Coming to Terms with the Online Instructional Revolution: A Success Story Revealed Through Action Research

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Abstract: This paper presents the course of action and outcome of a teacher-based action research project concerning development and evaluation of an online introductory biology course for non-majors. The research took place in a small community college and compared online and traditional instructional formats. A course was developed in an entirely web-centered format. After a semester of instruction, participants were assessed with a 50 item multiple choice test pertaining to content knowledge gained in the course. When their scores were compared with students taught in a traditional classroom format, the scores were essentially identical. The research format may serve as a model for teachers who wish to explore the issue of web-based instruction in their own practice.

Keywords: Online biology instruction, web-based teaching, action research

Introduction

It is very difficult to clearly define *online instruction*. Various monikers such as *distance learning* and *web-centered teaching* are quickly finding their way into our educational lingo. The terms may have different meanings to different teachers. Of course, the essential premise of learning outside of the traditional seat-based classroom is not new. Correspondence courses have been around for decades. What is relatively new, however, is the use of the internet as a primary delivery mechanism for instruction. As early as 1994, DeLoughry predicted that instruction involving online and distance lessons would likely grow very rapidly. Exponential growth, into the millions of students, continues to occur (Kriger, 2001).

Online science instruction probably has its roots in the programmed instruction movement (Melear, 1989; Deutsch, 1992) that first gained significant prominence during the 1970s. Surprisingly little has been written about teaching biology in a web-centered format. Much of what has been written involves the use of internet or multimedia resources as a valuable supplement to primary, traditional instruction (Seng and Mohamad, 2002; Ardac and Akaygun, 2004; Skinner & Hoback, 2004). King and Hildrreth (2001) reported that it is, indeed, possible to construct on-line science courses that are compatible to traditional, seat-based science courses. Only a few other writers have explicitly dealt with the issue of teaching biology in an online format in recent professional publications (Collins, 2000; Johnson, 2002). Even though some instructors have been teaching web-based biology courses for years, the whole issue of on-line biology instruction is certainly a contemporary one. It is our hope that this research report will assist our peers in making quality, informed decisions as they are faced with a revolution in biology instruction. We offer results from one small study on the issue of online biology teaching, as well as details about our methodology that may serve as a model for other classroom teachers.

Theoretical Framework

Qualitative research methods are highly valued for making sense of the experiences of people and communicating those experiences with a high degree of validity. They differ from traditional, empirically based research methods in that the focus is less on repeatability, large sample sizes and random selection of research subjects (Patton, 1990; Guba, 1995; Denzin and Lincoln, 2000). These are some of the reasons that classroom teachers very often utilize qualitative research designs in educational settings. They are often forced to make do with what is available to them (small classes, limited means of comparison and lack of randomization) as they try to answer their own important research questions. When faced with a dilemma outside of their routine and zone of comfort teachers usually seek practical solutions. One of the best ways to alleviate uncertainty about any situation is by way of action research. Simply put, action research involves a planned, reflective consideration of one's own practice (Reason and Bradbury, 2001).

We suggest that teachers, often without even realizing, routinely engage in action research. They regularly ask questions like “Does this work?” or “How could I improve this unit?” What many teachers often do not do is formalize the process and share findings with their peers or other interested persons. Knowledge gained from a research of one’s own world of action very often has mass appeal to those in similar situations (Jarvis, 1999).

In a formal, academic sense, action research was originated by Kurt Lewin (1947a; 1947b). In all its forms, a few things emerge to characterize the process. The practitioner realizes a problem, issue or question and then formulates a plan of action. The results are carefully reflected upon and may or may not be integrated into the practical knowledge base of the practitioner (i.e. “This worked well, but that didn’t.”). Although the outcomes of action research may have broad appeal, the goal is less about generalizing to other situations and populations than it is about coming up with a pragmatic, workable solution to the original problem faced by the practitioner (Jarvis, 1999; Reason and Bradbury, 2001).

This paper explores and communicates the action research efforts of a community college biology teacher in a small school in the Southeastern United States. The dilemma involved designing a new web-centered freshman biology course. As anyone new to a process such as this could imagine, there were a number of uncertainties, questions and concerns. So, the theoretical framework of action research seemed ideal for gathering information and making an informed decision. Figure 1 presents an overview of our research process involving problem, plan of action and results.

