

Use of a Spreadsheet Based Marking System for Assisting Learning and Assessment

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Abstract

This paper describes the development of a spreadsheet-based marking system and its use in first and second year accounting courses at the University of Sydney in 1994 and 1995. A live demonstration of the system is conducted as an integral part of the paper.

The paper begins with a relatively brief depiction of the two-fold motivation for the system's development: (1) the desire to provide large numbers of students with timely and accurate feedback on assignments in a resource constrained environment and (2) to foster use of the personal computer as a problem solving tool through development of expertise with a computer spreadsheet. The first motivation is in essence an integral part of one institution's strategy to deal with both the current economic environment and the needs of its customers (students and employers). The second motivation is a direct response to the changing needs of today's students in that the degree of data analysis required for much of their work cannot, in practice, be undertaken without the use of a computer.

A basically non-technical description of the functioning of the system is provided. Various features of the system are described such as the minimal instructor involvement required, student feedback options available, data security, instructor adjustable marking keys and mechanisms used to reduce over-collaboration between students. The flexibility of this development is discussed with regards to its use as either a learning tool or an assessment mechanism.

The paper concludes with a description of the experience at the University of Sydney in 1994 and 1995 with different methods of use. The conclusion includes the results of student evaluations as to their experience with the system.

Keywords

spreadsheet, assessment, feedback, Accounting

1. Introduction

The recognition that computer spreadsheets can assist accounting instructors has been made by a number of academics including Thomas (1983), Edmonds and Tsay (1989) and Beare (1993). These academics have recognised the gains that can be achieved in accuracy and efficiency of assignment grading as well as the opportunity to provide students with immediate feedback if desired. This paper describes the development of a spreadsheet-based marking system for accounting assignments and its use at the University of Sydney in 1994 and 1995.

2. Motivation for Development

The motivation for development of this system was twofold with the initial stimulus coming from the universal dilemma confronting educators. The overriding problem being how, within a resource constrained environment, to provide students with rapid feedback on submitted assignments.

The second motivation stems from recognition that a sizable percentage of students require “encouragement” before they will (a) gain familiarity with use of a personal computer (PC) and (b) develop a basic level of expertise with a computer spreadsheet. This student attitude was seen to conflict with the view taken by the Department of Accounting at the University of Sydney; that PC familiarity and spreadsheet expertise are essential skills in today’s business environment and therefore for its graduates.

This view is supported by the results of a U.S. survey (Heagy and Gallun, 1994) of over 1,000 accounting professionals in both public accounting firms and industry. Spreadsheet concepts and features in were found to be the topic with the highest knowledge desired. Respondents indicated the desire for entry-level accountants to have a good working knowledge of spreadsheet concepts and features in general. The desire for spreadsheet competency was significantly higher than for all other computer topics.

The problems arising from these two distinct stimuli were seen to have a common solution with the development of a marking system that would electronically assess and record the result achieved for student assignments using computer spreadsheet input. Use of a common medium for both student assignment preparation and for instructor assessment / mark recording was seen to be desirable for several reasons. First, it allowed the developer to proceed without incurring the costs of gaining expertise with a higher level programming language (i.e. he was already familiar with the Lotus 123 macro language). Second, it permitted testing of the general correctness of a student’s work within the most appropriate environment, the spreadsheet itself.

The most important reason, however, was that it allowed students to gain experience with the use of a spreadsheet through their assignment preparation, while at the same time gaining an appreciation for the spreadsheet’s higher capabilities as evident from the grading and registration programs. While there would exist programs that might arguably do a better job of developing accounting skills, the disadvantage of such programs is that the student develops expertise with a program that will be used once only - for that accounting course. The spreadsheet marking system develops both accounting skills and relevant computer skills.

3. The System’s Basic Principles

3.1 Comparison of Student Input with Model Solution

The marking system is based on the assumption that the various questions being assessed will have either one or a limited number of unique numerical solutions. While this requirement will make the system inappropriate for certain uses, it has not been found to be a serious obstacle to use in many accounting questions within the curriculum at the University of Sydney. In most cases it is simply a matter of rewording the question itself to limit the set of possible solutions.

For each answer input by the student, the marking system uses the spreadsheet’s *logical if formula* (e.g. Lotus 123’s @if) to compare the student’s answer with a model solution and give the available marks if correct or zero if the input does not agree with the model.

Table 1 shows output of various formulae that might be part of a marking system grading file. The entries in the *Student Answer* column would be cell references to the answer input cells on the

student assignment template. The *Model Answer* amounts are values that have been previously calculated and input by the developer as being the correct answers for each question. The *Marks Available* column provides the instructor's input of the value to be awarded for each question.

The *Marks Awarded* cell E3 contains a conditional if formula (Lotus 123's $@if(B3=C3,D3,0)$) in adherence to the general format of $@if(Condition, True\ answer, False\ answer)$ which yields the value 2 as the condition is found to be true. The second *Marks Awarded* cell (E4) contains the formula $@if(B4=C4,D4,0)$. In this case the condition is found to be false (\$1,200 is not equal to \$1,250) and thus the *False answer* of zero is displayed.

