

Establishing Information Technology (IT) for Teaching Laboratory in the Chemistry Department of HKUST

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ABSTRACT

IT-based teaching plays an important role in university education, especially in chemistry laboratory courses, which arouses safety concerns for the public. Thus, it is worthwhile for the university to develop IT-based teaching in laboratory courses. Thirty-one experimental teaching videos have been made in the HKUST chemistry department and these videos have been uploaded to the chemistry department website.

BACKGROUND

Practical courses for undergraduate teaching are an essential element of the Chemistry Department. There are two teaching laboratories in the Chemistry Department: the Synthetic Lab and Molecular Characterization Lab, each of only 175 square meters usable space. Because of the crowded situation, the students cannot learn efficiently from the teaching assistants' demonstrations. Furthermore, in Chemistry Department teaching laboratories are in general filled with nasty chemicals, gas cylinders, glassware and expensive instruments. In order to minimize accidents and the misuse of costly instruments, we have to repeat the demonstrations many times to guide the students during lab sessions, and this wastes lots of precious manpower.

One possible solution is to use a digital video-camera to produce a video for each experiment and then upload it into a teaching website. The students can watch the video from the teaching website before they attend the practical class. They can get the general idea of how to do the experiment and avoid accidents and misuse of equipment. From the departmental point of view, the number of teaching assistants in teaching labs can be released to other courses without affecting the safety of both labs.

INTRODUCTION

In order to make the course curriculum more effective for the three-year university system in Hong Kong, the HKUST Chemistry Department integrates all experimental courses into two courses known as molecular characterization laboratory and synthetic laboratory. The synthetic laboratory course descriptions are experimental

techniques of organic and inorganic chemistry; preparation, properties and reactions of representative compounds; and separation, purification, analysis and spectroscopic characterization and advanced synthetic techniques, including inert atmosphere manipulations. Because the content of the synthetic laboratory consists of synthesis, separation, purification, and identification of compounds, the teaching videos shall be made for these purposes. The synthetic laboratory videos include identification techniques such as ^1H -NMR Spectroscopy and Infra-red Spectroscopy, purification techniques such as recrystallization and distillation, and separation techniques such as thin layer chromatography and column chromatography. Students take synthetic laboratory in the second semester of their first year and the first semester of their second year.

At HKUST, we combine physical and analytical experiments together and call this the molecular characterization laboratory. Here, the students acquire skills in operating major chemistry instruments, analysis of data for precision and accuracy, principles and techniques of thermodynamics, kinetics, and electrochemistry. Twenty-three videos have been made for the molecular characterization laboratory. The major objectives in making these videos are to demonstrate the operational procedures for modern chemistry department equipment and to avoid accidents.

VIDEO PRODUCTION AND UPLOADING TO WEBSITE

Dr. Y. F. Yen and Dr. L. L. Yeung determined the titles and contents of videos for the molecular characterization laboratory and synthetic laboratory respectively. All videos are shot using two Sony DCR-PC3E Digital Handycams and are directed by Dr. Y. F. Yen. After shooting the primary video, we use Pinnacle System DV500 to capture films and save them as AVI format files. The video-editing program was used to edit the files and then background music, subtitles, and special effects were added to files. The scripts were written by Dr. Y.F. Yen and the Cantonese sound track was recorded by technicians using Sony MZ-R70 MD digital recording. Finally, we added the sound track to the videos files and saved them as MPEG-2 format video files.

After making the videos, we redesigned the Chemistry Department WebPages and uploaded videos into the Chemistry Department website. Because the video file sizes are very large, we need three different video file formats to deliver them to different users.

BENEFITS TO STUDENTS AND FACULTY

Students

During the lecture course, students learn the theory of major laboratory instruments but they do not have any idea about the details of the equipment. It is very difficult for students to operate instruments during their laboratory course without the proper instruction and guidance. With the teaching experiment videos website, students can watch demonstration videos anywhere in the world over the Internet before attending

the laboratory course. After viewing demonstration videos, students can operate the equipment by themselves with less teaching assistant manpower and avoiding mistakes. Repetition is one of the most important benefits of teaching experiment videos. Students can view the videos many times without any limitation.

Faculty and Department

Because students can watch demonstration videos over the Internet, faculty members can spend more time developing new experiments and improving laboratory courses. The Department can also save on teaching assistant manpower and deploy them to support other courses. By using the Lecture Theater multi-media computer system, the experimental videos also can be used in lecture courses such as instrumental analysis and physical chemistry to show students the details of the instruments.

The three-dimensional concept is very important in helping students learn about complicated instruments and molecular motions in chemistry. Teaching-videos are a better solution than plain images in providing students with three-dimensional detail and different viewing angles of molecular structures.

FUTURE DEVELOPMENTS

We shall improve IT in the teaching laboratory by adding English soundtracks, changing website for more interactive multi-media, and providing a question-and-answer forum on the teaching website.

Outcome

Molecular Characterization Laboratory

Video Title	Running Time
Biochemical Oxygen Demand (BOD) in Wastewater	5:52
Calibration of pH Meter	3:28
Chemical Oxygen Demand (COD) in Wastewater	3:20
Cyclic Voltammetry	4:48
Determination of Lead in Paint Samples by Atomic Absorption Spectra	13:19
Determination of Mercury in Paint Samples by Flow Injection Mercury System	4:20
Determination of Trace Metals Analysis of Water Samples by IPC-MS (part one)	7:20
Determination of Trace Metals Analysis of Water Samples by IPC-MS (part two)	10:34
Differential Scanning Calorimetry	9:40

Electronic	4:13
Gas Chromatography	6:55
Gas Phase UV Spectra and IR Spectra	13:28
Heat of Combustion: Bomb Calorimeter	10:43
High Performance Liquid Chromatography Determination of Caffeine in Beverages	9:55
Ion Chromatography	4:11
Low Temperature IR Experiment for Unstable Species	12:35
Microwave Digest	10:37
Molecular Weight Determination by Freezing Point Depression	5:10
Polarography Determination of Lead in samples	6:15
Sample preparation of Milk	3:45
Spectrofluorimetry	4:41
The Rate Constant for the Reactions of OH Radical with Hydrocarbons	6:52
Vapor Pressure of Liquids	5:26

Synthetic Laboratory

Video Title	Running Time
¹ H-NMR Spectroscopy	4:17
Infra-red Spectroscopy (1) FT-IR instrument operation	7:28
Infra-red Spectroscopy (2) Solid sample preparation	10:38
Infra-red Spectroscopy (3) Liquid sample preparation	11:43
Thin Layer Chromatography	3:24
Recrystallization	1:43
Distillation	5:48
Column Chromatography	8:03