A Woody Plant Identification Tutorial Improves Field Identification Skills

John R. Seiler,* Oana Popescu, and John A. Peterson

ABSTRACT

We tested a woody plant identification computer tutorial for its ability to improve field identification skills. If a specific field skill such as tree identification can be taught on the computer, students would have increased flexibility for studying, and the possibility of online computer courses for tree identification could be investigated. Our specific goal was to determine if knowledge gained from the computer tutorial transfers readily to the field environment, where it has its primary value. We also examined relationships among computer use time, grade point average, and grade earned in a woody plant identification course. Three different types of controlled experiments all indicated that use of the computer tutorial does improve field identification skills. One study found final grades increased from 75.9 to 80.8% for students who used the program. In a separate study in which students learned to identify trees only on a computer, field identification increased from 9.3% (before use) to 65.8% (after use). There were no correlations among class grade, grade point average (GPA), and computer use. Collectively, these results strongly suggest that students can learn field identification using a computer.

THE use of computer-enhanced instructional material is rapidly increasing in the classroom. Computer tutorials allow students to study in their own way and at their own pace. Computer tutorials exist for a wide range of skills, including the identification of weed seedlings, mycorrhizae and insects; the teaching of chemistry; and farm safety (Brooks and Brooks, 1996; Dodd and Rosendahl, 1996; Hall, 1996; Pomar and Hidalgo, 1998; Sheldon et al., 1994). Tutorials allow for easy tracking of student progress and can provide a detailed analysis of the learning accomplished (Kearsley, 1998). Although students generally feel good about using tutorials, little work has been done specifically testing whether knowledge gained on the computer transfers to where it is actually used. Several past studies have found that computer simulations used in combination with other types of conventional instruction resulted in more effective learning (Akpan and Andre, 1999; Brant et al., 1991). However, we were specifically interested in learning if a computer tutorial can teach a very specific field skill—woody plant identification.

Over the past several years, we have developed a rather large and comprehensive tutorial for the identification of woody plants. The first version, *Woody Plant ID* (Seiler et al., 1997a, 1997b), was published in collaboration with The Pennsylvania State University and the University of Georgia and covered 129 woody plants with approximately 2000 color photographs. A new version, *Woody Plants in North America* (Seiler et al., 2000), was published in the fall of 2000 and covers 470 woody plants with more than 9500 color photographs from across North America. Dr. Edward Jensen of Oregon State University joined in the development and writing of this much larger version.

We solicited a large amount of student feedback in the development of these products and are confident that students find them useful and easy to use (Seiler et al., 1997b). However, we were interested in knowing whether identification skills developed using the software were transferable to the field, where plant identification actually takes place. We were concerned that students might memorize pictures, but that little improvement in field identification would occur. If students could readily transfer woody plant identification skills to the field, then consideration could be given to developing online courses in plant identification.

This study presents the results from several experiments in which we examined the following questions:

1. Does knowledge gained from a computer tutorial transfer to the field environment where it is used?
2. Is there a correlation between the improvement in tree identification and time spent studying the woody species on the computer, and if so, how much time is needed for best results?
3. Is there any indication that the software is a more effective learning tool for specific groups of tree species [e.g., oaks (*Quercus*) vs. maples (*Acer*)]?

METHODS

The computer software is a comprehensive package for learning woody plant identification, and it provides students a tutorial in the vocabulary used to describe all woody plant parts. It contains full text descriptions, site requirements, interesting tidbits (e.g., human and wildlife uses) and range maps or range descriptions for all species. Multiple color pictures of the twigs, leaves, bark, fruit, and form are given so students can develop a feel for normal variation expected in plant parts. Key identifying features are often annotated. Perhaps most useful is the feature that allows students the ability to evaluate their own progress in identification with self-paced quizzes. A detailed description of the software can be found at www.cnr.vt.edu/dendro/wpina/index.html (verified 8 Apr. 2002).

Three separate studies were conducted to answer our research questions. In the first study, the student population enrolled in dendrology at Virginia Tech was divided systematically in half. Half were allowed to use the original program (*Woody Plant ID*) for a 2-wk period, after which their field scores were compared with those of a control group. The control group received a conventional indoor review session with an instructor and non-users (students who chose not to use the software). A few weeks later, the original control group was introduced to the program and allowed to use it for

Department of Forestry (0324), 228 Cheatham Hall, Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061. Received 18 Aug. 2001. *Corresponding author (jseiler@vt.edu).

