Some reflections on on-line tutoring and plagiarism

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***Abstract**: In 1995 the authors developed and implemented an online tutoring system for first year engineering dynamics. This involved a set of problems with diagnostic feedback and a sub-set of problems that earned credit. Initially the system was very effective but over the years the degree of plagiarism has increased. This paper is concerned with describing the history of events, describing remedies that were put in place, examining their outcomes and suggesting ways forward. In particular the issue of why students choose to cheat and not spend the time mastering a topic is discussed.*

Introduction

The on-line tutoring system known as 'Jellyfish' was developed and implemented during the 1995 academic year. It has been described in various papers [Scott and Stone (1998,1999)] but a summary is needed to understand this paper. Over 200 problems were written that had the following features. Each student received different numerical values and many possible wrong answers were programmed to provide diagnostic feedback. Each problem had a forum where students' questions were answered on-line. All students could see all the questions and answers on the forum but were anonymous to each other. Several practice questions were required to be completed correctly before access to the assessed questions was allowed. For the assessed questions there was a deadline after which no marks were given. Also every wrong answer resulted in the loss of marks. The University of Western Australia (UWA) has a policy that no more than 70% of a unit can be assessed by a final exam. Thus up to 30% of the unit was available for correctly answering the on-line questions.

Initially (1995) the students taking the unit (around 200) were very supportive of the new approach and made many helpful suggestions. It should be noted that the class did not include all first year engineering students but only those who were not electrical, electronic or information technology. The outcomes in the first years of implementation resulted in high pass rates for the unit and the lecturers being confident enough to pose 'hard' questions in the exam. Then in 2000 UWA implemented a review of engineering that resulted in a common first year so that all engineering students were required to do dynamics. This changed the overall attitude of the class and the numbers of students increased to around 450. During the first year of the common first year one student found a programming error in the java applets which posed the problems and was able to access correct answers without completing the problems. She/he was unable to keep this discovery to her/himself and the method of cheating spread exponentially. The situation was uncovered when one student decided to show off the discovery to another student who happened to be a very young looking tutor. Students were informed that if they 'confessed' they would lose the marks gained by cheating but nothing would be recorded on their academic record. At the same time they were warned that since 'Jellyfish' had records of the times when problems were first viewed and when answers were entered an investigation with appropriate penalties would be made when these two times were unusually close together. As a result just over 200 students confessed. This number had arisen in around 10 days

from the first occurrence. An interesting discussion commenced on the on-line forum about who was responsible for what happened. One such discussion went "*The person who wrote the software is responsible because the loop hole was there*". One of the authors of this paper responded, "*It is easy to shoplift as the goods are easily taken. Does this mean shopkeepers are responsible for shoplifting?"* This did not kill the discussion and it was clear that the ethics of some of the students was not of a high standard.

Another problem arose later because each of the questions has a full worked solution. For the practice questions these solutions are accessible after a certain number of wrong attempts. For the assessed questions these are accessible after the deadline for the problems. This feature was included because the authors' desire was that the tutoring system would be an effective way of improving understanding and trapping misunderstandings. This has been realised for many students as the results from surveys have shown. However it was not long before the solutions became available to students in subsequent years. This was possible because the problem set remained essentially the same as the loads on staff limited the time available for writing a completely new set of problems each year. The latest example of the availability of solutions arose in first semester 2008 when solutions for the practice questions were posted on the WWW site of a different unit. This may not seem so bad as the practice questions do not earn credit. However they do have to be completed before the assessed problems can be accessed. Also the practice questions were designed to construct knowledge of the topic so that the assessed problems could be readily completed.

We have no objection to students helping one another. Our problem is only with the type of "help" that seems to be most common. If a student were to assist a colleague by leading him or her through the sequence of logical steps required to apply the laws of Physics to a problem – as staff do – then this can profit both parties. Both can understand more clearly how the laws are applied in a general sense, and this is probably the key skill in examinations. Instead students seem to share what amounts to a single function or algorithm that returns the problem answer based on the problem parameters. This function is of course the result of applying Physics correctly to the problem situation, but it contains no clues about how it was derived. It is a short-cut which means no actual work need be done to get the answer, and so no learning need occur.

