An Autograding (Student) Problem Management System for the Compeuwtir Ilittur8.

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Abstract:

In order to develop analysis skills necessary in engineering disciplines, students need practice solving problems using specified analytical techniques. Unless homework is collected and graded, students tend not to spend much time or effort in performing it. Teachers do not, realistically, have the time to grade large numbers of homework problems on a regular basis. This paper presents and makes available a miracle cure. The Autograding Problem Management System (APMS) provides a discipline-independent mechanism for teachers to create (quickly and easily) sets of homework problems. The APMS system provides CRT and/or printed summaries of the graded student responses. This presentation will demonstrate both the speed and the drag-and-drop simplicity of using the APMS to create self-grading homework problem sets comprised of traditional types of problems and of problems which would not be possible without the use of computers.

Introduction:

In order to develop analysis skills necessary in engineering disciplines, students need practice solving problems using specified analytical techniques. Traditionally, instructors assign homework problems to provide students with the necessary problem-solving practice and give examinations to evaluate their skill.

Two things have changed over the last thirty years. First, a much larger percentage of high school graduates is attending college. This has broadened the range of academic skill and motivation in the student body. Second, faculty salary has been linked to student opinion. The combination of these two factors has led to a dilution of performance required of the students and to (well-documented) grade inflation. The challenge to instructors is to motivate the students to do the necessary work to learn without incurring their wrath.

We have found that assigning, collecting, and grading homework will motivate the students sufficiently and they will do well on examinations. We have also found that assigning but not collecting and grading homework is not sufficient motivation and that students tend not to spend much time or effort in performing it. This results in poorer performance on examinations and student unhappiness. Teachers do not, realistically, have the time to grade large numbers of homework problems on a regular basis.

The Autograding Problem Management System (APMS) was designed and developed to accomplish several very distinct goals. The goals were to provide a mechanism:

> for assigning homework that would be graded by computer; and,

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that would spark student interest by presenting more interesting problems in a more interesting fashion; and,

that instructors could learn to use in one or two hours; and,

to use colors and graphics which were previously unpractical.

The APMS is not presented as an earth-shattering breakthrough in the pedagogic use of computers. Rather, it is presented as a unique and simple-to-use packaging of those tools an instructor needs to create homework (or exam) question sets which the students can administer to themselves outside of the classroom.

The APMS System:

The APMS system consists of two Windows 3.1 programs. Hardware requirements are modest by today's standards. The minimum configuration requires Windows 3.1 and about 2MB of hard disk space. Both performance and versatility are enhanced with more modern hardware. The recommended minimum hardware configuration for the Student Program is a 33 MHz 486 processor with a 1024x768 1MB video display. The recommended minimum hardware for the Teacher Program includes a 100 MHz 486 or 75 MHz Pentium, a 1024x768 2MB video display, a color scanner, and a printer.

In the paragraphs that follow, the Teacher Program and the Student Program will be discussed. Following that, several implementation issues and observations will be given.

The Teacher Program:

The Teacher Program provides two basic functions. It allows the instructor to create and edit individual problems (exercises) and it provides a means to assemble new and existing problems into coherent sets of student assignments.

Creation of new problems is accomplished through "button clicking" and "drag-and-drop" operations. Initially, a new problem is presented as a blank work area. An array of "buttons" allow the instructor to "drop" any one of a variety of "objects" into the problem. These "objects" are: windows to display pictures; text boxes to contain problem statements; number boxes to receive and automatically grade numerical answers; word boxes to receive and automatically grade true/false and short-answer answers; multiple choice boxes to receive and automatically grade multiple choice answers; essay boxes to receive essay type answers (up to 32,000 characters each); and graphics boxes to receive drawings made by the student.

Once the "object" is dropped into the problem, the instructor can move its position, change its size and shape, and fill it with the correct answer (where appropriate). Each autograded box will spawn a self-descriptive dialog window to collect the correct answer.

