data indicate that both delivery formats (lecture and software) were equally effective in teaching students about landscape construction techniques.

Posttest scores for students in both the control and treatment groups improved on at least five questions (compared to pretest scores; Table 3). Overall scores for both groups (control 75.4%; treatment 82.8%) increased significantly ($P \leq 0.01$) compared to pretest scores that averaged 57.4%.

Graphic Response Questions

Results of the graphic response pretest indicated no significant differences between the control and treatment groups on any question (Table 4). As with the multiple choice questions, overall scores of the two groups were statistically equivalent (averaging 8.1%). Although students were not expected to do well on the pretest, the extremely low scores on the graphic response questions likely reflect the fact that participating students had no prior experience working with graphic representation of construction details.

Posttest scores for the control and treatment groups differed on two of the eleven questions, but overall scores for the two groups were statistically equivalent (averaging 48.0%; Table 4). As with the multiple choice questions, data indicate that the

Table 3. Percentage correct and P values on multiple choice questions for students involved in evaluation of landscape construction software.

	Percentage Correct[y]				P Values[z]			
Question	Control Pretest	Control Posttest	Treatment Pretest	Treatment Posttest	Pretest Control vs Treatment	Posttest Control vs Treatment	Control Pretest vs Posttest	Treatment Pretest vs Posttest
1	61.9	81.0	52.6	84.2	.57	.79	.18	.04*
2	90.1	100.0	100.0	100.0	.18	1.00	.15	1.00
3	38.1	52.4	57.9	73.7	.22	.17	.36	.32
4	47.6	85.7	52.6	94.7	.76	.35	.01*	.00**
5	42.9	61.9	68.4	89.5	.11	.05	.23	.12
6	100.0	95.2	94.7	100.0	.30	.35	.32	.32
7	19.1	52.4	10.6	55.2	.46	.07	.02*	.39
8	61.9	81.0	73.7	94.7	.44	.20	.18	.08
9	33.3	57.1	52.6	63.2	.23	.71	.13	.52
10	14.3	47.6	36.9	73.7	.10	.10	.02*	.02*
11	61.9	66.7	63.2	68.4	.94	.91	.75	.74
12	47.6	76.2	31.6	79.0	.31	.84	.06	.00**
13	66.7	90.5	68.4	84.2	.91	.56	.06	.26
14	81.0	76.2	73.7	89.5	.59	.28	.72	.22
15	61.9	90.5	84.2	100.0	.12	.18	.03*	.07
16	66.7	95.2	57.9	89.5	.58	.50	.02*	.03*
17	42.9	71.4	31.6	68.4	.47	.84	.06	.02*
Mean all questions	55.2	75.4	59.6	82.8	.60	.39	.00**	.00**

[z] *,** significant at P=0.05 or P=0.01, respectively.
[y] Means for control and treatment groups based on totals of 22 and 20 students, respectively.

lecture and software prototype were equally effective in teaching students about landscape construction techniques.

Posttest scores for students in both the control and treatment groups improved on all questions compared to pretest scores (Table 4). Overall scores for both groups (control 43.7%; treatment 52.2%) increased significantly

($P \leq 0.01$) compared to pretest scores that averaged 8.1%. Although overall scores were lower on the graphic response questions than on the multiple choice questions, percentage improvement between pre- and posttest scores was much higher for the graphic response questions (Tables 3 and 4). This may be because students, on the pretest, were being introduced to an unfamiliar format with the graphic response questions. On the posttest, student's familiarity with the question format is reflected in the test scores.

Likert Scale Survey

For both groups, the mean on all survey questions averaged between 3.0 (neutral) and 4.0 (somewhat favorable; data not presented), suggesting that students had a positive attitude towards both the lecture presentation and the software prototype. Comments concerning the software's navigability and graphics were mostly favorable. However, there were several negative comments concerning the automated voice instructions that were included in the software, and a number of students said they would prefer to read the instructions at their own pace.

Interestingly, a number of students in the lecture group commented that material was covered too quickly. Similar comments were not heard from the treatment group although the same amount of material was presented to them over the same period of time. This difference may be due to the fact that students can move through software programs at their own pace since familiar parts of program can be done quickly while more difficult parts can be done more slowly (Johnson and Oltenacu; 1992).

The majority of students felt that the software would be best used to supplement classroom lectures rather than as the sole method of instruction. This would likely be a good approach since a number of studies have shown students perform better when a number of different teaching methods are incorporated into the curriculum for a particular course (Christmann and Badgett, 1997; Miller and Honeyman 1996).