	A	B	C	D	E
1		Student	Model	Marks	Marks
2		<u>Answer</u>	<u>Answer</u>	<u>Available</u>	<u>Awarded</u>
3	Qtn.#1	\$1,000	\$1,000	2	2
4	Qtn.#2	\$1,200	\$1,250	3	0
5	<i>etc.</i>	<i>etc.</i>	<i>etc.</i>	<i>etc.</i>	<i>etc.</i>

Table 1. Grading File Sample Output.

The described procedure can also be used to evaluate text or written entries. However, even with the use of string functions to eliminate differences due to spacing and capitalisation the input answer must be an exact match with the grading file's model solution. This limitation may be overcome by including a list of possible answers including the correct entry within the template. The student is instructed to select his / her choice of correct answer through use of the spreadsheet's copy function. In this manner inappropriate assessments due to typing discrepancies are eliminated. This procedure has the additional benefit of requiring and reinforcing use of the spreadsheet copy command.

3.2 Partial Marks - Development of a Comprehensive Marking Key

The assessment system described above can be expanded to recognise the existence of more than one correct answer or to award part marks for partially correct responses. This may be accomplished in several alternate manners including the use of nested @IF functions.

A significant side benefit achieved through development of a partial mark grading key is that the instructor is forced to think through the question in a number of different respects in order to consider alternate answers that should receive full or partial marks. Preparation of such marking keys prior to assigning of questions will go a considerable distance towards the "debugging" of questions allowing more appropriate assessment and providing students with a better learning tool.

3.3 Testing the General Correctness of Student Inputs

The system described above has one glaring deficiency from the standpoint of proper spreadsheet use. This shortcoming is a reflection of the fact that the primary advantage of spreadsheet preparation is the ability to test the effect of alternate data on a particular situation, i.e. to perform *what if* analysis. The previously described assessment procedure is inadequate in that it does not distinguish between entry of a proper formula versus the typing of the correct value (a totally inappropriate practice from a spreadsheet standpoint in that numbers should be typed only in a spreadsheet's data section).

The marking system overcomes this problem by marking each question twice. The student's inputs are first graded by comparison with a master solution with logical if formulae in the manner described previously. The sum of the results of these formulae provide the student's *Accounting Mark* for the question. The program then changes each of the various input data that were provided

to the student in the original assignment question. The results of the student's inputs are then compared with @IF functions to a second master solution that has been prepared for this changed data set. The sum of the results of this second set of logical if formulae provides the student's *Spreadsheet Mark*.

This method of determining whether appropriate formulae have been used is seen to be totally consistent with the overall function of a spreadsheet being to perform "what if" analysis. The alternative of checking for entry of a specific formulae is viewed as being inappropriate given the number of different but equally correct methods of answering even basic questions.

If desired, the marking system could be refined whereby students are rewarded for use of simpler, more elegant formulae. For example, @sum(A1..A5) is more efficient than +A1+A2+A3+A4+A5 for adding the values in this range of spreadsheet cells. Bonus marks could be made available through formulae that test for the correctness of the student's answer AND the length of the formula used.

3.4 *Instructor Decision on Spreadsheet Formulae Emphasis*

The set-up of the system allows instructors to select the emphasis that they wish to place on appropriate use of spreadsheet formulae. The importance of the proper spreadsheet formulae aspect may be emphasised or downplayed / ignored simply through changing the values of *Marks Available* in the *Spreadsheet Component* part of the grading program. As such the instructor can use the system solely to test accounting knowledge or to assess both accounting knowledge and the use of appropriate spreadsheet techniques. In a similar fashion the instructor may easily change the marks available for various questions within the Accounting Component.

3.5 *Carry-forward Errors*

One mistake = one penalty is the marking philosophy that is probably followed by most academics. However this thinking creates considerable difficulties in complicated questions with answers dependent on subsequent calculations. In many respects attempting to assess an answer where one or more errors have been made early on is the marker's nightmare.

One way of dealing with this problem is through how the system is used. Treatment of the spreadsheet questions as a learning tool as opposed to an assessment component allows the problem of carry-forward errors to be ignored by allowing students to submit assignments as many times as desired.

With this method of using the system, an error made early in the assignment may result in a number of subsequently "correct" answers being assessed as being incorrect. It is argued that such a system is the clearest possible demonstration of the consequences of making "early" errors without unduly penalising the student as he / she can correct his / her mistake and resubmit the assignment.

Where an instructor wishes to allow only one submission of an assignment or with a formal computer test the problem of carry-forward errors must be addressed directly. This may be done by structuring the assessment such that individual question components are assessed in their order of required completion. After awarding the relevant marks to each question component the grading program corrects the student's answer if necessary. As such if proper formulae have been subsequently entered the student is not penalised again for the early error.

3.6 *Feedback Options*

The system provides three options with regard to feedback. The instructor may change the selected feedback on different assignments if so desired. In most cases, however, it would be appropriate to

select one feedback option for all assignments - the level of feedback provided being dependent on how the instructor has chosen to use the system, i.e. as a learning tool or as an assessment mechanism.

