Developing an Interactive Multimedia Computer Program for Learning Agronomic Principles

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Abstract

A Computer Interactive Multimedia Program for Learning Enhancement (CIMPLE) was developed to enhance student learning in an introductory agronomy course (Agron 114) at Iowa State University. The program was designed to improve learning tools for off-campus students in the distance version of the course. The CIMPLE program includes learner objectives, subject matter relevance, digitized tutorial video, key concepts of material to be learned, practice learning exercises, sub-unit and chapter self-diagnostic quizzes, and problem-solving scenarios including technical and environmental/ethical problems. During fall semester 2002, CIMPLE was incorporated into the teaching, learning, and assessment processes of the introductory course for resident students. At the end of the semester course, 104 students completed a survey designed to record student use and satisfaction with CIMPLE. Students used five of CIMPLE's eight components on over half of the course's 13 chapters. In response to the statement, "CIMPLE has increased your learning of course material," 93% of the students stated that they either strongly agreed or agreed. During fall semester 2003, CIMPLE was used to teach a distance version of the course to eight students in seven different states and one other country. All six distance students who completed the survey indicated that they liked CIMPLE, found the program easy to use and that CIMPLE helped them learn course material. The practice learning activities, self-assessment, video and practice problem-solving were the components most useful and helpful to distance students. CIMPLE was successfully incorporated into the traditional on campus course, was used to create a distance version of the course and is considered valuable tools for learning to both resident and distance students.

Introduction

At Iowa State University, Principles in Agronomy is an introductory course that serves as a foundation course for undergraduate students in several agriculture-related majors, including Agronomy, Horticulture, Animal Science, Ag Business, and Ag Education. Generally 300 students annually enroll in this three-credit 16-week Agronomy course (Agron 114). The primary focus of the course is to introduce material that will help students understand the science and strategies underlying crop production and soil management. The course covers a variety of subjects, including plant anatomy, plant classification and identification, plant physiology, climate, soil and soil water, tillage, plant breeding, seed/grain quality, weed, insect and disease management, and crop harvesting and storage. Educational institutions worldwide generally include a similar course as part of their undergraduate agriculture curricula.

Students use different learning styles in their learning process (Kolb, 1981, 1984). In an effort to meet the needs of students with different learning styles, Agron 114 instructors have used a combination of hands-on laboratory materials, video, live plants, greenhouse experiments, class discussions, and demonstrations to teach the subject matter. Despite the combination of material available, some students had trouble grasping certain aspects of the course material as it was presented. For example, students that have had little experience in agriculture have found the course particularly challenging. Over the years, student feedback indicated that they would benefit from more visualization of course material, the use of methods by which they can review material and test themselves, and more individual access to various learning activities and remedial programs.

The use of computer technology to assist students in the learning process is pervasive in higher education. While much attention has been placed on Web-based instruction, the use of computer-based tutorial systems has been shown to effectively help students learn in a natural resource related course (Seiler et al., 2002). In agriculture, computer technology has been used in a broad range of areas, including teaching sustainable agriculture concepts, understanding cropping systems, and developing critical thinking (Graves et al., 2002; Lippert et al., 1998; Tan et al., 2001). Research shows that the use of computer technology, coupled with face-to-face interaction with instructors, results in more student learning than either face-to-face or computer-only instruction (Chadwick, 1999).

Today people that have an interest in pursuing additional education beyond high school or college often do not live near an educational institution or may have work or time conflicts. Some employers

offer incentives or require employees to take continuing education courses, however, they may not have time or be located near an educational institution in order to enroll in on-campus courses. Distance education can provide opportunities for "non-traditional" students to pursue continuing education courses.

The objective of this project was to incorporate information technology into Agron 114 with the overall goal of providing better self-learning tools for traditional (residence) and non-traditional (distance) students. Specifically, an interactive multi-media computer program would be developed that would inspire critical thinking and enhance student understanding and learning of basic agronomic principles, while at the same time giving students complete access to all course material and control over their learning process.

Materials and Methods

Iowa State University (ISU) provided the initial funding for the design and construction of a prototype program for the first two chapters of the textbook used in Agron 114. The Agron 114 course text (Mullen, 2003) consists of 13 chapters of material, including 1) crop plant anatomy, 2) crop plant classification and identification, 3) crop physiology, 4) climate, 5) soils, 6) soil water, 7) tillage and seeding, 8) plant breeding, 9) seed and grain quality, 10) weed management, 11) insect management, 12) crop disease management, and 13) crop harvesting and storage. Developing the interactive computer program involved three stages: 1) designing the prototype program, 2) development and production, and 3) implementation and analysis. After establishing a design team consisting of a graphic artist, an instructional design expert, a computer programming author, and the course instructor, the team discussed the layout of the program, such as what components would be included and how the material would be presented.

