# Student Behaviour Near a Deadline as a Predictor of Academic Success

Nathan Scott and Brian Stone
*Department of Mechanical and Materials Engineering,*
*The University of Western Australia, WA 6907*
*nscott@shiralee.mech.uwa.edu.au*

**Abstract**

At The University of Western Australia a diagnostic, networked computer system is used to administer the entire first-year engineering dynamics course. A central computer records the actions of all students, so it is possible to form an idea of which students start work with enough time to spare, and which students leave things until the last minute. Correlation of this behaviour with high-school aggregate mark and with performance in a formal examination shows that the metacognitive skill of pacing oneself is a prime determinant of success in this typical maths / science subject.

**Key words**

*networked tutorial, metacognition, assessment, student characterisation*

## 1. Introduction

Engineering dynamics is the branch of mechanical engineering that deals with the effect of forces on moving objects. In some past years students have ranked the course at The University of Western Australia (UWA) their most difficult first-year subject. The difficulty arises from:

- the type of problems that are posed, in which the elements move about;
- the abstract nature of some of the quantities studied. It is difficult to visualise velocity and acceleration vectors that move, or to decide how connected objects will respond to forces; and
- the level of problem-solving ability which is demanded.

It is the third factor which terrifies the students the most. It is possible to memorise formulae, but the only way to do well in the examinations is to really *understand* how the taught material can be used to solve the problems. Some of the raw material of intelligence is also required since the problems are never exactly the same as any from previous years.

At UWA this course has traditionally been taught using lectures and small tutorial classes. In past years the tutorial classes have consisted of perhaps twenty students with one postgraduate tutor. Since there were typically 280 students in the whole course this meant that there were 14 such tutors. The classes would run for two hours each week for the entire teaching year. Despite this fairly intensive ‘contact time’ it was found that attendance at these classes was poor, and learning outcomes for many of the weaker students were not ideal.

## 2. Computer-mediated Tutorial System

Consideration of the failings of the traditional tutorial system in this subject led the authors to develop a new, computer-mediated tutorial system. A detailed description of the system may be found in Devenish *et al.* (1995). The main features of the system are:

- Students log in using a password.
- All the computer terminals are in one large room.
- Students attempt problems that are presented on the computer screen. The current problem must be solved before moving to the next.
- Students enter answers that are always a number with units e.g. ‘3.2 m/s’.
- There are typically eight ‘lead-up’ problems in each set, followed by two assessed problems. The assessed problems are marked based on the number of attempts required to obtain the correct answer. Although the ‘lead-up’ questions are not marked, they must be completed before the assessed questions can be attempted.
- The ‘lead-up’ questions form a carefully chosen sequence that explores each of the pitfalls of the assessed problems. An example question is shown in figure 1.
- The software surrounding the ‘lead-up’ problems is often able to ‘diagnose’ the difficulty with an incorrect answer, based on common student errors. If this occurs then the student can immediately view very specific explanatory material related to the misconception.
- All student actions are recorded by a central ‘server’ computer. Students who fall behind are thus easily spotted.

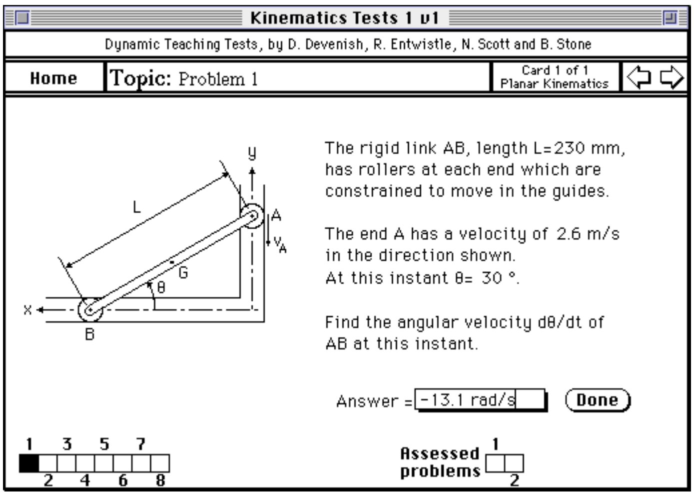


Figure 1. A typical ‘lead-up’ problem card

Tutorial classes in this new environment consist of perhaps 40 students with one tutor. Although students can and do come into the room outside the official tutorial hours, there is still a strong preference for the supervised times. The tutor is usually not in great demand since most students are able to get the help they need from one another or from the explanatory material surrounding the problems. The tutor certainly does not have a central role, and never commands the attention of the entire class.

