

Engineering Education by Distance Learning

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Abstract: To overcome the constraints and inflexibility imposed by conventional university education techniques; a new approach to Masters Degree qualifications has been developed at UMIST that exploits Distance Learning. The course in chemical engineering at masters degree level has been developed and structured in a way that enables a part-time student to work away from the University, but ensures that there is no deprivation of facilities. The teaching material is provided on CD-ROM or via the Internet using audio accompaniment. The methodology essentially provides a virtual classroom. The course is being made available outside the UK for forging university partnerships. The first such partnership was made between UMIST and Monash University in Australia, which is now offering a joint degree course with UMIST. Other such partnerships are planned for the future. The core of the course material is common to full-time and part-time students in the UK and students around the world.

Keywords: distance learning, virtual classroom, master of science, joint degree courses

1. Introduction

Traditional university education is both inflexible and expensive in terms of the human resources required for teaching activities. These conventional methods of teaching students via lectures and tutorials have hardly changed since the middle ages. The availability of personal computers and the Internet has opened up enormous opportunities to radically rethink the way education is conducted.

The Department of Process Integration at UMIST has been carrying out research into advanced chemical engineering design for a number of years. To ensure exploitation of the research, the Department has also been active in technology transfer through a provision of training for industrial sponsors, public training courses and masters level degree teaching in advanced process design. The need to provide technology transfer to an international group of industrial sponsors led the Department to experiment in methods of distance learning. Methods for providing training for industrial sponsors via distance learning were developed and these were then adapted to the provision of distance learning for Master of Science students. The Department now runs a part-time degree as well as the full-time degree. Joint degree courses are also being set up with a number of partner universities around the world. The first of these, at Monash University in Australia, has started extremely successfully. Others will be started in the near future. All of the students engaged in part-time Masters courses, both in the UK and Australia, are in full-time employment and studying for their masters degrees either in the workplace or at home.

The approach that has been developed can be readily applied at the undergraduate level to replace some of the conventional teaching. In this way, conventional undergraduate teaching loads could be considerably reduced. However, tutorial support is considered especially important if the methods are to be applied at undergraduate level.

The approach can also be adapted to training for continuing professional development. It is more and more considered necessary for the education process to be lifelong, rather than just during the university years. Distance learning programmes can be developed for engineers working in industry to keep up to date in a way which does not require them to leave the workplace for training and provides considerable flexibility for continuing professional development. This will also allow specialist research carried out at centres such as UMIST to be disseminated much more effectively.

2. Teaching and Learning Methods

To provide adequate methods suitable for distance learning requires a different approach from that used in most formal university courses. The structure and style adopted in the UMIST approach is standard for both full-time and part-time students. The structure of the course involves a combination of taught modules and design projects, with a research project. The style is such that lectures are kept short and include working sessions between each lecture. For the full-time students in formal classroom education, these are used to consolidate understanding. For part-time students in distance learning, they again support understanding but also provide a measure of self-assessment for the

students. The current course structure requires students to undertake nine formal taught modules from a list of twelve. In addition to the requirement to undertake nine formally taught modules, students are required to take a series of design projects, which collectively constitute a tenth module. These exercises are more open ended and intended to exercise the principles learnt in the taught modules. Finally, to complete the requirements for Master of Science, students are required to engage in a research project and to write a dissertation, or minor thesis. For part-time students engaged in full time employment, the research project is chosen to relate to the activities of the company employing the student.

The structure of the course provides flexibility for students to pick a range of modules and a research project suited to their requirements. Given the use of working sessions throughout the modules, allows students to consolidate their education, assess their own progress and to provide confidence in their ability to solve problems.

Clearly, other styles could be developed for distance learning. However, the one described here has been developed over a number of years and found to be successful for the subject matter to be taught in chemical engineering.

3. Presentation Format for Taught Modules

Each lecture constitutes of series of slides presented electronically. The slides have a high emphasis on graphical presentation and only key words and phrases in support of the graphical presentation. For full-time students the slides can be used in a classroom using electronic projection in a more traditional style. For part-time students engaged in distance learning, slides are presented on a personal computer with each slide given an audio back up. Modules are presented either using CD-ROMs or via the Internet. For the lectured modules, the CD-ROM is the preferred method because there are significant delays in downloading large amounts of information via the Internet. Also, there is no particular advantage in using the Internet for the taught modules as the modules are pre-defined and not subjected to significant changes over short periods of time.

An experimental package was developed a number of years ago for teaching a specialist subject that used a multi-media authoring package that allowed a large degree of student interaction with the material. However, this demanded an enormous resource to develop even a small module. Maintenance and updating were also extremely time-consuming. The present approach is much simpler and requires considerably less resource to set up. Maintenance and updating are also extremely simple. The elegance of the approach used is in its simplicity, rather than its sophistication.