Designing the Prototype Program

The course instructor and three assistants took approximately 24 months to complete a prototype for the computer and multimedia enhanced learning modules for the first two chapters of course material. The program layout included the following components: objectives, relevance of the material, digitized video tutoring of subject matter, key concepts of material to be learned, practice learning exercises, sub-unit and chapter self-diagnostic learning quizzes, and problem-solving scenarios including technical and ethical/environmental problems. As the design team proceeded, they frequently sought informal input from students on the organization and learning activities of the evolving computer program. JavaScript language and Authorware 5.2 by Macromedia were the software programs used to develop the computer program.

During fall semester 1999, students in Agron 114 were asked to use the prototype computer program for the first two chapters of the course, and then asked to complete a survey. The survey included questions regarding the program's function, organization and usefulness. Over half of the students indicated that the computer program was useful and enhanced their learning of the course material. As a result, additional funds were sought from outside sources for the continued development of the remaining 11 chapters of the computer program. Funds to complete the remaining 11 chapters were received three years later. Each chapter was presented in a similar manner to ensure continuity. The computer program was named CIMPLE (Computer Interactive Multimedia Program for Learning Enhancement).

Development and Production

Computer program components for each chapter were developed in a sequential manner, in order to be used in conjunction with classroom and text-based learning. This process involved identifying and developing educational text for each chapter, designing interactive learning activities, writing diagnostic self-assessment questions over the material, and developing problem-solving scenarios including technical and ethical/environmental problems. The components were designed to engage students in active learning tasks, diagnose learning progress, provide remedial study, and provide exploratory learning including problem solving. The instructional videotapes that were traditionally used in the course were digitized and incorporated within the computer-based program.

Three computer specialists who supported the Agronomy Department's Distance Masters' Program provided leadership and expertise for the project. As chapter material was completed, the material was given to the Distance Masters staff for programming. Distance Lab assistants and a Multimedia Coordinator at the ISU Instructional Technology Center developed chapter icons, interactive learning activities and other graphic material for the program. Distance Lab assistants combined the video, graphics, text and interactive practice exercises into one program. As each chapter was completed, a post-doctorate student, the course laboratory coordinator and graduate teaching assistants reviewed all of the components of the program to identify areas of revision, problems of function and to ensure the content material was presented clearly and accurately. Due to the amount of content and size of the CIMPLE program, reviewing required several hours of time, and took place over twelve-month period of 2002.

Implementation and Analysis

An ISU student-based computer fee fund was used to purchase twenty-six new Dell Optiplex

GX240 desktop computers for the ISU Crops Learning Center. CIMPLE was installed onto the computers, and the computer program was fully integrated as part of the Agron 114 course during spring semester 2003. Students were asked to report any problems in the content or function of the program. At the end of the course semester, students were asked to complete a survey on a computer. The survey asked students information regarding their demographic information, how often they used the computer program, which CIMPLE components they used, and their impression of the usefulness and educational value of the computer program. All students remained anonymous. After each student completed the survey, the responses were automatically downloaded into a spreadsheet. One hundred five of the 143 students (74%) enrolled in the course completed the survey. Numerical data were calculated and analyzed as percentages.

During fall 2003, CIMPLE and the course text were used to teach Agron 114 via distance. At the end of the semester, students were emailed a survey asking which CIMPLE components they used, and their impression of the usefulness and educational value of the computer program. Six of the eight students enrolled in the distance course completed the survey. Data were calculated and analyzed as percentages.

Results and Discussion

The program, CIMPLE

CIMPLE was developed over a period of eight years. The ISU Agronomy Department provided $10,000 in funding to create a prototype of the first two text chapters. The design team took three years to complete a prototype of CIMPLE, which included the following activities: designing the layout, collecting information, digitizing the chapter video, developing practice exercises and self-assessment tools, and editing and reviewing the final program. The original video footage for each of the 13 course chapter topics was recorded and edited in VHS format in the early 1980s. From beginning to end, the 115 hours of VHS footage took two people five years working part-time and $110,000 in grant funding to complete.

