

COMPUTER SUPPORT FOR TEACHING LARGE-ENROLLMENT COURSES

William H. Dodrill
West Virginia University

Computing systems are particularly useful for teaching support of large-enrollment courses where essentially the same material is covered during successive course offerings. Described herein are the computer capabilities developed and used for teaching introductory computer science courses at West Virginia University. Capabilities include examination question data base creation and maintenance, automated examination preparation and grading, and student records handling.

HISTORY

Just a few years ago, introductory computer science courses at West Virginia University were taught in relatively small sections by graduate students. Now, with increasing demand and greater emphasis on instructional quality, much larger sections are taught by experienced faculty members. It is currently quite common to offer several sections of the same course during each academic semester, and to have enrollments of well over 100 students in each section. This has required extensive changes in teaching methods with heavy reliance on computing systems for instructional support.

DIFFICULTIES

One of the first difficulties encountered as sections became larger was the grading of examinations. It was not uncommon for an instructor to devote many hours over several days exclusively to grading a single examination. The approach taken in solving this problem was to give multiple-choice examinations with machine grading.

Yet another difficulty arose when multiple-choice examinations were used, and this is that the preparation of multiple-choice questions is much more demanding than the preparation of conventional ones. To be effective, each multiple-choice question must be free of all ambiguities, must anticipate the individual traits of each and every student that will respond to the question,

and must provide a reliable means of evaluating student capabilities. No matter how competent the person preparing examination questions is and how diligently that person applies him or herself, it is practically impossible to generate really good examination questions consistently. The obvious approach to this problem was to rely heavily on questions which have proven to be of good quality through use on previous examinations. Accordingly, a computerized data base of examination questions was created and used for examination preparation. In preparing each examination, questions are drawn from this data base with only a few new questions being prepared and added. Questions found to be inadequate are modified or eliminated.

A disadvantage in using questions from previous examinations is that some students have access to previous examinations while others do not. This was overcome by making copies of the examination question data base available to all students. Each student, therefore, has the same access to questions which have appeared on previous examinations as does all other students. If a student learns to work all of the problems which have appeared on previous examinations, then that student will achieve superior grades.

Added to the difficulties associated with preparing and grading examinations are the problems encountered in maintaining records for larger numbers of students. Tedious arithmetic operations are required to compute statistical values such as student averages and class standings. Procedures are needed for detecting and removing inaccuracies in student data, and methods must be available for accessing, listing, reviewing, and updating the data. Computers provide an excellent means for this type of processing.

COMPUTING SYSTEM OVERVIEW

The instructional support system which is currently in use is implemented on a

Permission to copy without fee all or part of this material is granted provided that the copies are not made or distributed for direct commercial advantage, the ACM copyright notice and the title of the publication and its date appear, and notice is given that copying is by permission of the Association for Computing Machinery. To copy otherwise, or to republish, requires a fee and/or specific permission.



PDP-11/34. It is written in C and runs under the UNIX operating system. A previous version was implemented for and is fully operational on an Intel 8080 based microprocessor with floppy disks, CRT terminal, printer, and mark sense forms reader. The microprocessor-based system is written partially in CBASIC and partially in assembly language, and it runs under CP/M. Portions of the system have been implemented on other available computers which include an Amdahl V7A and a Vax 780.

SYSTEM OVERVIEW

A conceptual overview of the system logic is presented in the following subsections. Descriptive headings are used to identify primary features. Again, system capabilities include examination question data base creation and maintenance, automated examination preparation and grading, and student records handling.

STUDENT DATA FILE

Early during each course offering, each student prepares as a key punching exercise a data card for creating a record of the student data file. After collecting and checking the keypunched student data cards, they are processed to create the file. Records of the student data file include fixed data for each student (ID, name, course, etc.) as well as blank fields for grades to be accumulated during the course offering. Individual records are identified by student identification numbers assigned for the course rather than by university student identification or social security numbers. This provides a means of posting grades without violating confidentiality restrictions.

