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Cyber Astronomy: a cyber university course for school students

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Abstract

Teaching university physics through the internet is not new, but a new course providing the same service for secondary school students is the first of its kind in Hong Kong. Taking advantage of the fast and affordable broadband internet in the region, some university courses have been converted to a cyber curriculum suitable for secondary school students. In the spring semester of 2002 an astronomy and astrophysics course has been offered for the first time to secondary school students in Hong Kong via the region's first Cyber University project for secondary schools. The course *Introduction to Astrophysics and Astronomy* is a general education course offered by the department of physics at the Hong Kong University of Science and Technology (HKUST). In this article, we will describe our experiences in designing and running the course, discuss its effectiveness in comparison with traditional classes and suggest some possible future directions.

Introduction

The development of efficient networks and powerful computer programs in recent years has created a new medium for education—the internet. To make the internet a useful tool for teaching and learning, a number of supporting components must be implemented to make it work (e.g. communication and video conferencing, Bazley *et al* 2002). More and more institutions around the world are now distributing their courses via the internet. Because of the popularity of these web-based courses, some institutions have even designated special centres to help faculties to convert their traditional courses into web-based ones (e.g. Bothun 1996, James and Hodgson 2001). As well as distance education, classroom teaching has also benefited from these technologies through purpose-built multimedia teaching studios (Yu and Stokes 1998).

One of the first university astronomy courses designed for high school students was the 'Cosmology Distinction Course' offered jointly by the University of Western Sydney Nepean and the Blue Mountains Grammar School in Australia (Hollow 1995). The course was taught in a semi-distance learning mode with a residential component.

The physics department of the Texas A&M University in the USA has already developed a virtual physics department (Suson and Hewett 1999). In fact, online learning and virtual universities are becoming a trend all around the world; countries such as the UK and Pakistan have recently announced a nationwide virtual learning programme for school and public education (BBC 2001, 2002).

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Table 1. Hardware and software requirements for the course.

Hardware	Software	Network
• Pentium II or above • 128 MB RAM • 2 GB hard disk • Display card • Sound card • 17″ colour monitor • Speakers or headphones	• Windows 98/ME/2000/XP • Internet Explorer 5.5 or Netscape 4 or above (free) • RealPlayer (free) • Adobe Acrobat Reader 5 (free) • Shockwave 8 and Flash 5 Plug-ins for Internet Explorer or Netscape (free)	• 56K modem for general viewing • 'Broadband' for videos

'Introduction to Astrophysics and Astronomy' is a general education course offered by the department of physics of HKUST (Wong *et al* 2001). The cyber version has been offered to a group of gifted secondary school students through the *Cyber University for Academically Gifted Secondary School Students* project managed by the department of computer science of HKUST (Pong 2001). At the end of the course a certificate, worth three university credits, will be issued to those who have completed the course successfully.

A similar project was on trial at University College London in the UK for distance learning of a third-year university course on High Energy Astrophysics (Parker and Puchnarewicz 2001). The video teaching used a two-way audio and video system with live lectures delivered via the internet onto two large screens, one displaying the PowerPoint presentation and the other displaying the lecturer. The lecturer could see the studio on a computer monitor and hear the students via microphones placed around the room. A normal classroom whiteboard and a separate camera are also used in the trial.

Unlike the course given by UCL, our course is not conducted live. All lectures are pre-recorded in advance; only the question-and-answer (Q&A) part is conducted live. There are many advantages in not having live lectures. First, since we know the length of each presentation, we can plan our lectures more effectively. Second, the instructor and teaching assistants can spend more time on online facilitation via chat rooms and Live Q&A. There are also technical advantages: the bandwidth requirement would increase if we tried to stream two video components synchronously.

Course development

Developing a cyber university course is much more than just converting a set of lecture notes into a collection of web pages. A web-based course consists of a whole range of multimedia elements. Everything from lecture notes to problems and exercises has to be modified into a set of web-based objects suitable for internet distribution and learning. Apart from efficient networks, a powerful software platform is vital for distributing courses via the internet. For the present course, we have chosen WebCT™ as our platform for distribution. The highly customizable menus and items on WebCT™ enable us to implement a collaborative virtual learning environment ideal for on-line learning (Simoff 2001). We will not attempt to give a review of the WebCT™ platform here; interested readers can go to the WebCT™ website (www.webct.com) for details. The hardware and software requirements for this course are shown in table 1.