In 2001, after three years of searching for additional funding, $104,000 in grant money was received to complete the CIMPLE modules of the remaining 11 chapters. Over a period of two years, a post-doctorate worked full time, with part time assistance from the course instructor and lab coordinator, to develop, edit and complete the 11 modules. An ISU student-based computer fee fund consisting of $45,000 was used to purchase twenty-six new Dell Optiplex GX240 desktop computers for the ISU Crops Learning Center, the lab in which students use CIMPLE.

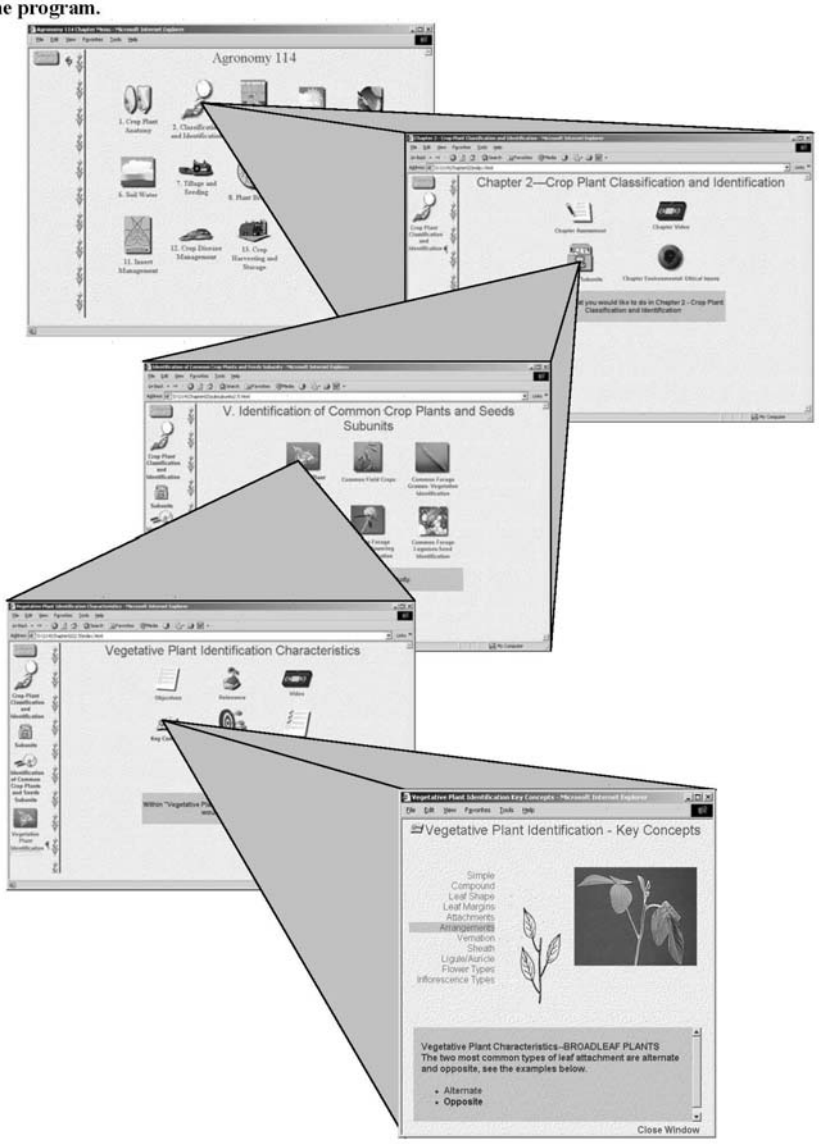
For each of the 13 chapters, learner objectives, relevance of the material, digitized video tutoring of subject matter, key concepts of material to be learned, practice learning exercises, sub-unit and chapter self diagnostic learning quizzes, and problem-solving scenarios including technical and ethical/ environmental problems were developed (Table 1).

Table 1. Description of the components of CIMPLE.