Published in J. Nat. Resour. Life Sci. Educ. 31:12–15 (2002).
http://www.JNRLSE.org

a 2-wk period. The group that had first used the software then had the option of participating in a conventional review with an instructor and was not allowed access to the program. Field scores were again compared among the three groups. After the two controlled testing periods, all students were given access to the program for the remainder of the semester. This testing structure was designed so that all students, by the end of the semester, had equal access to the program. Since students were not required to use the program or come to the review, we ended up with only 10 users and 11 who came to an indoor review, but we had 81 non-users. To compare scores, the percentage change in exam scores was analyzed for the 2 wk before use and the two field exams after computer use. This percentage change was then compared among users of the program, non-users, and students receiving an indoor review with an instructor.

The following year, a second study was conducted in which we allowed access to the program (a developmental stage of *Woody Plants in North America*) to all students from the beginning of the class. The software was made available on computers located in the college's microcomputer lab, and we kept track of student use by requiring them to log in using their student identification numbers. The computers logged the amount of time the students were studying. Students were logged off after 3 min of inactivity. At the end of the semester, we used the computer use time data to divide the class into two groups—users and non-users of the program. To control for any differences between the groups, overall GPA before semester of enrollment was held constant between the groups by pairing up students with similar GPAs. For example, a *user* of the program with a 2.00 GPA was matched to a *non-user* who also had a 2.00 GPA. Student final grades were then compared between the groups. Regression analysis was also conducted that examined relationships among use of the program, overall GPA, and grade in the class.

In a final study, we utilized 19 freshman students who had not yet taken the tree identification course with the specific goal of determining the effectiveness of the computer tutorial at teaching field identification. All instruction was with the computer, and all testing was outdoors on actual specimens. Students were solicited for the study by offering them the opportunity to participate in a predendrology class. The students were taught woody plant identification using only the computer tutorial (*Woody Plants in North America*). The tested tree species were split into six groups of seven or eight species (Table 1), with a new group being introduced approximately every week. Each group of trees contained woody plant species that either belong to the same family or are similar and often confused by students. By grouping the species, we were able to examine the program's effectiveness in teaching particular groups of species.

All students in the final study were first given an outdoor pretest for each group of trees without any previous studying session to determine their base knowledge in tree identification. This was necessary, since some students, through 4-H or similar activities, know some tree species before entering our major. Over the course of the week, they could study the group of trees using the software as much as they wanted and could give themselves as many self-exams on the computer as they liked. Following the study period, students were given an outdoor posttest only on the trees learned the previous week. Care was taken during the pre- and posttesting periods not to give any visual clues or verbal hints on tree identification. For example, students were never told outdoors what the correct answers were. At the end of all weekly studies and test periods, a comprehensive study and overall final exam on all trees was given. The students were given 2 wk to review all the trees they learned using the tutorial.

Table 1. Tree species quizzed outdoors for each week of Experiment 3.

Week	Tree species taught
1	Red maple (*Acer rubrum* L.), sugar maple (*Acer saccharum* Marsh.), box elder (*Acer negundo* L.), Norway maple (*Acer platanoides* L.), silver maple (*Acer saccharinum* L.), green ash (*Fraxinus pennsylvanica* Marsh.), silky dogwood (*Cornus amomum* subsp. *amomum*), flowering dogwood (*Cornus florida* L.)
2	White oak (*Quercus alba* L.), black oak (*Quercus velutina* Lam.), pin oak (*Quercus palustris* Muenchh.), scarlet oak (*Quercus coccinea* Muenchh.), chestnut oak (*Quercus prinus* L.), bur oak (*Quercus macrocarpa* Michx.), northern red oak (*Quercus rubra* L.)
3	American beech (*Fagus grandifolia* Ehrh.), American sycamore (*Platanus occidentalis* L.), black cherry (*Prunus serotina* Ehrh.), sweet cherry [*Prunus avium* (L.) L.], blackgum (*Nyssa sylvatica* Marsh.), sassafras [*Sassafras albidum* (Nutt.) Nees], yellow poplar (*Liriodendron tulipifera* L.)
4	Black walnut (*Juglans nigra* L.), pignut hickory [*Carya glabra* (Mill.) Sweet], mockernut hickory [*Carya tomentosa* (Poir.) Nutt.], bitternut hickory [*Carya cordiformis* (Wangenh.) K. Koch], shagbark hickory [*Carya glabra* (Mill.) Sweet], sweet gum (*Liquidambar stiraciflua* L.), witchhazel (*Hamamelis virginiana* L.)
5	Pitch pine (*Pinus rigida* Mill.), Norway spruce [*Picea abies* (L.) Karst.], white spruce [*Picea glauca* (Moench) Voss], white fir [*Abies concolor* (Gord. & Glend.) Lindl. ex Hildebr.], white pine (*Pinus strobus* L.), balsam fir [*Abies balsamea* (L.) Mill.], Virginia pine (*Pinus virginiana* Mill.), eastern hemlock [*Tsuga canadensis* (L.) Carr.]
6	River birch (*Betula nigra* L.), white birch (*Betula papyrifera* Marsh.), gray birch (*Betula populifolia* Marsh.), black birch (*Betula lenta* L.), ironwood [*Ostrya virginiana* (Mill.) K. Koch], muscle wood (*Carpinus caroliniana* Walt.), black alder [*Alnus glutinosa* (L.) Moench]

