Computer, Video, and Rapid-Cycling Plant Projects in an Undergraduate Plant Breeding Course

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ABSTRACT

Affordable products of technological advances can offer fresh opportunities for designing appealing and effective undergraduate student projects. I designed projects involving videotape production, computer conferencing, microcomputer simulation, and rapid-cycling Brassica breeding for undergraduate plant breeding students in two course offerings in consecutive years. Students in both years perceived differences in effectiveness of the projects as learning experiences. The 1990 class rated the video production project as the most effective, and the computer conferencing project as the least effective. In contrast, the differences in student evaluation of the projects in 1991 were expressed more in the degree of divergence in student ratings of a project rather than in the mean rating itself. Students in 1991 most uniformly rated the computer conferencing and rapid-cycling Brassica projects, but split their opinions regarding the effectiveness of the video production and computer simulation projects. Linking two projects, as was done with the computer conferencing and video projects in 1991, improved the ratings of the weaker project. In my opinion, using new technologies in projects motivates students by appealing to their curiosity and creativity. Incorporating new technologies in coursework also exposes students to communication and research tools that may be important in their careers.

PRODUCTS of technological advances can offer fresh opportunities for designing appealing and effective undergraduate projects. Examples of new and affordable products that can be applied to teaching include personal computers with increased processing speed and mass storage, enhanced computer networks, video production equipment, and rapid-cycling Brassica species. I designed a series of projects to supplement or reinforce specific topics introduced in plant breeding lectures and to give students hands-on experience with new communication and research technologies. The disciplinary content of the projects included crossing methods, societal issues involving plant breeding, recurrent selection methods, and heritability estimation. Students acquired this disciplinary knowledge by producing videos, debating in computer conferences, conducting computer simulations, and manipulating rapid-cycling Brassica populations. The computer simulation and rapid-cycling Brassica projects emphasized individualized experiential learning (Lewin, 1951; Kolb, 1984; Bawden, 1985) where the students conducted structured experiments with no predetermined outcome. Others previously developed and used undergraduate student projects involving computer simulation of animal (DeRouen et al., 1989) and plant breeding (St. Martin and Skavaril, 1984) and I previously reported heritability estimation in the classroom using rapid-cycling Brassica (Michaels, 1990). The computer conferencing and video production projects stressed cooperative group learning and communication skills; the group’s task was to logically explain a process or defend an argument. The computer conferencing project followed the precepts of a structured writing assignment (Parrish et al., 1985) in a writing-to-learn context. The video production project emphasized development of reasoning (Eversole, 1990) rather than improvement of oral presentation skills (Cox and Martin, 1989).

The objective of this study was to determine whether students perceived differences in the effectiveness of the four projects.

MATERIALS AND METHODS

Students in two consecutive undergraduate plant breeding course offerings (winter semesters of 1990 and 1991) conducted four projects. The students were in their third or fourth year of a biological or agricultural science degree program. The course format was traditional, with three, 1-h lectures and one, 2-h laboratory each week of a 12-wk semester.

Computer Conferencing Projects. TCoSy (Teaching Conference System, Univ. of Guelph, Guelph, ON N1G 2W1), an on-campus, teaching-oriented computer conferencing system resident on a central campus computer, served as the forum for a set of student debates. Students accessed TCoSy from departmental and library microcomputer terminals, and from personal computers via modem. Due to the high number of potential workstations and 24-h access to TCoSy, the students could work on this project independently and at any time of day or night. The debate topics focused on issues currently at the interface between plant breeding and society. Examples of resolutions that were debated include: ownership of plant breeding subsidiaries by multinational chemical companies should be prohibited; public sector breeding project proposals to develop herbicide-resistant plant varieties should not be funded; cultivar registration in Canada should be abolished; and breeders in public institutions should focus on development of cultivars explicitly suited for sustainable agricultural systems. The students formed groups of four (two affirmative and two negative) based on debate topic choice. Each student submitted a four-screen (approximately two double-spaced typewritten pages) constructive argument presenting his or her side of the debate topic, directed two questions to each member of the opposition, and responded to the four questions posed by the opposition. I set deadlines for submission to the conference of the constructive ar-

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arguments, questions and responses, and allowed a total of 5 wk to complete the project.