Component Name	Description
Chapter Assessment	Extensive set of T/F questions for students to assess their overall knowledge of chapter material. After completion, students receive results of the number of correct and incorrect answers categorized by subunit so students may see which areas they may need to review.
Video	20-30 minute digitized video that covers chapter material. For example, depending on the chapter, the video may include dissections of plants, demonstrate planting or breeding methods, or exhibit different tillage equipment and show the results of the implement's use.
Key Concepts	All key-concept units include several images, photographs, text and diagrams that provide in-depth information on key topics of each subunit of a chapter.
Practice	Interactive questions and diagrams for students to test their knowledge of key issues of each subunit of a chapter. For example, activities include matching images of plants, insects or equipment with the correct names, and labeling plant parts.
Self-Check	3-5 multiple-choice questions from subunit material to help students assess their knowledge.
Practice Problem-solving	Asks students to apply chapter material to solve a practical problem that is presented
Environmental & Ethical Issues	Presents a current day environmental or ethical issue relating to the chapter that people encounter in everyday life and asks students to consider information on both sides of the issue, develop an argument for one side of the issue, write a response and be prepared to discuss the issue in class.

A brief description of CIMPLE follows. After the student logs onto the computer, the screen presents 13 icons representing each chapter topic along with the chapter title (Figure 1). After selecting a chapter icon, the proceeding screen presents four major icons for 1) chapter assessment, 2) chapter video, 3) chapter subunits, and 4) chapter environmental/ ethical issues. Chapter assessment provides a number of true/false questions that allow students to assess their knowledge of material over the entire chapter. Chapter video provides visual footage of educational material related to the chapter topic. Chapter subunits refer to short sections of material within a chapter. Upon entering a subunit section, the screen presents students with the following chapter subunit options: 1) objectives, 2) relevance, 3) video, 4) key concepts, 5) practice, 6) self-check, and 7) practice problem-solving. The fourth major icon, environmental/ethical issues, presents a current issue or scenario in agriculture that people encounter. Students are asked to consider information on both sides of the issue and develop an

Figure 1. Example of CIMPLE depicting screen shots as a person would navigate through the program.



argument for one side of the issue, submit a one page paper presenting their reasoning and be prepared to discuss the issue in class.

The combination of materials in the Crops Learning Center, including CIMPLE, allows students access to all course information and learning tools, and students can proceed at a self-determined rate. After reviewing material, students can assess their mastery of material by taking the subunit multiple-choice quiz or the chapter self-assessment T/F questions. In both cases, CIMPLE presents student scores immediately after the assessment is completed. At the end of the chapter self-assessment, students are provided information on which questions were missed or correct, and the corresponding subunit, so students know which subunit of a chapter may need additional study.

CIMPLE Incorporated into a Residence Class

The Agron 114 course covers 13 textbook chapters, with one chapter being covered per week. The Crops Learning Center houses the 26 computers that were purchased specifically for students to use CIMPLE. The traditional education materials that have been used in the course to teach the subject matter, such as hands-on lab materials, live plants, greenhouse experiments, and class discussions, continue to be used. With the exception of class discussion, the computers and all other learning tools mentioned above are located in the learning center for the course, which is open to students and staffed by course instructors or graduate teaching assistants 35 hours per week. During the open hours, students are required to pass a weekly multiple-choice test over the week's chapter material. In this course structure, students have access to all learning materials, and control the frequency with which they use certain learning tools.

Of the 143 students enrolled in the introductory agronomy class during spring 2003, the 104 students who completed the survey came from a variety of majors: 20 (19%) agronomy, 9 (9%) animal science, 24 (23%) general agriculture studies, 27 (26%) agriculture business/education, and 25 (24%) other. Fifty-one (49%) of the students were freshmen, 27 (27%) were sophomores, and 26 (25%) were juniors or seniors. Sixty-four percent (n = 70) were raised on

Table 2. Student survey responses to the question, "How many times have you used each learning component of CIMPLE?"

Name of CIMPLE Component	Average Number of Times Used Per Student Per Semester*
Chapter Assessment	7.1
Video	8.2
Key Concepts	9.0
Practice	10.2
Self-Check	10.0
Practice Problem-solving	1.7
Environmental & Ethical Issues	2.3
Composite Total	48.8

* One hundred five of the 143 students (74%) enrolled in the course completed the survey.

a farm and had extensive field and farm-work experience, 17% (n = 18) were raised on a farm and had little field and farm-work experience, and the remaining 19% (n = 16) were not raised on a farm but had some field or farm-work experience. Over the semester, all of the 104 students used CIMPLE.

