PERGAMON

Computers & Education 31 (1998) 319–328

COMPUTERS & EDUCATION

Self Test: a flexible self assessment package for distance and other learners

Janet A. Taylor

Office of Preparatory and Continuing Studies, University of Southern Queensland, Toowoomba, Queensland, Australia 4350

Received 11 November 1997; received in revised form 2 July 1998

Abstract

In this paper we present a new flexible self assessment package called Self Test. This package has been designed primarily for distance students to assess their readiness or mastery of particular topics. It differs from other packages in that it allows a student to self-grade a series of questions as if they were an expert evaluator giving the student the flexibility to complete a problem in up to six different ways and to be awarded partial credit. Results of the evaluation of the package over two years with groups of engineering students studying mathematics are presented, and indicate that the package is efficient and effective. The applicability of the package for all subject areas is discussed.

1. Introduction

Self assessment, the process of understanding more about oneself is a valuable skill, both in life and when studying. This fact is acknowledged regularly in the many descriptions and models of instructional design currently expounded (Gagne, Briggs & Wager, 1988; Rowntree, 1991; Laurillard, 1993). Techniques to encourage or structure self assessment take many forms, depending on the reason for that assessment. For example journals or diaries encourage students to reflect upon their affective or metacognitive development while tests of one form or another can encourage students to examine their cognitive development, possibly in combination with affective and metacognitive components. In this paper we will focus on the latter example. Gale (1984) in a review that discussed self assessment purposes indicated that overcoming isolation, promoting active learning, controlling learning behaviours, providing diagnosis and remediation, and focusing responsibility for learning on the students were all important reasons for development and integration of self assessment into learning experiences.

0360-1315/98/$19.00
PII: S0360-1315(98)00044-X

However, although the consideration of the above is essential in any teaching/learning environment, it is particularly important in self instructional materials given to distance education students. In Australia such learners are often in remote locations, isolated from other learners and in some disciplines the first in their family to participate in tertiary education. The latter characteristic often means that they also are inexperienced in formal learning situations. The presence of such characteristics and the fewer opportunities for formal and informal interactions and monitoring of students in off campus programs led Ingram (1994) to state that "in distance education we must build self assessment opportunities into the instructional system explicitly. . .". This paper reports on the development of a computerised self assessment system (Self Test) that was designed primarily for distance students with the particular goal of providing students with a means to diagnose their preparedness for a subject or to ascertain their mastery of particular topics.

Self assessment of content objectives is not new and is discussed in detail in many instructional design textbooks. However, many of these systems are not designed to account for the diversity of backgrounds or approaches to study that many students bring with them to their learning. This is especially the case in distance education where many of the students are mature aged and although are very experienced in life, are uncertain of their skills in the tertiary environment. As a consequence many students are often unsure of when they really 'know' an answer. Self assessment systems that provide students only with model answers or solutions as a *fait accompli* are often not useful to students. Rowntree (1991) and Marland & Store (1982) caution course developers against assuming that students can use model answers or solutions without some indication of the context and instructions on how to use the solutions. Further, systems that use a right/wrong approach to assessment do not allow for situations in which a student is nearly correct, i.e., the part marks situations that expert markers often use. And finally in many instances there is more than one correct way to solve a problem. Systems which present only one way to come to an answer may end up confusing or frustrating a student especially if they are used to being successful problem solvers in the workplace and home. The team's experiences in teaching students, especially distance students, confirm these impressions.

Considering the above and the fact that for isolated students feedback needs to be instant and comprehensible to a novice it was obvious that a self assessment system was required that

- allowed for instant feedback on diagnostic or self assessment items;
- allowed students to use a range of solution methods to solve problems;
- provided students with instructions on how to use model answers;
- allowed students to be credited for successfully mastering some of the content within a single question.

The following paper aims to describe the design, development and evaluation of such a system.

2. Background

Many computer based diagnostic or self assessment packages have been proposed, designed or developed in the past (Ingram, 1994; Stewart, 1984; Ronau, 1986; Mann, 1988; Foreland, 1987; Travis, 1991). A number of these are now displayed on the internet (Geo, 1997; MQuest, 1997; The University of Calgary, 1997) and some are available commercially (TRANSMATH, 1997; QUESTION MARK, 1997; DIAGNOSYS, 1997). The systems available have been designed for varying purposes. Some are purely self assessment or diagnostic packages for particular subjects, others are tutorial packages which contain diagnostic or self assessment components, while others are diagnostic test generating and marking software packages. In most instances, however, self assessment systems focus on situations where students complete a series of questions or problems and then mark them. Students' solutions and answers to the problems are recognised by the computer in a variety of ways. Students might pick one answer from a number of answers as in multiple choice tests, they could use the mouse to click on a position in a graph or diagram, or enter a single word, number or expression. The latter may use specialised programs to enter answers, e.g., TRANSMATHS uses *Mathematica* to enter mathematical expressions. Once the students' responses are entered, systems also provide feedback in various forms. Some provide answers or model solutions, others provide step by step details of solutions while others provide summaries of right and wrong questions, often with associated comments.