In developing this course, we tried to keep the resource requirements to the minimum. For instance, the lecture notes are presented in two formats: *HTML*⁺ and video. The *HTML*⁺ format is a hybrid construction composed of three elements: text, picture and sound. The bandwidth requirement for this hybrid construction is 56 kbps, a normal modem speed. This hybrid construction has a definite advantage over other existing constructions in terms of bandwidth requirement, e.g., *Microsoft Producer* by Microsoft and *RealPresenter* by RealNetworks. The low bandwidth requirement of our hybrid construction is achieved by using highly optimized images (text and picture) and multi-bandwidth *RealAudio* voice streaming. Screen-capturing the original PowerPoint slides helped us reduce the production time from hours to minutes, while maintaining a sufficiently high degree of readability (figure 1).

The video format is a video version of the original lectures given to university students at HKUST. Each lecture was filmed by a professional camera crew capturing the PowerPoint pre-

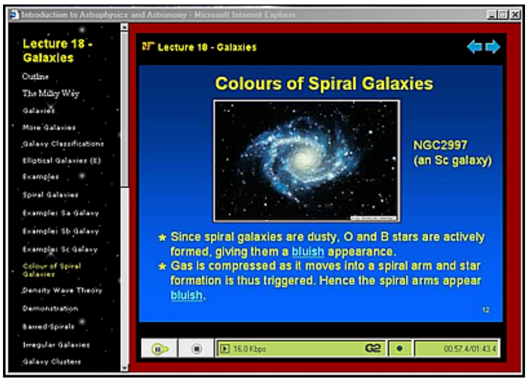

Figure 1. The *HTML*⁺ format of lectures.

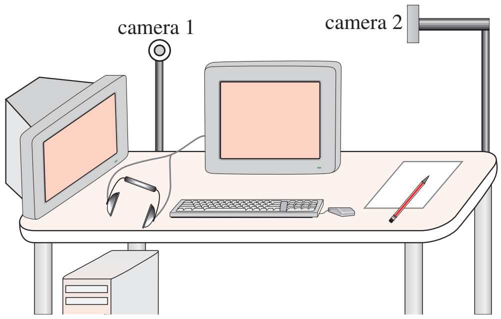

Figure 2. The Live Q&A Studio.

sentation and the live demonstrations. At the end of each shooting, the video was edited and encoded into multi-bandwidth streaming video for internet delivery. Video of each demonstration was extracted during editing and placed separately on the web. The videos have proven popular not only for the CyberU students, but also for the university students, especially when it comes to revision.

The benefits of using video in teaching are widely documented (e.g. Parry 1997). Thanks to the software and hardware technology, videos can now be streamed over the internet relatively easily. A conventional video presentation is fine if you want to view the lecture uninterrupted from start to finish, but for review and revision purposes the *HTML*⁺ is preferred.

Course delivery

The course consists of three components: lectures, tutorials and activities. A weekly online lecture is scheduled on the Wednesday afternoon and a face-to-face tutorial every other Saturday. The Wednesday lecture consists of a video presentation (in cyber classrooms, for those do not have access to the internet at home), plus a 'Live Q&A'. To minimize network overload and to provide ample opportunities for students to ask questions, each lecture is divided into two or more parts followed by a short Q&A at the end of each part of the presentation. All cyber classrooms are located in schools and are equipped with multimedia facilities.

The Live Q&A uses two video cameras—one pointing at the instructor and the other at a desktop whiteboard (figure 2). The desktop whiteboard is more flexible than a computer whiteboard: the instructor can write with normal pen and paper. At the moment, the Live Q&A is a one-way audiovisual system; the students can hear and see the instructor, but the instructor cannot see or hear the students: the students have to use the chat rooms on WebCT™ to ask questions. The set-up shown in figure 2 might appear complicated to new users, but after one or two sessions it becomes second nature.

The Live Q&A is supplemented by WebCT™ chat rooms throughout the entire session, termed online facilitation (Noakes 2001). The concept is to create a collaborative learning environment that will motivate students, stimulate and track discussions, and allow contribution of specialist knowledge. In our course, both the instructor and the teaching assistants act as online facilitators. The sessions encourage students to ask questions, even when they might find it difficult to so in a normal classroom setting (Pong 2001).

The forum is an offline Q&A located within the WebCT™, providing a channel for lengthier discussion where students can discuss questions among themselves and with the teachers. For better reference, the forum is subdivided into topics. By examining each discussion topic closely, we can also obtain information on students' reaction to a particular lecture or topic of the course, e.g. which lecture or topic they find most difficult. This is important for the preparation of the Saturday tutorials.