EXAMINATION QUESTION DATA BASE

The examination question data base was created by extracting questions from several years accumulation of examinations. Maintenance and update of the data base is part of the examination preparation and administering procedure. Each entry consists of a single question, and each question may include any number of parts. Questions are identified for retrieval according to category and individual question within a category. Assigned categories are:

- Programming Concepts
- Language Syntax
- Introductory Programming
- Controlled Flow
- Character Strings
- Arrays and Array Manipulation
- Controlled Input/Output
- Subprograms
- Computing System Concepts

EXAMINATIONS

Each examination consists of three portions: a header portion, a set of multiple choice questions, and a programming exercise. The programming exercise is included both for the educational value of writing code under examination conditions and as an evaluation of student programming ability. Examinations are prepared using an on-line text editor. Selection of questions from the data base is done manually. Additional questions can be inserted and questions retrieved from the data base can be modified. Intermediate listings can be obtained and modifications can be made through repeated editings.

When the instructor is satisfied with a set of questions selected for an examination, the examination header portion is added. A computer program is used to number questions sequentially, insert page breaks, and number pages. Output from this program is a file which is ready for listing. Once the examination has been finalized, a listing on reproducing masters is prepared, and copies are made.

Preparation of different versions of an examination is done quite easily with a computer-oriented system. The procedure is merely to rearrange the questions chosen for the examination and to rerun the examination preparation program. Thus, each version includes the same questions presented in a different sequence.

EXAMINATION ADMINISTERING

Examinations are administered at one time for all students enrolled in a course offering. Several versions of each examination are normally used so that students seated in the immediate vicinity of other students will be taking different versions. During the examination, students enter requested data and their answers for the multiple-choice questions on mark sense answer sheets. They also work the programming exercise on a tear-off sheet attached to each examination copy. At the end of the examination, students turn in their mark sense answer sheets and their solutions for the programming exercise. They may keep their examination copies.

MAKEUP EXAMINATIONS

The system allows for no makeup examinations. Instead, only the highest four out of five equivalent hour examination grades are used in computing an average grade for each student (The final examination is counted as two equivalent hour examinations.). Thus, each student can miss up to one examination

without any grade penalty.

EXAMINATION GRADING

Multiple-choice portions and programming exercise portions of examinations are graded separately. Programming exercise portions are graded by hand. Resulting grades are recorded in machine-readable form on the mark sense answer sheets used for answering the multiple-choice questions. Answer sheets are read for machine grading using a mark sense forms reader. The grading process includes comparing multiple-choice answers with a key to obtain a grade for the multiple-choice portion, weighted averaging of the multiple-choice portion and programming exercise portion grades to obtain an overall grade, entering grades into the student data file, and printing student grade reporting slips.

STUDENT GRADE REPORTING SLIPS

As part of the grading process, a student grade reporting slip is prepared for each student. These are returned to the students to inform them of their examination results. Information contained on each slip includes a listing of the examination key, answers supplied by the student, an indication of which questions were missed, and the student's grade.

FINAL GRADING

A significant service offered by this system is automated support of final grading. Assignment of final grades is based on a number of performance evaluations which are recorded throughout a course offering. These include grades for periodic examinations, a final examination, programming assignments, and quizzes. At the end of each course offering, a grading program is run which computes an overall average for each student. Letter grades are assigned according to overall numeric average. This may be done using fixed break points (e.g., 90-100 for A, 80-89 for B, etc.) or by curving. In either case a listing of the student data file sorted according to class standing is helpful.

EVALUATION

Experience using this system is highly encouraging. A tremendous increase in the number of students taking introductory computer science courses has been supported with only a very modest increase in required number of faculty members and graduate students. This has apparently been accomplished with improvement in,

rather than detracting from, instructional quality. Periodic course evaluations indicate a substantial increase in student satisfaction. Students entering more advanced computer science courses are demonstrating greatly improved comprehension of the fundamentals taught in the introductory courses. Student cheating has ceased to be a major concern, and faculty satisfaction with the course has increased markedly.

FUTURE DEVELOPMENT

There are many areas in which this system can be improved. Just one of these is in the preparation and administering of examinations. With automated examination preparation, it would be possible to prepare a separate examination for each student. Computerized administration of examinations could replace examinations given to all students at one time. Almost limitless additional possibilities for improvement can be envisioned.