The role of audiovisual technology in remote engineering/science education: case study of videoconferencing and online delivery

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Abstract
A programme of courses in molecular simulation techniques has been developed recently at the School of Chemical and Bioprocess Engineering at UCD, in conjunction with groups/departments at other Irish universities, under the auspices of the Nanoscale Simulators in Ireland. This is aimed partly at students in engineering and science beginning postgraduate-level research, although interested undergraduates, postdoctoral fellows and staff are also encouraged to attend. A key feature of the series of courses is the reliance on remote audiovisual teaching technology, via simultaneous videoconferencing and online delivery, and subsequent online archiving of material and lecture sessions. It was found that the numbers attending the courses grew by some 40% vis-à-vis initial numbers over several months, as the remote/online availability was found to attract students in comparison to more conventional teaching methods.

Keywords: videoconference, remote teaching, online learning, audiovisual technology

1. INTRODUCTION
Advances in videoconferencing technologies have facilitated the development of remote and, crucially, interactive, teaching, learning, collaboration and research [1-3]. Coupled with this has been the increasing popularity and sophistication of online resources for delivery of lectures/content, archiving of material, or group-based communication [4]. Many of the younger generation of potential future engineers and scientists have become accustomed to such audiovisual and web-based technology from an early age, and are comfortable with this as a learning environment. Therefore, the development and successful delivery of courses via remote teaching technologies at both undergraduate and postgraduate level is increasing in importance [5], and high-quality approaches in this area may serve to
attract students to engineering and science education. The aim of this paper is to outline recent experiences at University College Dublin (UCD) and other Irish institutes in an inter-institutional remote teaching and learning environment, focussing particularly on videoconferencing.

2. PROGRAMME PHILOSOPHY

A programme of courses in molecular simulation techniques has been developed recently at the School of Chemical and Bioprocess Engineering at UCD, in conjunction with groups/departments at Queen’s University Belfast (QUB), Trinity College Dublin (TCD), University College Cork (UCC) and the Irish Centre for High End Computing (ICHEC), under the auspices of the Nanoscale Simulators in Ireland (NSI). The courses comprise aspects of statistical mechanics, classical molecular simulation and first-principles quantum-based calculations, and a complete list is available [6]. These courses are aimed partly at students in engineering and science beginning postgraduate-level research, although interested undergraduates, postdoctoral fellows and staff are welcome to attend. The programme is intended to facilitate an introduction into the techniques of molecular simulation at the nanoscale. Maturing algorithms, approaches and computing power have led to the increasing use of computational techniques for many diverse applications [7], and this underpins Ireland’s future development in technology and innovation [8]. Clearly, the availability of high-quality training throughout Irish universities is required to attract bright and committed young engineering and science students to this area, and this motivated an all-Ireland approach by the NSI to the development of this education initiative.

Detailed curriculum design was undertaken during Spring 2008 by the course instructors, and the courses commenced in Autumn 2008 and proceeded through to Spring 2009. The courses were delivered by simultaneous videoconference and online delivery from each institute (vide infra), although many local students and participants opted to be present physically for each lecture given by the instructor.

3. VIDEOCONFERENCING & TECHNOLOGY

The role of communications technology, particularly in the audiovisual area, was crucial to delivering the courses remotely at each site in an interactive way. Both traditional and web-based audiovisual technology was used to allow teaching for small/medium groups at several remote locations. IP-based videoconference networks were installed and commissioned at each institute to communicate interactively via the H.323 protocol over the Irish Higher Education Agency’s network’s (HEANet) Multipoint Control Unit (MCU)-based ‘gatekeeper’. However, use was also often made in tandem of inexpensive PC/laptop-based videoconference software to broadcast desktop lecture content at high digital resolution to the MCU, to complement the dedicated fixed/portable videoconference equipment. In addition,
lectures were broadcast in real-time online via streaming on a dedicated HEANet website; this required only a web-browser and broadband internet connection for those to view without access to either videoconference facilities or inexpensive PC/laptop VC software. The videoconference sessions were recorded and also archived online as video files by the HEANet along with the original material (slides, exercises, etc. [6]). In some locations, ‘smart’ boards were also used for lecture delivery to allow real-time broadcast ‘electronic scribbling’ on top of the lecture notes, akin to a physical blackboard, and these were also recorded ‘live’ and statically on the lecture slides and archived. The simultaneous use of desktop videoconference software broadcasting to the MCU gatekeeper allowed these ‘electronic scribbles’ superimposed on the lecture material to be viewed in full resolution. In practise, it was found that high-quality audio facilities were essential and echo-cancelling and noise feedback technologies were employed in all microphone and speaker systems to ensure a smooth audio experience.

4. DYNAMICS OF COURSE DELIVERY

The dynamics of teaching and learning in small groups have been studied extensively, e.g., [9]. However, course delivery in several ‘hybrid’ small groups present either physically or ‘virtually’ was found to be different in rather subtle ways. Chief among these was the requirement of the lecturer or tutor, as the de facto video conference ‘host’, to regulate question-asking and comment-making in the lectures and tutorials by the students to avoid too many simultaneous questions from each group present physically or remotely. In the case of those of those viewing via web-based streaming, questions could be taken by telephone in the instructor’s classroom with the telephone on loudspeaker mode so as all participants could hear. However, an etiquette / pattern was soon established to manage the interactive communication once participants became accustomed to the mode of delivery.

Other aspects of the dynamics, from the lecturer’s perspective, which required careful consideration and calibration included:

(i) The maintenance of eye contact both with those present locally and with the camera by switching whilst speaking;

(ii) Speaking more slowly and distinctly;

(iii) Asking those present ‘virtually’ at each site (either remotely by VC or by live web-streaming) if they had questions on a frequent basis and waiting up to 10 seconds for an answer;

(iv) Muting the microphone when not speaking for more than 10 seconds or so to minimise any background noise and echo (particularly if the echo-cancelling audio set-up is not operational or at optimal settings);

(v) Saving the electronic ‘scribbles’ on top of the screen for subsequent online archiving as lecture recordings and static notes documents.
Following group-based discussions between students and instructors after several months’ experience, the general view amongst the participants was that the overall pedagogical goals were well served by the combination of local and remote groups using videoconference technology. These goals were as follows:

(i) Increase technical knowledge of the courses whilst interacting with the lecturer and other students to pose questions ‘on-the-fly’;
(ii) Develop a network of colleagues and student peers with whom course exercises, tutorials and research questions can be discussed;

It was found that the numbers attending the courses grew by some 40% vis-à-vis initial numbers over a six-month period, as the remote/online availability attracted students greatly. This was evidenced by positive comments from the students that the courses, which were very helpful and interesting for them, were available to them at all, whereas previously they had often not been. The limited numbers of students interested in these courses (40-50 nationally) and lecturers available (approximately 15), and in particular in each institute (5-15 students and 2-5 lecturers), meant that it had not usually been previously viable to deliver the courses locally (in terms of teaching expertise and reasonable minimum number of students). The ‘economies of scale’ for student numbers and pooling of teaching expertise via remote teaching facilitated the development of an entirely new programme and curriculum which had existed previously, if at all, in a more ‘patchy’ and ‘ad hoc’ fashion at each institute with a much more limited curriculum.

5. CONCLUSIONS

An inter-institutional programme of courses on molecular simulation has been developed and delivered via videoconference and web-based technologies. It was found that the courses were met by enthusiasm, and group discussion led to good feedback for future changes and refinements by both the students and instructors. It is intended to expand on the courses somewhat during the 2009-10 academic year, incorporating many of these suggestions with respect to course content and technical aspects of remote teaching.

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References