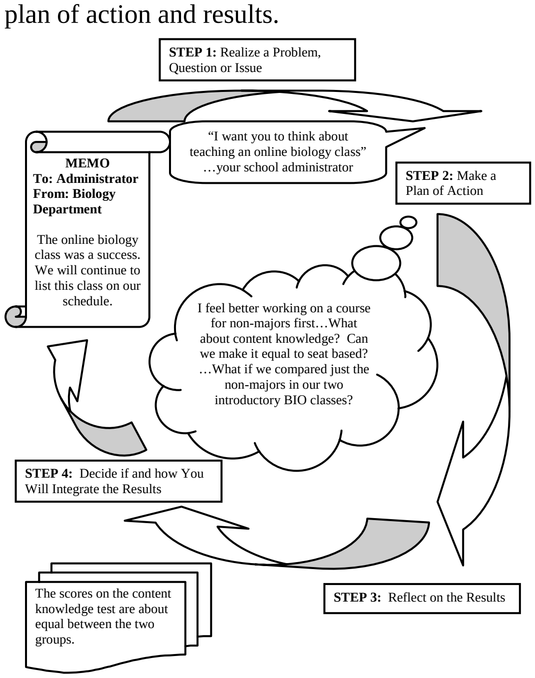

FIG 1.Summary of action research plan and outcome.

Background of Research

Both the authors are biology teachers in what could be described as a community college or junior college environment. Neither had taught in a distance learning situation at the onset of this project. The first author was recently encouraged to explore the idea of designing and delivering a freshman-level biology course entirely online to benefit distance learning students. Both of the author’s schools have excellent and rapidly growing catalogs of distance learning courses. Most of the courses offered are non-scientific in nature and include such things as history, composition and humanities classes. Within the science departments at both schools, a freshman level chemistry course has successfully been taught with the lecture component online. One school offers some anatomy labs in an on-line format. However, at the time our research project began, the concept of a science course delivered completely online (with no student visits to campus, even for lab) was new to the members of the science department at the school where this research took place. A recent study comparing electronically delivered materials with traditional, text-based delivery found that lab instruction by way of an instructor designed CD-ROM tended to produce lower lab grades among non-majors in biology (Brickman, Ketter and Pereria, 2005). A study such as this clearly has implications to teachers designing a web-centered biology class and lab component.

One goal in developing the new course was to keep it as equitable in content as possible to traditional, seat-based biology classes at the school. A number of pre-made, one-size fits-all computerized course programs and cartridges are quickly finding their way on the market. Many have flashy simulations that while impressive, offer little opportunity for students to practice science. In the words of La Velle (2002) “It just isn’t real.” Several such packages were examined as possible materials for the new course but none seemed appropriate for the instructor’s goals and pedagogical style. It was important to the instructor that the students have as many authentic lab opportunities as possible, working with legitimate scientific questions, hands on materials and with living organisms whenever possible. This is consistent with national reform recommendations for teaching college science (Sibert and McInthos, 2001). The instructor ultimately selected a number of simple lab activities that could be done in the students’ homes, as well as activities utilizing library or internet research, to guide and/or supplement the instruction.

The school, where this research took place, has two freshman-level biology course options available to students. One is a two semester sequence, designed for science majors. The other is a one semester version (Principles of Biology) for non-majors which has not been recently taught at the school. The first semester of the sequence for science majors (General Biology I) is most akin to the non-majors class in terms of content. Because of the small size of the school (and other factors), the course for science majors is taught most often, in multiple sections, and attracts both science majors and non-majors. In fact, non-majors account for the larger percentage of enrollees in the class. Figure 2 compares the essential features of the two courses. Members of the school's science department agreed that the place to begin exploration of web-based learning in biology would be in the course especially designed for non-majors. Due to factors that are beyond the scope of this paper to discuss, classroom sections of the non-majors course have not been offered at the school in some time. While comparing two different courses (majors and non-majors) is not ideal, focusing study on non-majors from both courses seemed to be a viable means of evaluation of the new on-line course.