Many of these systems are excellent and are well suited to achieve the aims of their original designs. However, within the context presented in the introduction of this paper they have some shortcomings. Some programs present students with an answer or solution with no clues as to how to compare their answer to it. In others, students can proceed directly to an answer with no incentives to think through or write out a solution before entering the answer. For example, the solution of a mathematics problem might require students to complete mathematical calculations and to draw diagrams and/or graphs. In such situations students are required to present arguments in a logical order and to have the skills to draw appropriate simple diagrams and graphs without the aid of computers. None of the programs so far examined allow for students to select a range of ways to solve the same problem.

In an attempt to overcome many of these shortcomings Self Test was designed for students studying mathematics, so that novice students

- when presented with a problem were encouraged to write out their solution in detail, including diagrams and graphs if necessary;
- would have a mechanism of comparing their solution with a model solution;
- would have a way of deciding if their solution matched the model solution;
- would have a number of alternative model solutions available to them if appropriate;
- would be credited, if necessary, when they got only part of a solution correct;
- would have a summary at the end of each self assessment session detailing which topics they still had to master.

It was also designed so that creators of a self assessment test

- would require only the most basic computer skills,
- could customize a test to suit any subject area using simple word processing, graph and picture drawing software if necessary.

3. Architecture of the system

Within the Self Test environment when students want to diagnose their readiness for a subject or mastery of a topic they are first presented with a written test which can be printed from the screen. Students would complete the test detailing solutions, diagrams and graphs as necessary. They then proceed to Self Test to assess their progress in the test. Fig. 1 describes the processes the student would follow.

The key to the production of a final diagnosis for students is the inclusion of a set of vital points for each question. These have two purposes. Firstly to guide a student through a solution indicating which parts of a solution are essential. Secondly, each vital point is linked to comments or a topic that you would want included in the final diagnosis or study plan. Ticking a vital point indicates that mastery has been achieved for that point. Fig. 2 shows typical screens that are presented to students.

The program has been developed using readily available software—*Microsoft Multimedia Toolbook* was used as the base authoring package, *Microsoft Word* 6 was used to write text and mathematical equations while *Microsoft Excel* was used to create graphs. It has been designed so that any teachers wishing to create their own test within a particular subject area would simply complete a template which would include:

- question or problem;
- answer;
- solution (or solutions if a number of alternatives were possible);
- vital points and linkages to comments or topics;
- other important points;
- reference buttons for solutions.

A test creator is presented with a number of options when writing the solutions in that up to six alternative solutions methods and up to six vital points can be included for each problem. Further, creators can nominate how individual questions will contribute to the students final diagnosis. For example, perhaps you would want students to achieve 100% mastery of Questions 1–10 and 80% mastery of Questions 11–20. The program allows its creator to set the level of mastery for individual or groups of questions. The program is designed so that linked to each vital point is a topic (or comment) that the creators would want included to describe the final diagnosis. The program produces the diagnosis or study plan by tallying up the type of individual vital points that a student gets correct. Note that if a student's answer matches the correct answer perfectly, then that question is marked correct meaning that they have mastered all the vital points for that question. If a student's answer does not match the one provided then the student goes to the next screen where they select one of the alternative solutions available for that question. The next screen will then provide the student with a complete solution accompanied by a set of vital points. A demonstration of the package can be viewed at http://www.usq.edu.au/users/taylorja/Selftest.htm.