After creation, each problem can be saved individually as a DOS-type file (recommended). That problem can then be copied, edited to become a slightly different problem, and saved. Homework sets are generated by collecting a group of individual problems and creating student assignment diskettes

The Student Program:

The Student Program administers the homework set. It presents the individual problems and collects the student's answers. Depending on choices made by the instructor, various types of grading will be available.

After the student opens an assignment set, he/she can work on individual problems in any order. The answer boxes spawn dialog windows to collect the answers. The answers can be saved and work continued or answers changed at any time.

Problems for Drill:

As instructors in engineering, we want students to accomplish at least two levels of understanding. Initially, we want the students to learn about and to understand some fundamental theoretical concept or characteristic behavior. To achieve this, we explain, demonstrate, present examples, ask questions, draw pictures, discuss analogs and do all sorts of other things to help the student to understand. Secondly, we want the students to be able to use this understanding to solve problems. To this end, we can employ a two-step process. The first step is to give the students a variety of drill-type problems. By completing the drills, the students achieve competence in using analytic tools and convince themselves that they understand the underlying concept or behavior. The second step is to give students problems which are "fresh" and which require the student to consider how a problem should be solved and to select the proper analytic tools to solve it.

While most instructors have no difficulty in conceiving good drill problems, posing the problems has generally been tedious and time consuming. A large variety of basic engineering problems require some sort or picture or graphic to pose the problem adequately. This requirement has tended to keep us "married" to the textbook problems, with their printed graphics. Newer texts are using color printing of the problem graphics. Color can be used very effectively to help the student understand the problem, but it kills the instructors ability to generate drill problems based on the graphic which cannot be faithfully photocopied.

With the APMS, it becomes quite easy to modify existing pictures or graphics so as to quickly build large sets of drill-type exercises. I believe that students relate better to problems which are presented as clean originals than they do to marked up photocopies.

Grading Options:

There are a variety of points-of-view among instructors as to how and when students should have access to correct answers. Some feel that the students should know the correct answer before starting the problem solution; some believe that the student should have instant feedback, either incrementally as they solve the problem or immediately upon completion; and some believe that part of learning to solve problems requires the student to have enough confidence in his/her technique to defend the work without being given the correct answer. The APMS was designed to accommodate each of these points of view. When the instructor creates the assignment disk for the student, he/she has the option of specifying how and when the student can access the correct answers.

Networks/ Large Graphics Sets:

One of the major advantages of the APMS is its ability to present photographic quality color graphics to the students. In the default configuration, the APMS includes a copy of each graphics image referenced within the problem set on the assignment diskette given to the student. Graphics files can be very large. There may be occasions where it is desirable to install the graphics images on the computers available to the students or on a network server, and not include them on the student assignment disk. The APMS provides an easy to use

mechanism that allows you to specify on the student assignment disk, the location of the graphics images referenced within the set. The images themselves can then be installed on your network server or on computers available to the students. This option allows you to transfer "compressed" files or to use more than one diskette to distribute an assignment set.

Textbook Editions:

It is common for authors/publishers to produce a new edition for a given text every three or four years. This practice tends to keep commerce in the used book market relatively low. It also creates work for instructors. Frequently, the content of a newer edition (for basic engineering courses) will present little or no new information, although the material might be slightly rearranged. The problem sets given for homework do tend to change. This means that instructors must commit considerable time evaluating the new problems and preparing solutions for those problems selected. With the APMS, it becomes quite easy for the instructor to maintain his/her own sets of homework exercises (collected over time). In this manner, the instructor can move to later editions with relatively little "busy-work".

Conclusion:

The APMS seems to meet all of the design goals. What remains to be evaluated is student acceptance. There is little doubt that our students will have a lot to say about the APMS. We hope that their input can be used to make this system a better tool for both the teacher and the student.

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Glenn S. Kohne is an Associate Professor of Electrical Engineering at Loyola College in Maryland. He received a B.S.E.E. from the University of Maryland in 1970. He worked as a Lead Electrical Engineer for Raytheon Company and as a Lieutenant Commander for the U.S. Public Health Service. He received a M.E.S. from Loyola College in 1981. He is currently in his 14th year at Loyola.