**Video Production Project.** The students formed groups of four and scripted, shot, and edited a VHS-format video approximately 15 min long. They shot the video using a VHS-format portable camcorder and edited their program using a pair of Panasonic (Panasonic Industrial Co., Secaucus, NJ) AG-1950 VHS-format video cassette recorders linked by a Panasonic AG-A95 editing controller. In 1990, the students produced videotapes that described floral morphology and crossing methods for tobacco (*Nicotiana tabacum* L.), canola (*Brassica napus* and *B. campestris* L.), soybean (*Glycine max* (L.) Merr.), strawberry (*Fragaria Xanassa* Duch.), barley (*Hordeum vulgare* L.), and tomato (*Lycopersicon esculentum* Mill.). In 1991, the students remained in the groups they formed for the computer conferencing debate project. The debaters produced a video presenting both sides of their topic through on-screen monologs, graphics, and interviews with experts and peers. The whole class viewed these videos during subsequent lecture and laboratory periods. I allowed the students 4 wk to complete the project.

**Computer Simulation Project.** The students received copies of Gregor, a genetic computer simulation program developed by Nicholas A. Tinker (Dep. of Plant Science, McGill Univ., Macdonald Campus, PQ H9X 1X0) and simulated population improvement of an outcrossing diploid plant species. The Gregor software required an IBM PC-compatible computer with at least 256K RAM. Each student constructed a 100-member heterozygous and heterogeneous source population of an imaginary species with 10 linkage groups where 30 loci controlled the target quantitative trait. The students then guided their populations through five cycles of mass and $1$ recurrent selection and monitored the changes in genotypic and phenotypic mean and variance from cycle to cycle for each selection method. The exercise climaxed when the students extracted inbreds from their best $C_5$ population and created hybrids. I allowed the students 3 wk to complete the project.

**Rapid-Cycling Brassica Project.** The students grew two generations of rapid-cycling *Brassica rapa* L. plants (Wiliams and Hill, 1986) and measured morphologic characteristics at flowering. They then regressed offspring values on parent values to determine narrow sense heritability. They then regressed offspring values on parent values to determine narrow sense heritability. The structure of this semester-long project was previously reported (Michaels, 1990).

**Student Responses.** In both years the students were asked to evaluate three aspects of each project: the potential of the technology underlying the project, the concept and planning of the project, and the overall effectiveness of the project as a learning experience. Each student applied his or her own definition of effectiveness when evaluating the projects. The students recorded their evaluations in an end-of-semester survey using a scale of 1 (very good) to 5 (very poor).

**Statistical Analysis.** The student evaluation data were first summarized into separate two-way (r × c) contingency tables (Steel and Torrie, 1960) for each project where the classification variables were year (r = 2) and student evaluation scale (c = 5). Counts for each year × scale combination were summed over the three aspects (technology, planning, and overall effectiveness) evaluated for each project. Chi-square analysis was then used to test for independence, that is, to test whether the frequency of student responses in each scale was the same from year to year. Additional two-way contingency tables, where the classification variables were project (r = 4) and evaluation scale (c = 5) summed over aspects, and where the classification variables were aspect (r = 3) and student evaluation scale (c = 5) for each project, were constructed for each year. Independence of the student responses for each project and for each aspect were tested using ch-square analysis.

**RESULTS AND DISCUSSION**

The 1990 class was composed of 19 students, 18 of whom were enrolled in the crop science major. In 1991, the class size was 36 and represented a more diverse background: 17 students from crop science, 7 from horticultural science, and 12 from other biological sciences.

The chi-square test of independence for year × evaluation scale was significant (p ranged from <0.0001 to <0.013) for each project, indicating that the classes differed in their evaluation of the projects. The 1990 class on average evaluated each project more favorably (numerically lower) than the 1991 class (Table 1). The standard deviation for each project confirms that the frequency distribution of student responses was tighter in 1990, whereas students differed more in their opinions in 1991. The 1990 class seemed more cohesive than the 1991 class, perhaps because of its smaller size or from friendships established in previous common courses. This cohesion may have led to their consistency of evaluation.

The chi-square test of independence for aspect × evaluation scale for each project in each year was not significant. Students did not appear to rate the technology, planning, and overall effectiveness of a project differently.