We analyzed the percent improvement (difference between the pre- and posttest) in outdoor quiz grades using a paired *t* test. Regression analysis was used to examine the relationships among percent improvement, average use time per student, and GPA.

RESULTS AND DISCUSSION

In the first study (software available for a 2-wk period), we found that users improved their field scores 8.0% ($n = 10$), non-users improved 1.0% ($n = 81$) and those attending an indoor review session fell 0.9% ($n = 11$) (Fig. 1). These changes represent the percent change in quiz grades for the 2 wk before use compared with the 2 wk following use. Due to the large difference in sample sizes, we did not compare all three groups statistically; however, differences between the users and the indoor review group were significant ($p = 0.038$). It is interesting that, out of such a large class, so few students took advantage of either the software or indoor reviews.

In the second study, final course grades were compared between those students who used the program for at least 120 min and an equal number of students who never used the program over the course of the semester. Overall GPAs were held as constant as possible between the two groups by matching each user to a non-user with a similar GPA. In the end, we had 24 paired users and non-users with GPAs that averaged 2.39 and 2.42, respectively. Users of the software had an overall final grade in the course of 80.8%, compared with 75.9% for non-users. Among users, neither total use time, average time per visit, nor number of visits was correlated with class grade.

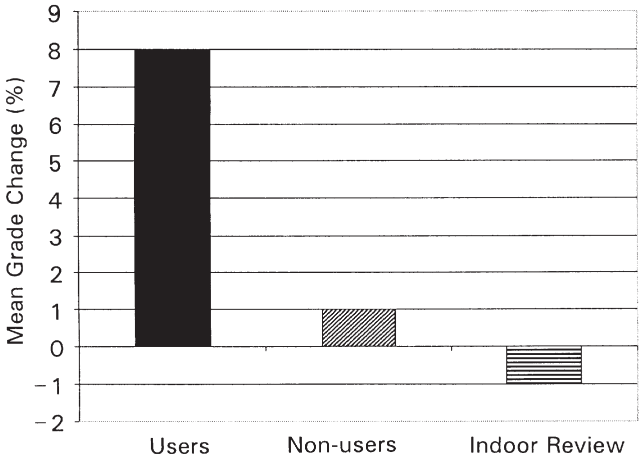

Fig. 1. Percentage change in quiz grades for the 2 wk before computer tutorial use compared with the 2 wk following use (students are routinely quizzed every week). Users (n = 10) had access to the program for a 2-wk period. Indoor review students (n = 11) received a *conventional* session with an instructor. Non-users (n = 81) chose to not participate in the study.

However, this does not suggest that computer use did not help students, since the average grade did increase nearly 5%. Students with a wide range of grades appeared to use the software equally; therefore, no correlations between computer use and class grade occurred. Potentially, a student who might have received a D in the course received a C-minus (a 5% increase), or a student who might have received a B received an A-minus by using the software.

It is likely that there is also considerable variation in individual students' ability to learn using the computer. Baxter (1995) found that on average, computer simulation was just as effective a learning tool as a real electrical circuit problem. However, in his study, individual student success varied considerably in that some students performed better with a computer simulation while others performed worse.

In the third study, we monitored computer study time each week before the outdoor test on a specific group of trees. Weekly study time on the computer varied between 3 and 122 min. Occasionally, a few students did not study but took the outdoor posttest. In these cases, the data were excluded from the analysis. In total, there were 74 pairs of pre- and posttest comparisons in which students studied with the software.