With feedback option 1 the student is provided with immediate detailed feedback on his / her assignment submission. Indication is provided of which question components were correct or incorrect. This feedback option is consistent with treating completion of the computer assignments as a learning tool. This is the option that was used in the point system described following.

Option 2 provides the student with immediate limited feedback through provision of the overall mark achieved but without any indication of where marks were achieved or lost. This option could be seen as being a middle-road approach between using the system as a learning device as opposed to use as an assessment mechanism.

A further option is for the system not to provide immediate feedback, the assignment is acknowledged as being received only. This alternative would be appropriate when the system is being used primarily as an assessment tool. With this alternative, results could be posted immediately after the submission deadline. At this time the detailed feedback option could be made available. This would allow "keen" students to resubmit their work to see where they went wrong and to submit a corrected attempt(s) for learning's sake.

3.7 Disk Registration / Reducing Student Cheating

Each student is provided with spreadsheet assignment questions through a registration program. The obvious functions of this program are twofold. First, it provides each student with copies of the assignment questions on his / her own computer disk. Second, it personalises each of the questions with the student's name and number.

Not apparent to the student is the fact that the registration program also encrypts the student's identification number to his / her disk and to each of the assignment templates. On submission of an assignment the instructor's assessment program decrypts this number and compares it to the student number in the visible student information area. As such the system checks to determine if the student has prepared the assignment from his / her own registered disk. This procedure thus prevents a student from simply making a copy of a classmate's completed question and typing his / her name and student number to the template's student information area.

The registration program provides a second means of "encouraging" students to complete their own assignments. System registrants are provided with one of nine different versions of each assignment template. These versions are different with respect to the cell locations of the question's data and answer cells. While this procedure will not prevent the dedicated copier from doing so it does make the task considerably more difficult. Hopefully the realisation will be made that it is not that much more difficult and is more beneficial, in the long run, to do the work themselves.

4. Experience with the Marking System at the University of Sydney

Experience across several semesters and courses with the marking system used in different means has provided varying results. The marking system was used in the Department of Accounting's introductory course in 1994 and 1995. In 1995 the computer component of this course comprised 20% of the overall course's assessment component with 10% attributable to completion of 8 computer assignments and 10% coming from a one hour computer test in the last week of semester. While the average mark received on the computer assignment component was 9.5 out of 10 marks, on the computer test the percentage marks ranged from 20% to 98% with an average of 52%. This

was seen as being an indication of an excessive amount of “cooperation” in the completion of the computer assignments.

The system was also used in the Department’s second year Management Accounting course in 1994 and 1995. In 1994 computer assignments comprised 20% of the assessment for the course. Multiple submissions were allowed but with the student’s mark being received from his / her first submission. This use of the system was judged to be unsatisfactory as it created a motivation for students to wait to submit their work so they could learn from the mistakes of other students.

The system was used in the Department’s 1995 second year Management Accounting course as a learning tool. This was accomplished via a point system whereby students were required to achieve a minimum of 1,000 points. Points were earned through submission of any of 14 computer spreadsheet assignments with 100 points being available for assignments submitted prior to the weekly Friday 6:00 p.m. deadline.

Students were allowed to submit an assignment as many times as desired with the system recording points from their best attempt. For example, a best mark of 80% earned 80 points if submitted before the deadline. This assessment system was seen as being highly successful with some 325 of 330 students achieving at least the minimum 1,000 points. The point system was also popular, a reflection perhaps of the fact that it allowed some scope for deciding which assignments to complete.

4.1 Student Evaluations

Table 2 provides the computer component questions of the course evaluation completed by 239 students enrolled in the course in which the “point system” was used. Not included are questions 1-15 of the evaluations which related to other components of the course (tutorials, lectures, etc.). Appendix A contains a graphical summary of the results of student evaluations.

Question 21 provides the positive result that over 75% of students indicated that the computer assignments increased their spreadsheet skills. This result is interesting in that completion of the assignments requires use of only very basic spreadsheet skills. The conclusion that may be drawn therefore is that only a minority of students possessed these basic skills prior to the course and that the overall objective of developing student’s spreadsheet competency was at least partially achieved. The notion that this overall objective has been achieved is also supported by Question 22 in that over 80% of students indicated that completion of the computer assignments developed skills they expect to use after university.

The course computer assignments ...
16. Were not useful.
17. Provide a good way to learn accounting.
18. Were more enjoyable than your average assignment.
19. I learned a lot of management accounting from them.
20. The computerised grading system worked very well.
21. Increased my expertise with a computer spreadsheet.
22. Developed skills that I will use after university.
23. I recommend this course as it was taught in 1995.

Table 2. Partial Course Evaluation Form.

Each question provided a scale from *Strongly Agree* to *Strongly Disagree*

5. Conclusion

Overall the evaluations would appear to indicate that the computer component of this course was highly successful. The objectives of this development to cope with large numbers of students and to foster development of spreadsheet skills were achieved. As such the described system offers accounting instructors and those in other number based subjects (e.g. engineering) the opportunity to provide students with an improved learning experience in an efficient, cost effective manner. The system is an excellent example of appropriate use of technology.

6. References

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Appendix A Results of Student Evaluations

