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# On the Development of an IT-Enhanced Environmental Science Module

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## Abstract

In this paper, we discuss our efforts in curriculum development of an environmental science module that will be conducted in a networked teaching and learning environment, complemented by laboratory sessions and field work. The aim of the curriculum is to promote collaborative and distributed learning of environmental science that emphasizes the acquisition of higher order thinking skills. Some aspects of the curriculum that will be highlighted include the contents of an interactive multimedia teaching system for self-paced learning, and scenario generators that allow the participants to experiment with hypothetical environmental situations.

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## I. Introduction

Advances in Information Technology (IT) are expected to have a great and continuous impact on learning and the teaching process. The growth of the Internet, for example, enables a student, at a stroke of the keyboard or the click of a mouse, to enter a virtual world rich in information, where he can read on topics he is interested in or communicate with someone in another part of the world. In the new information era, the role of educators will shift from information provision to that of enabling the population to access, assess, process, apply and update information. In addition, educators should also harness the power of IT to enhance the quality of teaching and learning.

Recognising the above needs, we set out to develop an IT-enhanced environmental science module, complete with laboratory sessions and field work. We are fully aware that IT and the Internet are merely tools to complement and supplement the traditional teaching methods, where appropriate, and should not totally replace the traditional approach. In this paper, we describe how these tools can be used to teach the topic "Pollution" in the environmental science module.

## II. Desired learning outcomes for the topic "Pollution"

At the end of the lessons on pollution, first-year B.Sc. students should be able to

- (a) define pollution and list the various types of pollution;
- (b) analyse case studies based on historical examples of pollution;
- (c) make recommendations on how to minimise pollution in a given situation, and present cogent arguments to support their recommendations.

## III. Potential ways in which IT can enrich and enhance the learning experience

- (a) Allows quick retrieval of information (e.g. access to databases) and provision of feedback;
- (b) Facilitates independent, collaborative, and distributed learning;
- (c) Facilitates self-paced and mastery learning by giving learner the opportunity to pause, rewind and replay lessons;
- (d) Provides sophisticated tools for interactive animation, visualization and data-mining;
- (e) Encourage critical and creative thinking through risk-free simulation and generation of scenarios;
- (f) Enables the setting of "electronic" assignments and assessments.

The role of IT in the teaching and learning of the topic "Pollution" is illustrated in Fig. 1. For the teacher, access to the network is a matter of choice and personal preference, so that the network is only enabled in situations where learning can be enhanced through IT. In addition, learning science also involves real-life experiences and hands-on experiments. In these cases, access to the IT environment may not be necessary until the data-analysis or information-sharing stage.

## IV. Techniques used in the networked teaching & learning environment

- (a) Access to text- or graphics-based web-sites, e.g. web-sites with

information, photographs and news clips of the Exxon Valdez, Minamata and Chernobyl incidents, and feedback boxes for pupils to key in their own ideas of how to reduce or minimize pollution.

Fig. 1. Illustration of the role of IT in the teaching and learning of the topic "Pollution". The dashed line encloses aspects of the course in which IT is almost always used.

(b) Access to dynamic and interactive web-sites, which allow students to role-play various government officials in futuristic scenarios, e.g. "Singapore in the year 2015 is devastated by increasing sea-level and pollution". Students may also be asked to suggest measures that can be presently implemented to avert the scenarios painted. The computer will be used as a simulation, visualisation and analysis tool to examine the effects of their measures. The main aim of these exercises is to highlight to the students the alternative routes leading to different consequences.

(c) Database management/retrieval: students will be given access to an intelligent database that is organised by countries and environmental problems. This database will provide a global picture of environmental problems and will serve as a comprehensive multimedia resource for background study. Through this database, students can also access the Internet for information on environmental problems. One form of the database will be presented as a map of the world highlighting "Hot Spots", so that when the students click on say, Brazil, multimedia information on the effects of gold-mining and pollution will be made available to the students. The database system will also generate questions to arouse students' curiosity and guide their learning and selection of information.

(d) Interactive modelling: students will write simple computer programs using built-in program templates or modify built-in programs to model their proposals and hypotheses. The main focus of these exercises is on the generation of ideas and testing these ideas rather than computer programming. The software tools provided will be user-friendly. For example, diffusion equations may be used to model the spread of radioactive dust following a leak from a nuclear power plant. The diffusion models can be overlaid on a world map to examine the effects of different spreading patterns on countries in close proximity or far away.

(e) Standard multimedia capabilities: students will be provided with multimedia computers, simple authoring tools, and access to Internet. These provisions may be used for attachment of new data, data-analysis, and interactive tutoring.

#### V. Proposed Lesson Plans for the First and Second Lessons on Pollution Lesson 1

##### Activities

##### Media & Materials

##### Class Organisation

1.

Introduction: teacher shows pictures of famous sites of heavy pollution, e.g. Minamata, Chernobyl, Exxon Valdez accident to stimulate interest.

Graphics/video clips from multimedia computer system.

Whole class.

2.

Teacher defines pollution.

Text, not necessarily on computer.

Whole class.

3.

Students list types of pollution and teacher classifies types according to habitat and nature of pollutant. Teacher elaborates and gives examples for each type of pollution.

Computer graphics.

Whole class.

4.

Students brainstorm on consequences of each type of pollution.

Access information through the network.

Small groups.

5.

Conclusion: teacher summarises and assigns homework, which involves electronic reading material on the network.

Whole class.

Lesson 2

Activities

Media & Materials

Class Organisation

1.

Quick multiple-choice quiz.

From the network.

Individual students.

2.

Students discuss case studies based on previous reading assignment.

Students can access more information from Internet.

Group work.

3.

Students share their findings and conclusions.

Students key in their findings on a common template on the network, to be viewed by class on a common screen.

Students stay in same groups.

4.

Oral presentation of findings by students.

Presentation software.

Students stay in same groups.

5.

Conclusion: teacher summarises.

Whole class.