4. Remote Access

Students engaged in engineering education often have the need to use advanced software in support of their education programme. This is required for various exercises, design projects and the research project. For the UMIST masters degree, students need to access specialist software packages, which have been developed within the Department and also commercial software packages, such as simulation software. Remote access is provided to students by making the software available on a server at UMIST. To access this software, students require Internet access via a dial up service. Access to the server at UMIST is protected by a security system.

5. Student Interaction

The style and structure of the modules are such that students tend to require much less support than using more traditional teaching methods. However, there is always the need to provide some level of support. Students need to be given the option of visiting a local centre, perhaps twice a year, for help with any problems. Such sessions can be used to consolidate understanding and to provide additional exercises for students to solve to provide confidence and help with the examinations to follow. However, such infrequent contact is far from sufficient to provide the support necessary. Here, the power of the Internet can provide the necessary support. E-mail is the first obvious option and this has proved to be very efficient and very effective as a mechanism for dealing with minor problems. Internet-based discussion groups have also been provided, which allows a better simulation of a team-working environment. For more substantial problems, desktop video conferencing can be used, again via the Internet.

6. Course Duration

The course materials are identical for full-time and part-time students via distance learning. Full-time students complete the masters degree in one year. Part-time students complete the course in a minimum of two years. Examinations are conducted for part-time students in the same way and to the same standard as full-time students. This obviously requires a centre for part-time students via distance learning to be able to attend.

7. Partnerships for Global Education

The electronic provision of teaching and learning, in principle, allows the educational system to go global. However, it is still at this stage considered necessary to provide some face to face contact for tutorial support. This means that, even though education can go global, there is still the requirement for local centres for students to be able to attend for tutorial support and for examinations. Partnerships are currently being forged between UMIST and a number of universities around the world for provision of joint degree courses. There are legal issues associated with having true joint degree qualifications. To avoid such legal problems and the necessary changes in the constitution of universities, the partner universities award the degrees. However, the degree certificate carries the testamur of both universities. A Memorandum of Understanding has already been established between UMIST and Monash University in Australia. This has now been operating successfully for over a year and the first students are expected to graduate at Masters level in 2001.

Distance learning techniques not only allow more efficient and flexible teaching provision, but also allow specialist research from centres such as UMIST to be made available much more rapidly and effectively available than using conventional methods of technology transfer.

8. Some Concerns

The framework outlined in this paper for provision of education by distance learning does, in principle, allow truly global education. However, the fees in one country do not easily translate to the fees in another country because of differences in currency and local economics. Fees need to be charged at a rate that is appropriate for local conditions. This needs to be taken into account in the overall economic viability of the course. Also, given the fact that students are engaged in full-time employment, there needs to be a flexible provision for examinations. Part-time students need to be able to defer examinations because of excessive workload in their employment or personal problems. One way around such problems would be to use continuous assessment, rather than formal examination. However, continuous assessment is almost impossible to police via distance education. It is considered that the only way to ensure that standards are maintained is by formal examinations.

The evidence so far from the examinations carried out is that there is no significant difference between the performance of part-time and full-time students in the examinations.

9. Future Development

The mechanism for presentation of the teaching material via electronically projected slides is not the most effective method that could be used. The biggest drawback of this approach is that there is no scope for interaction with the material. It is obviously possible to be able to animate the slides. However, what is not possible at the moment is to co-ordinate the animation with the audio support. It is hoped that this will be able to be overcome in the future and to be able to allow more interaction without providing an undue burden on resource.

At the moment, the beauty of the approach is in its simplicity. The current system is readily put together and easy to maintain. It is also likely that in the not too distant future, it will be more practical to download large amounts of data via the Internet. This will eliminate the use of CD's and simplify the organisation and maintenance of this system.

10. Concluding Remarks

To overcome the constraints and inflexibility imposed by conventional university education techniques, a new approach to Masters degree qualifications has been developed at UMIST. This exploits distance learning methodologies. The course in Chemical Engineering at masters degree level has been developed and structured in a way that enables part-time students to work away from the university, but ensures that there is no deprivation of facilities. Teaching material is provided on CD-ROM or via the Internet using audio accompaniment. The methodology essentially provides a virtual classroom.

The approach that has been developed for masters degree education can also be adapted to undergraduate teaching and training for continuing professional development. In the future, the teaching modules will be offered on an individual basis for professional development via distance learning. This will allow engineers working in industry to keep up to date in a way which does not require them to leave the workplace for training and provides considerable flexibility for continuing professional development.