The result of these difficulties was that various remedies were tried and are still being attempted. They have been reactive to the problems that arose from time to time. These are described in the next section.

Remedies tried

Log books

After the first example, quoted in the introduction, the students were required to keep log books of all their working. When they discovered the loophole for accessing the answer they would have no working to show. They were informed that these books could be called in at any time and that they would be collected after the exam. It was also stated that three questions would be selected for each student where the working in the log books would be compared with the answers entered into Jellyfish. Thus it would be expected that all wrong answers entered on-line would be found in the log book and also the working that gave rise to that answer. If the log book working matched the answers the credit for their assessed questions would remain. However if there was a discrepancy then a mark out of 100 would be given for how closely the working matched their entries. Their total mark for the assessed problems would then be reduced accordingly. For example if the log book only rated 50% agreement and the student had 20 out of 30 for the assessed questions the mark would be reduced to 50% of 20 ie 10 out of 30. This worked well the first year it was implemented but over time with increased numbers of students (700 in 2008) and complaints from invigilators about collecting an enormous pile of log books, it was decided that the log books would not be collected after the exam. However it was still possible for a student to be required to produce a log book at any time during the semester, with the same penalties applying to the marks gained up to the date of the inspection of the log book.

Multiple solutions

A less obvious check on students was put in place by using problems that produced very different solutions that depended on the numerical values presented to the student. Such a problem is shown in figure 1. The numerical values for the parameters and the coefficients of t in the equation are those presented to one student. There are 3 possible solution scenarios depending on the values. The block may slip when t= 0, when the block has moved to the left or to the right. For those students that just copy the solution of a friend this problem becomes extremely frustrating. On the forum we have had questions/statements of the following kind, '*I used the solution of *** and he/she got it right but my solution is marked wrong. There must be a problem with Jellyfish and I would like my lost marks back*". We are taken aback by such admissions of copying while complaining about the system. It seems it is acceptable to be amoral when it benefits you but if you feel an injustice to you has been done then you take the high moral ground.