The two-hour Saturday tutorials were conducted live at HKUST campus. Their main purpose was to go over material covered in previous lectures, particularly covering the areas students found difficult, and to answer any questions the students may have. Since the Cyber University concept is new and unfamiliar to students, the tutorials can also provide a means of transition from a normal teaching environment to a Cyber classroom one. They also provide an opportunity for those who have missed the Wednesday session to come and ask questions.

The attendance for Saturday lectures varied from 50% to 70%, significantly higher than the 20% to 50% attendance at the Wednesday session. In comparison, the attendance for the traditional university classes varies from 70% to 90%. This higher attendance is because the tests for the course are conducted during the lecture. The low attendance for the Wednesday session for the CyberU class is quite understandable because of the high degree of commitment to after-school extramural activities required by schools in the region. The turnout rates also indicate that the students still prefer a face-to-face style of teaching. Since the CyberU concept is new to everybody, this is quite expected in this transition phase.

Like students on its sister course at HKUST, a student on the CyberU course must complete two activities from a list, submitting a written report on each of the activities he or she attended. The activities range from shows and lectures to observations and camps, most of which are organized by local astronomy clubs and museums.

To monitor the students' progress, a weekly multiple-choice objective test is administered via WebCT™ (Gladwin 2001). In order to make it harder to cheat, we deliberately compiled a large number of questions and randomized the selection. The computer automatically marks the quiz and the score is returned instantly. The majority of the questions are conceptual with occasional short calculations (Mazzolini 1999).

Course evaluation

As discussed by many researchers (e.g. Cummings *et al* 1999), technology alone will not automatically generate good results in student learning. The adoption of effective teaching methodologies is necessary for a technology-assisted environment to achieve its full potential. A number of teaching innovations and enhancements have been introduced into the present course as discussed above. The adoption of these enhancements was driven by the need for improvement and by results of research carried out by other practising individuals.

The course was evaluated both online and offline. From the built-in monitoring facility in WebCT™, we were able to see which items were being accessed, together with the frequency at which they were accessed. This was used to measure the interactivity of a web-based course (Bodomo *et al* 2001), giving us useful guidelines for improving on the course design. The offline evaluation was carried out at the end of the final examination using a series of yes/no and five-point Likert scale questions. Results are shown in figure 3.

Looking at the charts in figure 3, we can see that the forum is the least effective component of the course. Using the forum in learning is a new experience for students used to the normal classroom and we don't think we can change this overnight. Like other supporting tools on WebCT™, the forum is particularly useful for implementing collaborative learning in online and distance education. Together with other supporting tools, e.g. web mail and an online quiz, we believe the students taking the online course will gradually convert from traditional classroom students to independent learners (Role 2002).

Since the same course is also given to the university students at HKUST, it would be useful to make some comparisons between the two classes. The university course is delivered live twice a week in lecture theatres. Instead of online quizzes, the students are given live quizzes during the lecture with the help of an electronic interactive response system called PRS (Cue 1999). Both classes sat the same papers for the two midterms and the final on campus. The average marks for the two classes in various assessments are listed in table 2.

The difference in the average total mark between the two classes is less than 2% despite the CyberU class having less teaching time. The CyberU students lost most of their marks on the first midterm and quizzes and activities; the scores for the second midterm and the final for the two classes are very similar. The low average score in the quizzes and activities was because many CyberU students had not attempted some items and thereby dragged down their scores. This is something we have to work on in the next run of the course. On the whole, the relatively high score attained by the CyberU students is both surprising and encouraging.