The chi-square test of independence for project × evaluation scale was highly significant (p < 0.0001) for each year, indicating that students perceived differences in effectiveness among the projects. The 1990 class rated the video production project on average as the most effective; 91% of the students rated its effectiveness as 1 or 2 (very good or good) and only 5% rated it as 4 or 5 (poor or very poor). The computer conferencing project

![Table 1. Mean and standard deviation of student evaluation scores for four projects in an undergraduate plant breeding course. Scores for technology, planning, and overall effectiveness were combined.](image-url)
was rated as poorest on average, but with the greatest split in student opinion, as indicated by the highest standard deviation. Although 67% of the students rated the conferencing project as 1 or 2, 11% rated it in the poorest two scales. The 1991 class evaluated the effectiveness of the computer conferencing project as approximately equal to the other projects on average. This was surprising given its poorer evaluation by the 1990 class. The higher rating of the conferencing project in 1991 may be due to the linkage of topics and maintenance of groups between the conferencing and video projects.

The standard deviations suggest that the differences in student evaluations of the projects in 1991 were expressed more in the degree of divergence in student opinion about a project rather than in the mean itself. For instance, the 1991 students rated both the simulation and rapid-cycling Brassica projects, on average, as very near 3. However, only 26% of the students actually rated the effectiveness of the simulation project as 3; 39% rated the project better and 22% rated it poorer. In contrast, 46% of the students rated the rapid-cycling Brassica project as 3, while 32% rated it better and 22% rated it poorer.

The 1990 results provide some evidence that projects stressing cooperative learning in groups (video production and computer conferencing) were slightly preferable to projects organized to promote individualized experiential learning. No such relationship occurred in 1991. Buhr and Knauft (1984) found that students were almost equally split in their opinion regarding experiential learning projects with unknown outcome.

Students in 1991 reported anxiety about completing the projects in the time allotted. When the students were asked in their end-of-course survey how many hours they spent on the course each week, 58% of the 1991 students responded that they devoted 8 or more hours (3 or more hours outside of normal class meetings), whereas only 23% of the 1990 students devoted 8 or more hours. This difference in time commitment may have been the result of a larger number of students in the 1991 class who were from other biological science backgrounds; were unfamiliar with cropping systems, species, and problems that could be addressed through genetic improvement; and who needed additional time to understand these relationships. This difference may also be due to a more challenging video project in 1991, or simply the result of two different student samples. These responses suggest that I overloaded the students with too many projects in addition to the lectures, weekly or bi-weekly quizzes, and other laboratories that I also expected them to complete in the course.

Students in these two classes clearly favored the video project. This project continues to be mentioned years later when I see former students. Prospective students ask if they will also be allowed to produce a video. One improvement to the project that would reduce the students' time commitment without loss of learning would be to eliminate or reduce the editing component and challenge the students to organize their production so thoroughly that they can edit in the camera (one take). Students in my 1992 Economic Botany course offering highly rated this type of no-edit video project (data not shown).

I believe that linking two projects, as was done with the computer conferencing and video projects in 1991, improved the ratings of the weaker project. The computer conferencing project, which relied heavily on writing skills, was cited as much more effective in the year when it was linked with the video production project than when it stood alone. Communication skills and awareness of issues beyond the technical aspects have been cited by employers as a general weakness of our graduates. I found that this linkage between the computer conferencing and video projects allowed students to exercise their written and oral communication skills, and to explore social issues more thoroughly than might normally occur in an agricultural science course.

An instructor who is considering using the products of technological advances in developing new projects for the classroom will likely wonder whether the technology will actually make the project a better learning experience, or whether it is merely a gimmick. I believe that it is both. First, it is gimmicky, but not in an entirely pejorative sense. Many students and instructors share a fascination with new technology. New technology can initially capture a student's attention. A well-designed project using that technology may have a greater chance of reaching the student than a conventional approach to learning to which the student may be somewhat numb. Second, the new technology encourages students to approach projects with a clean slate. They may have developed a pattern for their approach to a term paper, laboratory report, or class presentation. Asking students to produce a video, for instance, appeals to their curiosity and renews their creativity. It is a fresh experience, one to which they have no patterned approach. Third, some of these technologies may be important communication and research tools in their careers. Exposure now may help graduates quickly adopt and apply these and other new tools in the future.

REFERENCES