According to survey results, students used the practice and self-check components most frequently (Table 2), with five components used on over half of the course chapters. Students preferred immediate subunit assessment to the chapter assessment. Some students indicated that using the practice exercises was a non-threatening way to check their knowledge of the key concepts. In response to the statement, "CIMPLE has increased your learning of course material," 93% of the students that completed the survey stated that they either strongly agreed or agreed (Table 3). The students appreciated managing their access and control over course materials rather than having limited access to material through an instructor. On the survey, students were asked the following question, "Consider technology that you and/or your instructors (high school or college) have used in the classroom. How does CIMPLE compare to other technology that has been used to help you learn in other courses?" Eighty-nine percent of the students that responded stated that CIMPLE was above average or far above average (Table 4).

Table 3. Student survey response to the statement, "CIMPLE has increased your learning of course material."

Response	Students that responded (number)	Students that responded (percent)
Strongly agree	49	47
Agree	49	47
Neutral	6	7
Disagree	0	0
Strongly disagree	0	0
Total students that responded	104	100

Table 4. Student survey responses to the question, "Consider technology that you and/or your instructors (high school or college) have used in the classroom. How does CIMPLE compare to other technology that has been used to help you learn in other courses?"

Response	Students that responded (number)	Students that responded (percent)
Far above average (among the top 10%)	47	45
Above average (among the next 20%)	46	44
Average (among the middle 40%)	9	9
Below average (among the next 20%)	1	1
Far below average (among the lowest 10%)	0	0
Have not used or been exposed to technology in the classroom before this class	1	1
Total students that responded	104	100

CIMPLE Incorporated into a Distance Course

During fall 2003, the Agron 114 course was offered via distance to nine students in different states and countries. Students received the text, course syllabus and assignments and were given access to CIMPLE. Weekly assignments consisted of two-to-three hands-on activities to enhance student learning of chapter material. To encourage students to work on the course on a regular basis, students were asked to complete the chapter assessment for each week and either fax or email their results to the course instructor. Students accessed course PowerPoint presentations on the course website. The presentations displayed real world questions that ask students to apply information learned in the course to solve actual problems. To ask questions, students could contact the instructor via e-mail or by telephone. Over the course semester, three exams were mailed to a designated exam proctor. The proctor mailed the completed student exams and assignments to the instructor in a postage paid envelope that the proctor received with the exam.

Of the eight students who finished the course via distance, six completed an end of the semester short answer course evaluation. When asked "How do you like the CD computer program, CIMPLE?", all of the respondents indicated they liked the program, with words expressed as, "awesome," "great" and "very much." The practice, self-assessment, video, and practice problem-solving were mentioned as being the components of CIMPLE that students thought most useful and helpful. No respondents said they had any difficulty using CIMPLE. In response to the question, "How important is this course offering by distance technology in meeting your personal and professional goals in your career?", all respondents said the course was "very important."

Summary

An interactive multimedia computer program, CIMPLE, was developed to enhance student learning of the fundamental principles of agronomy. Students seemed to embrace the computer technology as an important tool for learning. The program allows students to combine a variety of learning tools and proceed through the material at a self-determined pace. Information presented should aid in students ability to apply learned material to real agronomic challenges. CIMPLE was successfully incorporated into the on-campus and distance Agron 114 course, thereby allowing the Agronomy Department to offer a technology enhanced learning environment for resident students in Agron 114 and a constructive and engaging agriculture course to distance students. We are currently investigating how students use the program, for example which components students use and in which sequence to

learn chapter material, and if this may be related to the student's learning style using Kolb's Learning Style Inventory.

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An abstract for submission should consist of original and completed work. The purpose of an abstract is to communicate to readers in restricted length significant contributions of a study for evaluation purposes. Since an abstract becomes a part of the permanent scientific literature, clearly stated, simple sentences with exact wording must be used to ensure clarity and brevity (maximum of 2,500 keystrokes). The quality of an abstract for presentation is a direct reflection on the image of the author(s), and the North American Colleges and Teachers of Agriculture (NACTA). The author submitting the abstract is responsible for its quality and content.

An abstract should include the following:

1. Objectives of the study concisely stated at the beginning of the abstract
2. Pertinent experimental conditions (if applicable) included to give an indication of the scope of the study
3. Results compiled, condensed, and presented with great care
4. Summary clearly stated

Authors are asked to submit their abstracts electronically, via e-mail as an attachment using MS Word or Word Perfect programs to Dr. Shah Rahnema (330) 264-3911, ext. 1262 (rahnema.1@osu.edu). Also, Dr. Rahnema can provide typing instructions for abstracts. The deadline for submission of abstracts is March 31, 2005. The author submitting the abstract will be notified of its receipt within 48hours of its submission.