The program has been designed to allow students to complete the test in stages of their choice producing an interim report at each incomplete stage. A student can enter and go directly to any question using the help menu with lists of questions currently incomplete being

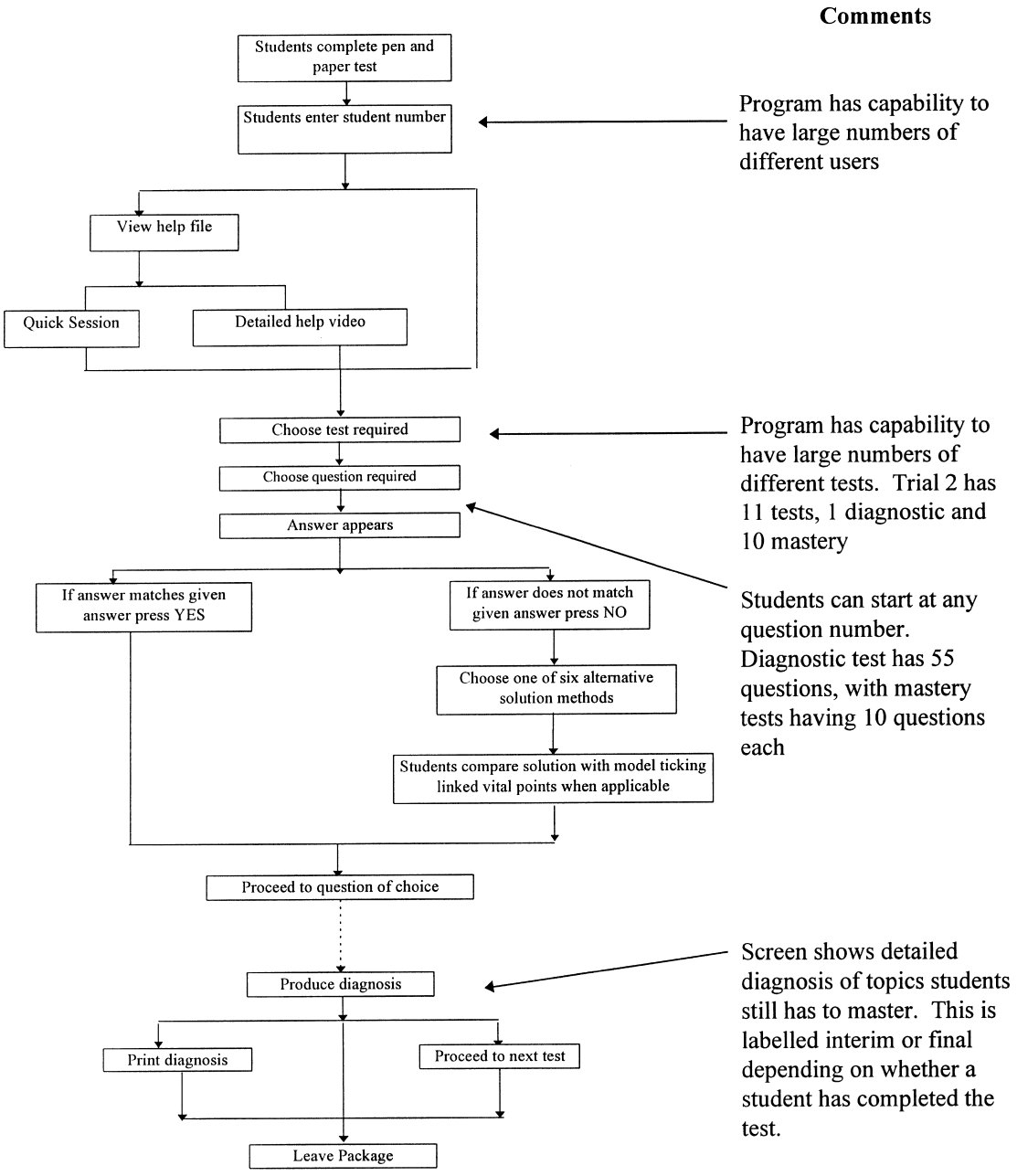

Fig. 1. Standard steps through Self Test.