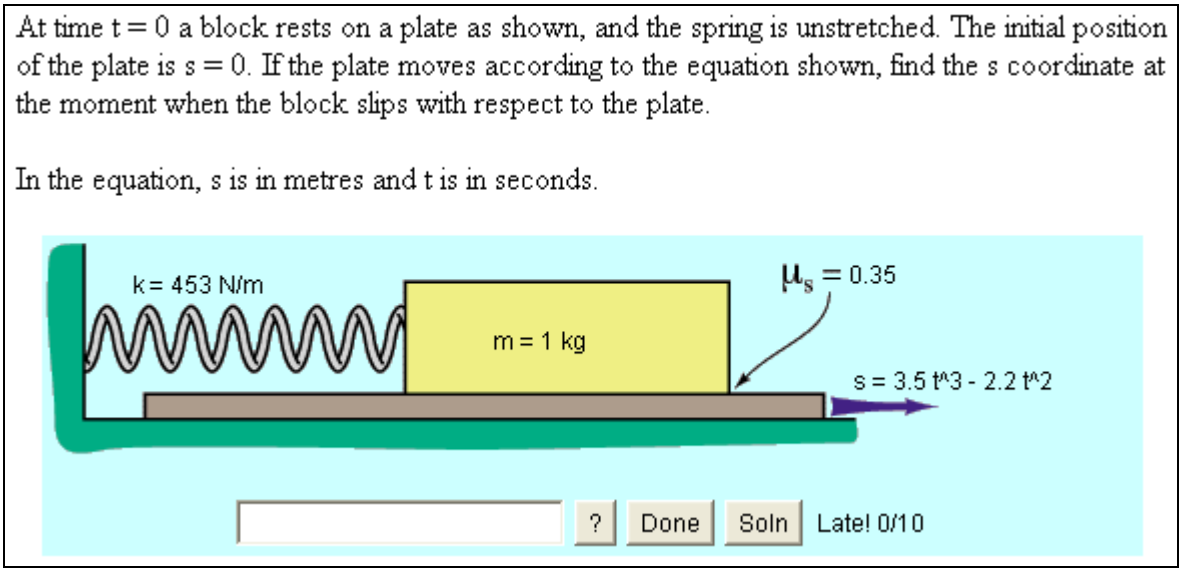

Figure 1: A kinetics problem with different solutions depending on parameter values. The solution is offered because the deadline has passed.

New problems

The most obvious way of preventing solutions being handed down from year to year is to generate new problems. This is very time consuming. The initial set of 200 problems was generated in 1995. The authors found it took around 90 minutes to generate a question that included the words, diagram, solution and computer code that examined the entered solution to see if it was within $\pm$ 2% of the correct answer or an expected wrong answer. It requires some skill to produce the diagnostics for wrong answers and some academics, who have generated their own problems for Jellyfish, have opted out of providing diagnostics.

Required and optional problems

As noted above, to generate a completely new set of diagnostic problems every year is not feasible on the grounds of the time required and the cost involved. It has been the practice to generate a few new problems each year in the topic areas where it was considered some aspect had not been covered by the original set.

By 2003 in some topics there were enough problems that it was feasible to require students to solve only a random selection. This was implemented by showing the menu of all problems to all students but marking some "required". In the most well-developed set there were 20 practice problems with 10 required. The idea was to make it less likely that two students sitting next to one another would have identical problems to solve. However the reality is that the students are quite sociable and mobile and it is not at all difficult to find some colleague nearby who is working on the same problem. To be

effective we think there would have to be vastly more problems than required problems, perhaps ten times as many.

Quizzes

The second semester dynamics unit has two quizzes and these provide an environment that does not allow cheating/plagiarism. In 2008 the students have been informed that if their quiz result is significantly different to their performance on-line they will have a viva. They will be required to explain solutions from their log books and their poor quiz performance. The results of this approach have yet to be determined.

Minimum exam mark

The extent and degree of 'plagiarism' has resulted in the requirement that to pass the unit a minimum mark in the exam was required. This has been set at 40% for the exam. There are those who would prefer to return to the exam counting for 100% of the unit. This is because for on-line assessments plagiarism is rife and there is often no way of knowing who has completed the assignment.

Polymorphic problems

One solution to the need for more problems is currently under investigation and will be tested in second semester 2008 in an optional follow-on unit to the common unit. Recall that the first-semester student has all students in the Faculty including those who will go on to study Electrical Engineering or Computer Science – and who we think therefore resent having to learn what they see as irrelevant content. The second-semester unit has only those students who will go on to take Civil, Mechanical or Mechatronics degrees and therefore may have a better attitude on average.

Most problems involve a set of parameters, for which numerical values are chosen randomly and shown to the student. The traditional problem type, for example Fig. 1, asked all students to solve for the same unknown parameter. To make such a problem "polymorphic" we will keep the code and diagram the same, but ask different students to solve for different parameters.

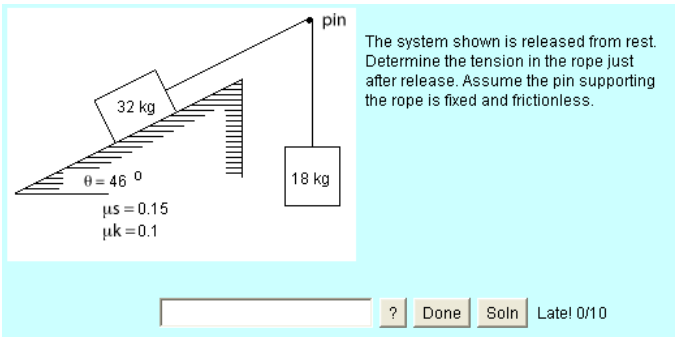

Figure 2: Problem Kinetics71008 in its original non-polymorphic form: all students solve for the tension in the rope.

