

Distance Tutoring in Mechanics

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Abstract—Tutoring has been a central part of the educational system at the long established universities of Cambridge and Oxford in the UK. Previously, at most two students could be tutored in the mathematical sciences, one on each side of the supervisor. Today in the age of computing and Internet, any number of students, in principal, could be supervised at a distance, as each student will be sitting in front of his or her own computer. This paper describes an attempt to carry out tutoring in the subject area of mechanics in small groups and at a distance, i.e. the tutors and the students communicate via an Internet based e-meeting system rather than being present in the same physical room. This is used at a KTH (Sweden) mechanics distance course supported with tutoring from AUT (New Zealand) and the reverse tutoring of students at a regular mechanics course at AUT tutored from KTH.

Index Terms—Tutoring, collaborative learning, peer learning, peer assessment, flexible learning.

I. INTRODUCTION

The central rationale of our project is the fact that tertiary education enrolments is increasing drastically. It will be impossible to expand the traditional universities to keep up with these both as regards infrastructure and qualified human resources, especially if one wishes to preserve the present standards of tertiary education.

The solution is to expand the present university paradigm to include distance education to reduce the need for extensive premise investments and to use more effectively distributed competence resources.

This can come about in various ways: Traditional universities can expand their educational programs, new universities - like open universities - can be started to specialize in distance education, or institutes can specialize in a few subjects, and students can enroll for individual courses. And universities can specialize in course delivery methods, educational and pedagogical methods, and in examination methods. Student cohorts may cooperate globally in synchronous or asynchronous modes independent of place. To handle laboratory work there is an extensive development of remote laboratories.

There is intensive activity taking place as regards international accreditation, and once the main issues have been resolved students will be able to put together an education by taking different courses at different universities.

II. TUTORING

A. Human Contact

One important issue which always appears when discussing the future of distance education is the importance of human contact. This regards both student-student interaction and student-teacher interaction [1]. It is important that distance education does not consist of students solely interacting with a computer no matter how sophisticated the software. We believe this is an important component in all forms of education.

To introduce an element of community in our distance course in mechanics we have introduced the concept of “tutoring.” Tutoring has been a central part of the educational system at the long established universities of Cambridge and Oxford in the UK. Previously, at most two students could be tutored in the mathematical sciences, one on each side of the supervisor. Today in the age of computing and Internet, any number of students, in principal, could be supervised at a distance, as each student will be sitting in front of his or her own computer. Recent developments in hardware and software have made it possible for each student to be fully active at the tutorials.”

In the original Oxbridge system, tutoring is a form of supervision, whereby the students discuss and work through topics and examples. Tutoring is basically aimed at engaging and stimulating the student in the subject.

Today this is a possible model for distance education. We wished to simulate a tutorial whereby a group of students sit together with a tutor and discuss various topics in mechanics. An interesting point is that computer networking allows a lecturer to tutor more than two students in mathematical subjects.

B. Selected Disciplines

An introductory (basic) course in mechanics is essential for most engineering schools. One reason for this is the mechanics studies *per se* of motion, forces and the relations between them; related to this is the basic vocabulary it gives, needed for studies in many engineering and science courses. Another reason is that because of the subject’s emphasis on problem solving, it develops the students feeling for mathematical modeling. A third reason is a general insight into scientific thinking and reasoning.

It has been well known, for many years, that students find the study of mechanics difficult; the mathematical treatment *per se* may create problems but also physics misconceptions are common and students meet difficulties to distinguish between reality and model, have

difficulties to select a relevant model and to perform physical and logical arguments [2, 3].

These more general difficulties manifest themselves in more specific discipline oriented problems as wrongly constructed free body diagrams with wrongly introduced contact forces, inability to time differentiate and integrate kinematics quantities (as position, velocity and acceleration) correctly, problems with using vector algebra, problems with understanding the difference between a definition and a theorem which lead to difficulties in handling formulas and derived quantities.

We believe that the use of non-traditional teaching and examination forms with project work in small groups and with support from interactive learning environments with intra- and inter-group peer support and instructor tutoring will create better learning and understanding in mechanics [2, 4].

C. Selected Tutoring Methodology

Up to very recently it has not been possible to attempt serious distance tutoring in any of the mathematical sciences, basic mechanics, mathematics, physics, fluid mechanics, thermodynamics, etc. This is because such subjects have required the student to be present besides the tutor as they discuss the subject using pen and paper by writing down formulae and drawing diagrams as they go along.

However to simulate the tutoring environment is now possible using recent developments in computer technology, in both software and hardware.

On the software side free available systems as MSN Messenger have appeared [5]. MSN Messenger allows one-to-one communication voice and video conferencing. Each participant has access to a whiteboard which both can write on (text, formulae, diagrams) and can show each other documents and other programs which they have on their individual computers, as well as surf the net together. All that is needed is a connection to the Internet. A webcam may be used if both have access to a high speed connection but this is not essential when studying mathematical subjects.

On the hardware side, besides preferably a headset, participants may use a graphics tablet which is superior for use on the whiteboard compared with a conventional mouse. Experiences show that many prefer an inking pen in combination with a paper on the surface of the tablet. Without inked text the eyes go from the tablet surface to the computer screen and some then have difficulties to write readable text. Such hardware diminishes the problems of discussing technical subjects with mathematical content at a distance. Access to a scanner or fax can prove useful for preliminary submission of material by student.

Fast Internet connections allow connection of more than two persons via meeting conference systems. The software system we chose was Marratech [6]. It allows us to hold scientific discussions of a mathematical nature. And it has an excellent whiteboard which facilitates diagram drawing even in real-time, with many useful features. As regards writing formulae in real-time we decided that all students as well as the teacher would have a digital tablet linked to their computers. Using a digital tablet one can write formulae in real-time as easily as writing with pen and paper. Once again we can note that

this set-up is more conducive to mathematical discussions as compared to traditional tutorials where the tutor and two students share the same piece of paper. All participants have a headset and a webcam, but this last piece of equipment is not at all essential.

D. Accomplishment

During 2005 we have experimented with tutoring in distance education in mechanics. The actual tutorial takes place in real-time, however deciding on the time of tutorials usually meant correspondence using e-mail. Two departments have taken part, Department of Mechanics, KTH, Sweden and Mechanical and Production Engineering Department, AUT, New Zealand. Four students at AUT have been tutored from KTH. In the other direction four Swedish students were tutored from AUT.

The choice of four students per group is based on how much funding a student brings in to the department for taking part in a particular course and the staff costs per hour. The figures for New Zealand and Sweden are quite similar and probably many other countries in the industrialized world would have similar figures. Assuming most resources in a distance course is spent on tutoring we found that the course would be economically viable if tutorials have four to six students although probably six is more realistic.

III. CONCLUSIONS

To be economically practical we need to test the system on groups of four to six students. This is what we used have started.

Large tutorial groups will be necessary for most universities where the student staff ratio is much higher than at Cambridge or Oxford in the UK.

In fact traditional tutoring in mathematics, mechanics, etc. can only be done satisfactorily with at most two students, one on either side of the tutor. On the other hand computer networking allows a lecturer to tutor more than two students in such subjects. In fact it is not even necessary to use Internet if all the students can be physically in the same locality. A local computer network is enough and will probably not have the same technical problems we experienced. Thus economically there opens up the possibility of tutoring in mathematical subjects at campus universities with high student staff ratios.

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