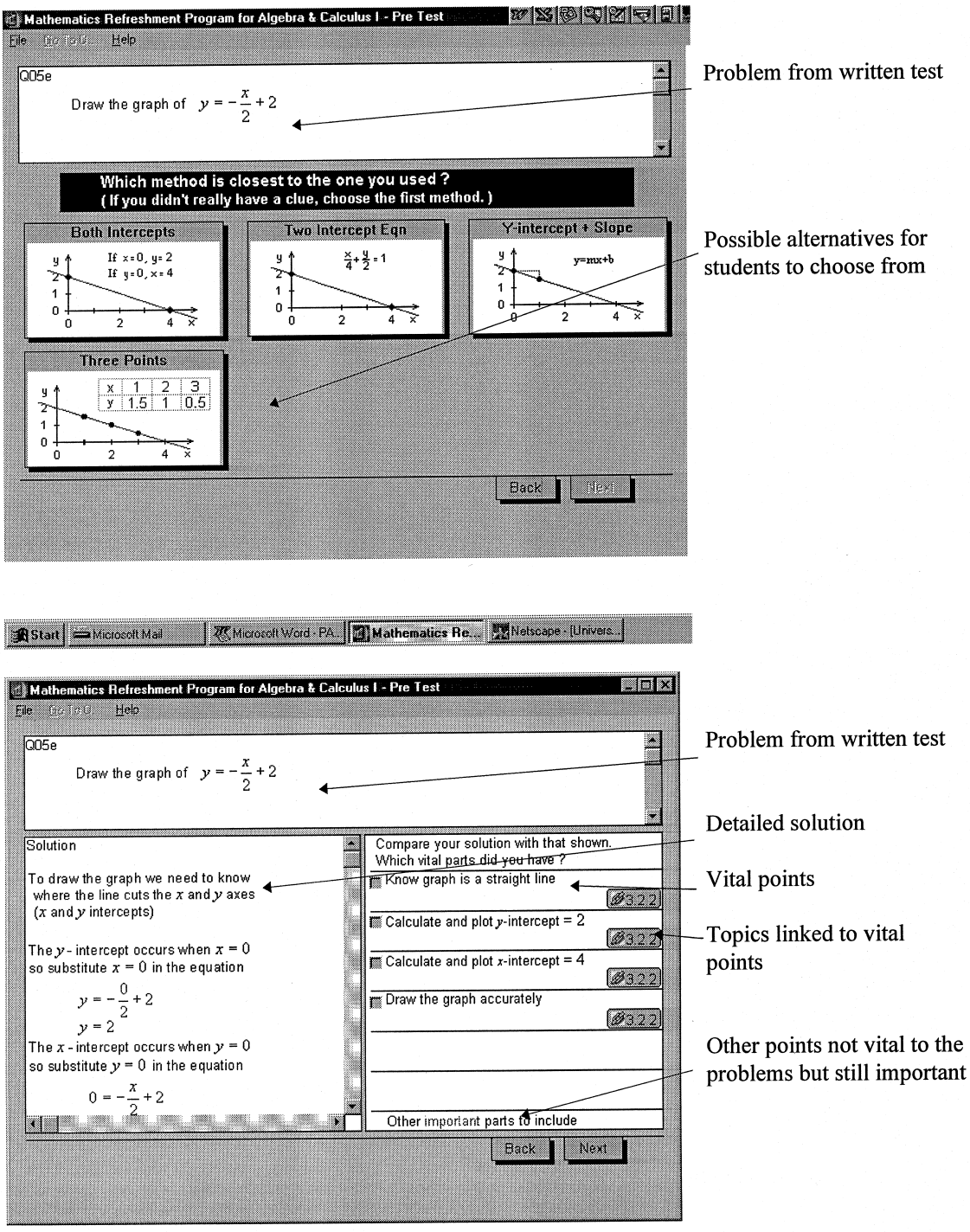

Fig. 2. Typical screens viewed by students completing Self Test for mathematics.

available from the menu bar. Detailed and quick help facilities are also provided with the detailed facility including a video of a student progressing through a mathematics test.

4. Case study

Students studying Engineering mathematics at a distance come from a range of backgrounds and experiences (Taylor & Morgan, 1996a) and because of their time away from study often experience difficulties (Taylor & Morgan, 1996b). The Self Test package above was initially designed to help such students decide if they could remember the mathematical skills necessary to successfully complete their first year of Engineering mathematics in a Bachelor of Engineering degree. The program was evaluated over two years. In 1996, 68 engineering students were mailed Self Test on floppy disks and in 1997, 234 students (engineers and others) were mailed a CD-ROM containing Self Test and a set of refreshment materials. The evaluation of Self Test asked the following questions:

4.1. Question 1: Can students diagnose their mathematical preparedness as well as an expert tutor?

Thirty-one students participated in this part of the evaluation which was designed to compare a student's self assessment results with an experienced teacher's assessment of the same student. In the first trial in 1996, 68 test packages were sent to Bachelor of Engineering students only, who were asked to voluntarily participate in the program. The pre-tests which had been incorporated into Self Test contained 55 individual questions on topics from basic arithmetic to integral calculus. Students were asked to complete the pen and paper tests including answers and workings (if necessary) then mark them using Self Test. Included in Self Test at this evaluation stage were instructions to down-load results and diagnosis to another floppy disk (the results disk). Students were then requested to mail the written solutions and the result disk to USQ for analysis. Fifteen students returned all the required details. Tests were then marked and a diagnosis produced by an independent experienced teacher. Student and teacher diagnoses were compared using paired t-tests for 43 topics. In 41 of these topics there were no significant differences at the 0.05 level between the teacher's and students' prepared study plans. In the two topics that were significantly different the students had been the harder markers. Although details as to why this occurred are not known, it could have been due to one of two factors. Either students, especially mature age students, are much more demanding of themselves than teachers or, if only answers were given without solutions then it is easier for students with Self Test to mark their solutions in more detail than the teacher who only had the final answer.

