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Edited by

Jon Baggaley (Athabasca University)
Terry Anderson (University of Alberta)
Margaret Haughey (University of Alberta)

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TEACHING SCIENCE AT-A-DISTANCE: what is so difficult?

Robert Holmberg, Michael Liston, Lisa Carter

Robert Holmberg is a biologist at Athabasca University, Alberta. He has taught science by distance education for two decades, and has developed and delivered courses in introductory biology, ecology, animal behavior and science projects. In addition to distance education in science, Robert's research interests are in ecology and behavior of arthropods, especially arachnids.

Michael Liston is a biologist at Athabasca University. He has been involved in the production and delivery of several biology courses, including introductory biology, ecology, animal behavior, and plant taxonomy. Michael's background is in ecology, marine biology and limnology. He is currently completing his PhD thesis at the University of Alberta, in boreal wetland development.

Dr. Lisa Carter has worked in program and curriculum development related to human science for distance education students. Her specific teaching interests include human anatomy and physiology, human genetics, microbiology and cell and molecular biology.

The presentation will outline the history of science courses delivered at a distance, and will address current challenges faced by educators. Comparisons will be made between the distance delivery of non-science courses and science courses, especially those involving laboratory work. We will examine the interactions of six factors that significantly influence distance delivery of science courses: distance learners, subject matter, safety, technology, pedagogy/ androgogy, and economics. Several fundamental criteria that form the basis for developing laboratory activities in distance education will be discussed, including elimination of laboratory exercises, modification of laboratory times and locales, use of laboratory kits, substitution experiments, and simulations.

The difficulty of doing science by distance education boils down to one word, 'labs'. Although the number of institutions in Canada and the United States that offer university courses at'a'distance has tripled in the last two decades, the fraction that offer even moderate numbers of basic science courses (i.e. biology, chemistry, geology, and physics) has remained about one-third. In contrast, nearly all traditional universities and colleges offer substantial numbers of such fundamental courses. This paper outlines the past and present situation of science courses offered at-a-distance in these two countries, addresses current challenges faced by science educators, and explores some general solutions. It also serves to introduce three other papers in this conference that give more specific solutions in physics, biology and anatomy.

SCIENCE = DIRECT EXPERIENCE WITH THE REAL WORLD

By their nature, most science disciplines require direct (i.e. 'hands-on') experience with materials from the real world. Such experience traditionally has been obtained in laboratories or in the 'field'. Basically, laboratories are spaces designed for making observations and doing experiments to test hypotheses. Because scientists, and students of science, usually require specialized equipment to make measurements and often work with hazardous materials that need to be safely contained, laboratories are expensive to build, furnish and maintain. Although some

non-science disciplines also require specialized equipment and facilities (e.g. athletics, graphic arts, language laboratories), most do not. Besides the benefit of students being able to gain experience with various techniques, specimens and equipment, laboratory activities are also useful for reviewing concepts or introducing new ones, practicing problem-solving, and increasing intellectual curiosity about and appreciation for the subject matter.

Presently there are about 1,365 accredited universities and colleges in the United States and 85 in Canada. The percentage of these institutions that offer 20 or more courses by distance education is slightly higher in Canada than the United States (45% vs. 38%). However the percentage of distance education institutions that offer five or more basic science courses by distance education is higher in the United States (37% vs. 32%). The most commonly offered science courses are in the areas of biology, geology, chemistry and physics, respectively. In each of these disciplines, proportionately more institutions in the United States offer science courses than in Canada. Only in the area of astronomy do Canadian institutions offer relatively more courses.

LABORATORIES AT-A-DISTANCE

When science courses are considered for distance delivery, what is done with laboratory components falls into four categories:

1) modification of existing laboratory times and locations;
2) simulations or substitutions by computer, audio-visual, or other means,
3) use of home laboratory kits, and
4) elimination of all laboratory activities.

The fourth alternative is the easiest, cheapest, and, all too often, the usual choice. However, in the long run, elimination of lab activities in science courses is a way of ensuring that distance education institutions never become true universities. In the same way that art appreciation courses (i.e. courses where students observe art but not partake in creation of art) are not true art courses, courses that discuss science topics but do not allow direct experience with materials and methods are not true science courses. Although it can be argued that any particular course that usually has laboratory-like activities can be offered without such activities, it is not possible to offer credible science programs or majors without a substantial number of courses that do have labs or their equivalents. It is our contention that more work needs to be done in the other three areas to make laboratory activities accessible to distance education students. Other presentations at this conference discuss these options more thoroughly.

There are six factors that must be taken into account in the development of science courses that are to be delivered at-a-distance:

1) characteristics of the potential students (e.g. educational background and experience, age, geographical locations, social and cultural environments);
2) subject matter to be learned;
3) safety of the students and their families;
4) pedagogical (or, for adults, androgogical) techniques;
5) availability of various technologies (e.g. telephones, computers), and
6) economics (i.e. budgets of the schools as well of those of the students).

All six of these factors interact and any one may preclude development in one direction or another (Holmberg & Bakshi, 1982).

FUTURE POSSIBILITIES

Besides the achievement of educational objectives, the goal of lab activities associated with distance education courses is to increase the flexibility of time and place for students. Since delivery of laboratory science for distance students is limited in most institutions, work on laboratory activities for delivery at-a-distance provides an area for much research and development, including partnerships at several levels. For example, teachers have to know what others have done in order to avoid duplication of effort. If new materials are produced, there are questions of copyright and patents. Credit transfer between institutions is still a problem. Technological advances in lab equipment, and student-teacher communication, continue to change what is potential and what is possible. Moreover, successful developments in, say, home labs and simulated lab activities, may have considerable impacts on traditional universities.

Reference

Holmberg, R.G. & T.S. Bakshi, 1982. Laboratory work in distance education. *Distance Education 3* (2), 198-206.