Summary

Both the software prototype and lecture presentation resulted in improved test performance by students. The delivery methods were equally effective in this regard, a result similar to that observed in other studies that have compared CBI to a lecture format and reported few differences in learning

Table 4. Means, standard deviations, percentage of possible points, and P values of pre- and posttest on graphic response questions for students involved in evaluation of landscape construction.

					P Values[z]			
					Pretest	Posttest	Control	Treatment
Question	Group	Test	Mean[y]	Percent of Possible Points	Control vs Treatment	Control vs Treatment	Pretest vs Posttest	Pretest vs Posttest
1	Control	Pretest	0.24 (0.44)	8.0				
		Posttest	1.43 (0.98)	47.7				
	Treatment	Pretest	0.26 (0.45)	8.7				
		Posttest	2.00 (0.94)	66.7				
	Significance				.86	.07	.00**	.00**
2	Control	Pretest	0.19 (0.40)	9.5				
		Posttest	1.00 (0.71)	50.0				
	Treatment	Pretest	0.05 (0.23)	2.5				
		Posttest	0.53 (0.70)	26.5				
	Significance				.20	.04*	.00**	.01*
3	Control	Pretest	0.14 (0.62)	8.0				
		Posttest	0.95 (1.28)	31.7				
	Treatment	Pretest	0.16 (0.50)	5.3				
		Posttest	1.74 (1.24)	58.0				
	Significance				.66	.06	.03*	.00**
4	Control	Pretest	0.05 (0.22)	2.5				
		Posttest	0.57 (0.68)	28.5				
	Treatment	Pretest	0.00 (0.00)	0.0				
		Posttest	1.26 (0.81)	63.0				
	Significance				.35	.01*	.00**	.00**
5	Control	Pretest	0.29 (0.64)	9.7				
		Posttest	0.76 (1.18)	25.3				
	Treatment	Pretest	0.21 (0.54)	7.0				
		Posttest	1.16 (1.34)	38.7				
	Significance				.69	.33	.05*	.01*
6	Control	Pretest	0.48 (0.60)	16.0				
		Posttest	2.24 (1.14)	74.7				
	Treatment	Pretest	0.37 (0.68)	12.3				
		Posttest	2.47 (0.61)	82.3				
	Significance				.60	.43	.00**	.00**
7	Control	Pretest	0.14 (0.48)	4.7				
		Posttest	1.43 (1.36)	47.7				
	Treatment	Pretest	0.00 (0.00)	0.0				
		Posttest	1.37 (1.01)	45.7				
	Significance				.20	.88	.00**	.00**
8	Control	Pretest	0.52 (0.60)	13.0				
		Posttest	1.52 (0.98)	38.0				
	Treatment	Pretest	0.68 (0.65)	17.0				
		Posttest	2.11 (0.88)	52.8				
	Significance				.43	.06	.00**	.00**
9	Control	Pretest	0.05 (0.22)	1.3				
		Posttest	0.81 (1.44)	20.3				
	Treatment	Pretest	0.05 (0.23)	1.3				
		Posttest	1.05 (1.08)	26.3				
	Significance				.94	.55	.02*	.00**
10	Control	Pretest	0.05 (0.22)	1.7				
		Posttest	1.14 (1.11)	38.0				
	Treatment	Pretest	0.11 (0.32)	3.7				
		Posttest	0.74 (0.81)	24.7				
	Significance				.50	.20	.00**	.00**
11	Control	Pretest	0.48 (0.81)	16.0				
		Posttest	2.57 (0.75)	85.7				
	Treatment	Pretest	0.74 (1.15)	24.7				
		Posttest	2.79 (0.54)	93.0				
	Significance				.41	.30	.00**	.00**
All Questions	Control	Pretest		8.2				
		Posttest		43.7				
	Treatment	Pretest		8.0				
		Posttest		52.2				
	Significance				.92	.16	.00**	.00**

[z] *,** significant at P=0.05 or P=0.01, respectively.
[y] Means and standard deviations (in parenthesis) for control and treatment groups based on totals of 22 and 20 students, respectively.

outcomes (Collis, 1992; Niemiec and Walburg, 1992). Question format had an influence on results, as percent improvement between pre- and posttest scores was much higher for the graphic response questions than for the multiple choice questions. Data in this study, as is true in other studies of this type, could be strengthened by increasing the number of students in control / treatment groups and by repeating the study over time with different student populations.

This software, upon completion, may be useful to universities that are trying to establish programs in landscape construction, and should also serve as a supplement to established programs. It may also prove useful to professionals in the landscaping industry both as an information resource and cost-effective method by which to train new employees.

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