In the second trial in 1997, 234 tests were sent to all students in the first year mathematics unit. This included students in Bachelors of Engineering, Business and Commerce. In this instance, tests covered 39 topics from basic arithmetic to trigonometry spread over 51 individual questions. Of the students who mailed the CD-ROM, sixteen voluntarily submitted completed solutions with the results disk. In the majority of instances students included only answers to test questions with no details of solution methods. As in the first trial, when the

diagnoses produced by the teacher and the students were compared, there were no significant differences at the 0.05 level. In the few instances where students' study plans did differ from the teacher's study plans, the students' included an extra topic. In these cases it was apparent that the student's detailed knowledge of their solution allowed them to analyse it in more detail than the teacher, who only had the final answer.

In both trials we concluded that students were able to diagnose their mathematical shortcomings as well as an expert tutor. And further, that if the tutor did not have access to complete solutions then students were able to diagnose their mathematical shortcomings better. In the 173 evaluations we received over all (evaluation of the support program are reported elsewhere) we received no complaints about the accuracy of the diagnoses.

4.2. Question 2: is Self test easy to use?

This question was evaluated in 1996 and 1997 trial using both questionnaires and interviews (Table 1).

The responses to Self Test in both trials were overwhelmingly positive and are summarised below (Table 2).

Interviews in 1996 indicated that 95% of students thought that the package was extremely useful and when asked to name the most significant aspects of the entire package to them personally, the majority indicated that "it allowed them to identify for themselves their own strengths and weaknesses . . .". Typically students made the following types of responses

> "I think this diagnostic test is a very good way to start the semester. The program was also well written."

> "The insight and assistance afforded by the package is greatly appreciated. Thanks for making the effort. The ease of use and the high quality presentation enabled me to focus on the program."

Table 1
Number and type of evaluation responses from students who used Self Test

Type of evaluation	1996 (68 students involved)	1997 (234 students involved)
Questionnaire	23	51
Interview	23 (all possible students contacted)	23 (random sample of students contacted)
Total number of students	46	74

Table 2
Percentage of responses that agreed with question in questionnaire or interview

	1996		1997	
Question	Questionnaire	Interview	Questionnaire	Interview
Aims of the program clear	100	*	96	100
Instructions to package clear	96	*	92	91
Package was easy to use	87	*	80	95
Easy to diagnose mathematical skills	95	*	95	95

* Not asked at this interview.

One interesting aspect of Self Test was that students used the self-diagnosis as a tutoring tool in itself. The solutions and vital points were all that many students needed to quickly refresh knowledge that they had understood and used in the past but had now forgotten. For example one student said:

> ''Basically, I forgot the details in 80% of the wrong ones. After seeing the correct answer I've started to remember.''

5. Conclusions and future developments

It is clear from the evaluation that Self Test has achieved what it originally aimed to do. We have produced a self assessment package which

- is very user friendly;
- is easily delivered to distance students (either on disc or CD-ROM) providing them with instant feedback on self assessment questions;
- allows students to mark test questions as well as an expert tutor;
- recognises that students answer questions in different ways;
- credits students for getting parts of a question correct;
- produces an individual study plan (the diagnosis) for each student;
- allows students to easily assess their own strengths and weakness in a predetermined subject area.

The positive responses from the many students who participated in the program indicate that students are ready for such innovations in distance education. The nature and design of Self Test means that it has applications outside the distance education setting. It would be particularly useful to lecturers who used self paced instruction, e.g., Keller Plan, in their

teaching. It is anticipated that in the future, further Self Test packages will be developed and evaluated in subject areas other than mathematics with the final aim being the production of software which will allow teachers in any subject area to quickly and cheaply create customized self assessment packages for their own students. Modification of Self Test for web delivery is currently underway.

Acknowledgements

The project reported here was the result of work by a larger team consisting of M. Morgan, D. Ross, G. Postle. Programming and computer design was completed by D. Grant assisted by A. Edwards. W. Baker assisted with evaluation and data analysis. This project has been supported by a grant from the Committee for Advancement of University Teaching (CAUT) Australia and the University of Southern Queensland.

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