The student response to this new way of doing tutorial classes has been overwhelmingly positive. In a survey taken in June 1994 a large proportion of the class requested that the method be applied to another core first-year unit, engineering statics. It is suggested that this response is due to

- the careful choice of the problem sequence,
- the availability of worked solutions,
- the degree of collaboration which is possible in the computer lab, and
- the diagnostic nature of the assessment.

### 3. TEE as a Measure of Performance

In Western Australia final-year high-school students complete examinations in their chosen subjects. The marks for these exams, with a component for coursework through upper school, becomes a measure of academic performance called the TEE (Tertiary Entrance Examination) score. This score is used by the mainstream tertiary institutions to rank and select candidates for admission. Therefore it is of interest to compare this measure to a measure of success in Engineering Dynamics (figure 2). This chart unfortunately represents only about 100 out of 270 students for 1995, but it does suggest there is at best only a weak correlation between the measures: success at high school is not a strong determinant of success in dynamics.

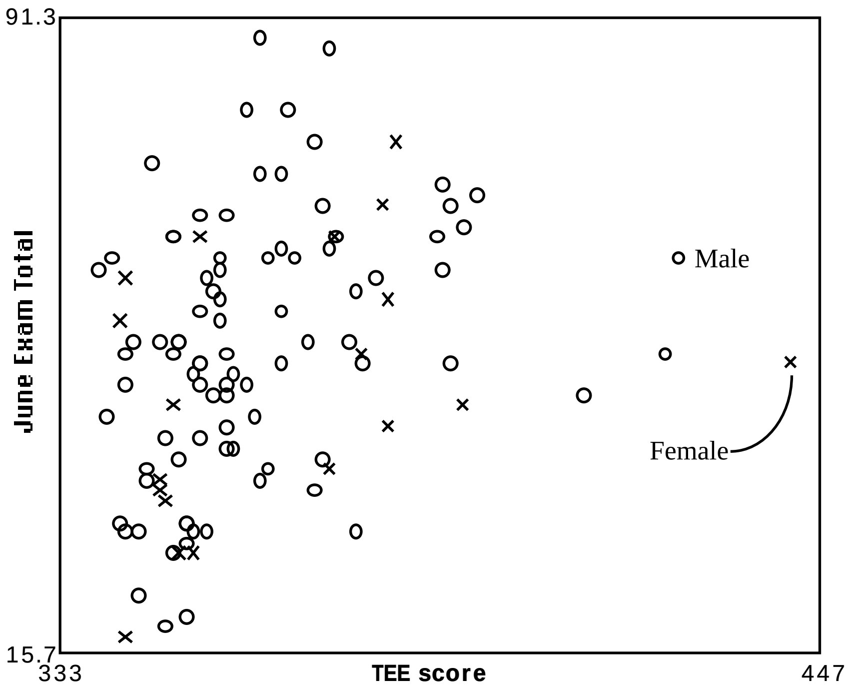


Figure 2. Poor correlation between June Exam and TEE scores

## 4. Student Behaviour Near a Deadline

Success at university is at least somewhat determined by metacognitive skills, rather than simply intelligence. Metacognitive skills include the ability to pace oneself, assign appropriate priorities to tasks, and correctly estimate task difficulty. Another important factor in successful learning, currently under investigation in many quarters, is the relationship of learning approach to learning outcomes. In a given learning environment, do I do just as much as will satisfy the requirements of assessment, or do I see it as an opportunity to really understand something new?

In the context of this new tutorial environment, where student actions are centrally recorded, there seemed to be a unique opportunity to study numerical measures of these metacognitive skills and compare them to traditional measures of academic success. The danger inherent in development of such numerical measures of performance is that it automatically places the 'blame' for student failure squarely in the students' camp; there is no room in the analysis for the idea that perhaps the teaching method is at fault! (Entwistle 1984, p. 12).

The deadline for each problem set was well known to the class. It was published with each set and also announced in the lectures. It was also well known that assessed problems handed in late received no marks. On average deadlines occurred ten days apart, and there were perhaps ten questions in each set. The majority of students kept to the deadline schedule; on the day after a deadline typically less than 10% of students were 'late'.

It was observed that the computer room became very crowded on the deadline date. Students would queue for computer terminals in order to enter their answers. To teaching staff this was not amusing since at other times during the ten days the room may have been essentially empty during assigned tutorial sessions. An interesting footnote to this observation is that when surveyed some students perceived that there were too few tutors in the class. The situation became so extreme at times that some students claimed to have been unable to complete the work due to a shortage of terminals. Although actual lateness was comparatively rare, many students *risked* lateness by trying to do the work 'at the last minute'. This attitude to deadlines was also observed by Jones and Kane (1992), who allowed students to submit work at midnight on a Sunday and found that as much as a third of the class began the assignment on that day.