The data strongly suggest that students were able to learn outdoor tree identification by using only the computer (Table 2). On average, pretest scores were 9.3% and posttest scores were 65.8%. Overall average scores improved 57%, ranging from 0 to 100%. Trees in Group 6, which included species belonging to the *Betulaceae* family, were the easiest ones to learn, with an improvement of 77% and an average time studied of only 35 min. On the other end of the spectrum, trees in Group 2, containing oak species, appeared to be more difficult. The improvement was only 38% and the average study time was 40 min. We cannot conclude that the software was less effective at teaching oak species, since these trees are generally considered by students to be harder to differentiate.

We found no relationship between time spent studying and student GPA. This is not too surprising, since participation in the third experiment was voluntary and likely all students were more motivated to study. A significant relationship

Table 2. Average grade change and average study time spent using the Woody Plants in North America program for each week of Experiment 3. Nineteen students participated in the study but sample sizes varied each week due to individual students missing weeks.

Week	Pretest score	Posttest score	Grade change	Avg. time	Sample size
	%			min	
1	11	66	55	46	16
2	17	55	38	40	11
3	5	75	70	33	13
4	15	69	54	25	12
5	2.5	47.5	45	37	12
6	5.5	82.5	77	35	11
Overall avg. weighted by sample size	9.3	65.8	57	36	

was found between percent grade improvement and study time ($p = 0.0568$). However, this relationship was highly influenced by one student who studied on average nearly 90 min. When this student was removed from the analysis, the relationship became nonsignificant.

Since there was no correlation between class grade or GPA and computer use time, it is clear that no certain *type* of student is predisposed to using the software more than any other type of student. Students who do well in overall classes and in dendrology use the software, and some of these same types of students choose not to use the software. Similarly, some students with low GPAs used the software, while others did not. There was only a weak relationship between time spent studying and percent improvement, so it is impossible to suggest an optimum study time. Not surprisingly, the strongest relationships were between student GPA and performance.

All three of these very different studies suggest that use of the software does improve field identification skills. The first two studies, using students already enrolled in a tree identification course, showed that field scores improved from 5 to 7%. The third study, using students with little or no prior tree identification skills, demonstrated very clearly that working only on a computer resulted in dramatically improved field identification skills. This is somewhat similar to a study by Akpan and Andre (1999), which found prior use of a frog dissection simulator enhanced student performance on an actual frog dissection.

We are confident that students can learn tree identification using this software. In fact, we are now offering an online class for nontraditional students (i.e., biology teachers) in which learning and evaluation are performed entirely on a computer. Results in this class indicate that students are very successful at identifying previously unseen tree pictures online after using only the software. We have yet to be able to evaluate their field identification skills.

REFERENCES

Akpan, J.P., and T. Andre. 1999. The effect of a prior dissection simulation on middle school students' dissection performance and understanding of the anatomy and morphology of the frog. J. Sci. Educ. Technol. 8:107–121.

Baxter, G.P. 1995. Using computer simulations to access hands-on science learning. J. Sci. Educ. Technol. 4:21–27.

Brant, G., E. Hooper, and B. Sugrue. 1991. Which comes first, the simulation or the lecture? J. Educ. Computing Res. 7:469–481.

Brooks, H.B., and D.W. Brooks. 1996. The emerging role of CD-ROMs in teaching chemistry. J. Sci. Educ. Technol. 5:203–215.

Dodd. J.C., and S. Rosendahl. 1996. The BEG Expert System: A multimedia identification system for arbuscular mycorrhizal fungi. Mycorrhiza 6:275–278.

Hall, D. 1996. Multimedia in the entomology classroom. Am. Entomol. 42:92–98.

Kearsley, G. 1998. Educational technology: A critique. Educ. Technol. 38:47–51.

Pomar, J., and I. Hidalgo. 1998. An intelligent multimedia system for identification of weed seedlings. Comput. Electron. Agric. 19:249–264.

Seiler, J.R., J.A. Peterson, R. Croft, and C.D. Taylor. 1997a. Woody plant ID. Kendall/Hunt Publ. Co., Dubuque, IA.

Seiler, J.R., J.A. Peterson, and E.C. Jensen. 2000. Woody plants in North America. Kendall/ Hunt Publ. Co., Dubuque, IA.

Seiler, J.R., J.A. Peterson, C.D. Taylor, and P.P. Feret. 1997b. A computer-based multimedia instruction program for woody plant identification. J. Nat. Res. Life Sci. Educ. 26:129–131.

Sheldon, E.J., R.L. Tormoehlen, and W.E. Field. 1994. Comparison of CAI/multimedia and traditional instructional methods for teaching farm tractor and machinery safety certification programs. *In* Int. Winter Meeting, Am. Soc. of Agric. Eng., Atlanta, GA. 13–16 Dec. 1994. 94:3503–3522.