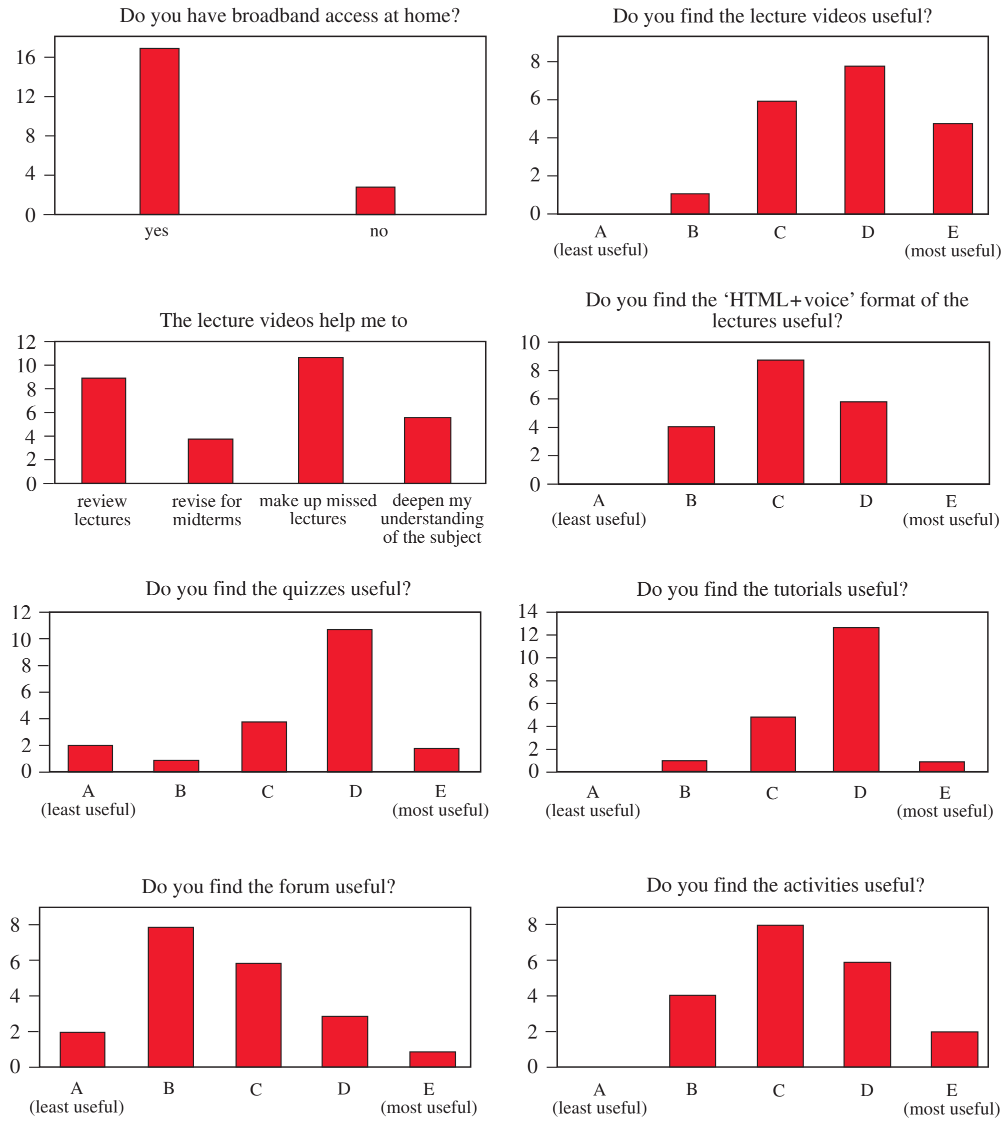

Figure 3. Results of the offline evaluation at the end of the final examination.

Conclusion

We have introduced a number of enhancements in the following areas of the course: course production, course delivery, teaching and learning.

- *Screen capture*
  Instead of painstakingly converting the texts and pictures into HTML, we used a screen-capture technique to convert PowerPoint slides (containing text, equations and pictures) into highly optimized images for fast downloading. This method helped us reduce the production time from hours to minutes.
- *HTML+*
  On the delivery side, we have constructed a hybrid system for delivering our lectures online using a combination of optimized images and multi-bandwidth voice streaming.
- *On-line facilitations*
  Via the WebCT™ chat rooms we sought to create a collaborative learning environment to motivate students, to stimulate and keep track of discussions, and to contribute special knowledge. Both the instructor and the teaching assistants acted as online facilitators and encouraged students to ask questions.

Table 2. Average marks for the two classes.

	CyberU students	University students
Midterm 1 (28%)	19.92	20.68
Midterm 2 (28%)	15.24	15.40
Final (28%)	19.50	19.04
The rest (quizzes, activities etc) (16%)	10.51	11.37

Several areas of the course need to be improved. Since the course is delivered in a semi-distance learning mode, the traditional course design must be replaced by a more independent approach. One possible solution is to supplement the course with a collection of independent study units such as the FLAP (Flexible Learning Approach to Physics) package (Stewart 1995). On the instructional side, a two-way audiovisual system can be implemented to improve communication between the instructor and students.

The internet is a vast store of information and data, which can be put to great use if you know how. Many researchers believe that selection is the key to learning from this huge collection of information (e.g. Clinch and Richards 2002). In our offline course evaluation, many students have commented on the usefulness of the reference materials discussed during the online facilitation. For a course like astronomy, which is changing all the time, providing reference materials in the form of up-to-date information appears to be very stimulating to students. In our next stage of course development, a comprehensive list of references will be added to the teaching materials.

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