### *4.1 Measuring lateness*

If a student is choosing to leave work until 'the last minute', and then blames failure on an external factor such as perceived overcrowding, does this behaviour correlate with marks awarded in formal assessment? To answer this question we need some way to numerically characterise the 'chronically late' student. We tried several parameters, and found the 'best' correlation with one we will call 'final earliness'. It is defined as

| |
|---|
| The average number of days before the deadline that the last problem in each set was completed. |

Or symbolically as

$$e_f = \sum_{i=1}^{n} \frac{d_i - t_i}{n}$$, where

$e_f$ is the parameter, 'final earliness', n is the number of problem sets,

$d_i$ is the deadline time expressed in days, and

$t_i$ is the time the problem set was completed in days.

The time measures in days are naturally from some arbitrary reference, for example since the beginning of first semester. In this work fractional days were considered since the sum was actually done using absolute ‘Macintosh’ times in seconds recorded by the serving software.

## 5. Results and Discussion

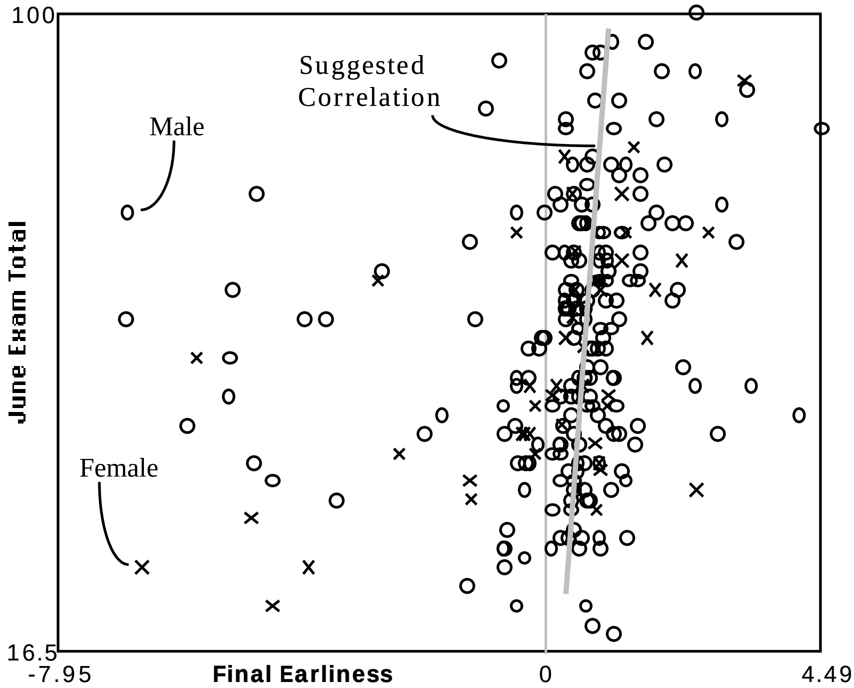


Figure 3. June Exam total versus Final Earliness as of late August 1995
Each data point represents one student in a class of 270.

Considering only the first 13 topics, consisting of about 130 ‘lead-up’ problems and 28 assessed problems, we were able to generate the plot of figure 3. The division of the class of 270 into male and female students was done for some other work not reported here; for the purposes of this work there was no appreciable difference between the sexes.

Figure 3 should be compared to figure 2, where the same examination result is plotted against TEE results. The correlation shown in figure 3 is not particularly strong, but it is stronger than that of figure 2. It should be noted that the line shown in figure 3 was **not** calculated from the data: it is simply to draw attention to a prominent grouping of data points.

In general it seems that a student who submits work *on average* a day or so early has a higher chance of getting a superior exam score. The difference of a *single day’s work* between the high achievers and the low achievers was surprising to the authors. Does this single day distinguish students who intend to learn deeply, or at least responsibly, from those who are simply there to ‘get the marks’? In the case of courses with large class sizes, this observation may allow us to offer new kinds of feedback to the students. Currently the tutorial software attempts to diagnose conceptual errors in each problem using the answers entered by the student, but it never attempts to diagnose ‘errors’ in general habits of study or ways of approaching learning opportunities. If we were to calculate the ‘final earliness’ parameter half-way through the first semester, and tell the student what our experience suggests based on it, might this level of feedback prompt students-at-risk to examine how they work through the material?

## 6. Conclusion

The nature of the current tutorial software in use at UWA allows us to ‘sample’ the students’ tendency to hand work in late. A correlation between a measure of this lateness and marks awarded in a formal examination suggests that the difference between excellent students and average ones manifests itself in a willingness to start work with a day to spare. The quality of starting early predicted success in an examination better than the TEE entrance score.

## 7. Acknowledgment

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