To illustrate the work required to change an existing problem to a polymorphic problem, the java™ code for each case is shown in detail in Fig. 3.

It took one of the authors about one hour to modify the code, which is an acceptable investment of time provided the polymorphic behaviour does in fact lead to a real increase in individual student effort. The solution that has been historically provided after the deadline will no longer be available.

Alternative approaches

Plagiarism and possible solutions have received much attention. The penalty approach seems to be ineffective and giving good reasons against plagiarism has been recommended [Rudolph and Radcliff (2007)]. They suggest that students be informed that, *plagiarism may result in incompetent professionals that represent a safety risk to the community. Plagiarism can stifle the acquisition of key skills and knowledge that may stifle professional development and success. Plagiarism can reduce the community's value and belief in a degree title and the host university - which is to the disadvantage of*

the student. However the observation from the combined course at UWA is that students who see no relevance of the material to their degree course or of any application in their future employment are not moved by these reasons. Electrical/electronic students do not want to be studying a hard dynamics course in first year. The solution that is advocated by many is that of problem based learning.

Figure 3 Non-polymorphic and polymorphic forms of problem Kinetics71008.

Problem based learning

Many engineering programs around the world are now moving toward a more "problem based" learning approach. This means very different things in different places. The important point of PBL seems to be to increase the size and open-endedness of problems given to students, to allow the students to exercise higher levels of judgement within the problem context. Ideally the problems

chosen should also exercise lower level skills such as analysis. In well-designed PBL programs it is claimed that students have an improved attitude to their work, and also manage to learn the technical detail we desire [Kjersdam 1997]. The fundamental tenet of PBL seems to be that learning is proportional to the product of "Content" and "Enthusiasm", so that although the amount of "content" may seem to be reduced, it is learned so much more effectively that graduate academic competence is quite good. Meanwhile students are immersed in an environment more like that of professional engineering, with positive outcomes for skills such as time management, teamwork and so on. We agree with these ideas but have so far not found a way to implement them in our large first-year classes.

Conclusions

As teachers we wish to somehow get our students to work hard at learning, to suffer slightly in the short term in order to profit in the long term. We set up an environment which we think will have that effect, but the students do not necessarily respond by actually doing the expected work. It is like an electrical system in which there is a driving potential but the current does not necessarily flow through the desired load – instead there can be a short-circuit with no power delivered to the load. Or it is like an arms race in which the teachers increase their weaponry, only to find the students soon increase their armour. But it is deeply saddening that staff and students are in such an adversarial relationship, given that the staff want only the best for the students. To some extent this may be the result of very large classes where the teacher has little contact with any one student. The 'distance' between teacher and student seems to remove any feeling of 'letting down the lecturer' who is trying to help. It does appear that with very large first-year classes it is inherently difficult to stop/prevent plagiarism/ cheating.

We have done efficient teaching with computers for many years and the learning outcomes have been reasonably good. We now propose to invest a little more time to update our problem set and make it less easy for students to share low-level algorithms which amount to a short-circuit. The new polymorphic problem type may mean that students must now at least share a set of equations rather than a single equation, so perhaps this will cause an increase in the amount of learning in the important area of solution strategy.

It will be interesting to see what the threat of vivas accomplishes. As noted earlier those with significantly different quiz results to their on-line marks will have a viva with an inspection of their log books. This is likely to be very time consuming but may be worth the effort.

Finally, it does appear that the current cohort of students has very different morals/ethics to those of a generation ago. This bodes ill for the future and it is to be hoped that this issue will be addressed at home, in schools and at universities.

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