General Biology I (designed for science majors)	**Areas of Overlap Between Both Courses**	**Principles of Biology (designed for non-science majors)**
CONTENT	**CONTENT**	**CONTENT**
A more detailed treatment of all topics.	Nature of Science Basic Chemistry Cell Biology Metabolism Taxonomy & Classification Genetics Evolution	*A less detailed treatment of all topics.* Ecology
SPECIAL COMMENTS ON LAB	**SPECIAL COMMENTS ON LAB**	**SPECIAL COMMENTS ON LAB**
	Introductory Microscopy Lab	
Completed in traditional seat-based lab.		*Completed with guidance from an approved off campus lab mentor (lab technician, teacher, etc.)*
	Guided Inquiry Project	
Students work with earthworms and mealworms. They select their own research question, dependent & independent variables.		*Students work with yeast. They select their own research question and independent variables. Dependent variable is assigned.*
	Other Labs	
Building & Using Taxonomic Keys Detailed Taxonomy & Diversity Study of 20 Organisms Mitosis Meiosis	Measurement in International System How to Use Scientific Literature Dietary Analysis DNA & Protein Synthesis	Writing a Science Autobiography (Icebreaker Activity). Short Taxonomy and Diversity Study of 11 Organisms Observation of Mealworms Acid-Base Indicator Activity Identification of Fat in Foods Studying Diffusion Modeling Mark & Recapture Internet Research on Symbiosis Modeling Genetic Crosses With Coin Tosses

FIG 2. Comparison of both courses with areas of content overlap.

Methodology

The school's science department and one of the authors (who developed the on-line course) had several concerns about the new venture into online biology instruction. A major concern of the teacher (the first author) was whether a web-based course could be developed that addressed content knowledge (Sibert and McInthos, 2001) as equitably as a traditional seat-based course would. Since the biology course for non-majors had not been offered at the school for some time, there initially appeared to be no way to equitably compare seat-based and on-line instruction. To deal with this methodological complication, the instructor compared the content knowledge objectives that the two courses (the class for science majors in seat-based format and the class for non-majors in online format) had in common. These objectives were compiled into a list. A 50 item multiple choice test, sampling most of the objectives, was generated by the second author (not the teacher of the online course). It was important to initially keep this researcher blinded regarding the nature of this study so as not to influence the choice of questions toward or against the online instructional format. Students in both courses were given copies of the test at the conclusion of the academic term. The test results had no impact on the students' course grades. Completion of the test was entirely voluntary, anonymous and with informed consent. Students were asked to identify the format (seat-based or web-based) in which they studied biology and were asked to list their academic major. All tests were assessed with a pre-made test answer key by one author. The four students in the course for science majors who listed a science or health science related major were eliminated from the study. In this way content knowledge among non science majors could be more effectively compared between the two instructional formats. There were nine active participants in each group.

Results and Discussion

Interestingly enough, the two highest scores on the exam (94 and 92) were made by students who identified themselves as science majors. Recall that the tests of the science majors were not included in our analysis. Mean test scores and ranges between the two groups of non-science majors are presented in Table 1. With such a small sample size (n = 9 per group) and with no random selection and other methodological complications, no statistical comparison of the data was completed. However, it is obvious that the mean test scores of the seat-based and web-based groups were essentially identical (69.77 vs. 70.00). The range of scores was a bit broader in the online group (36 – 88) than for the

TABLE 1. Comparison of test scores between groups

	Principles of Biology (designed for non-science majors) Taught Web-based n = 9	General Biology I (designed for science majors) Taught Seat-based n = 9
Mean Score on Test (100 Point Scale)	69.77	70.00
Range of Test Scores (100 Point Scale)	36-88	46-88

seat-based group (46 – 88). Also, a few more students in the on-line group surpassed a score of 70 on the examination. Figure 3 displays a comparison of individual scores between the two groups.

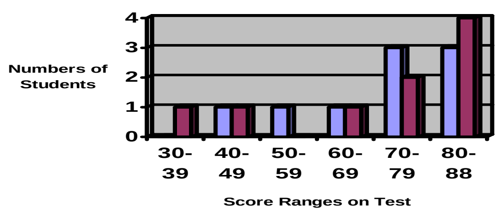

FIG 3. Comparison of individual test scores between groups. Seat-based scores are the lighter bars, while web-based scores are represented by the darker bars.

Remembering that the primary goal of action research is to provide practical and pragmatic information to the researcher (Jarvis, 1999; Reason and Bradbury, 2001), we can state that our concerns about content knowledge of biology in on-line verses traditional instructional formats have been allayed. We believe that we have demonstrated that the non science majors in our study (the primary target population for the new online course offering) are served equally well in both formats in terms of their performance on a summative assessment of content knowledge. With this information, an informed decision was made to continue teaching the web-centered course in the format described above. We were satisfied that, for our non-majors, the web-based format was equitable to the traditional classroom format to which we were accustomed. We certainly do not make a generalized claim to other groups that one format is equal to, inferior to or superior to the other. More research on that point, involving multiple studies with students from various schools, is clearly needed. However, in keeping with one scholarly purpose of action based research, we do present our findings to our peers. We also offer this paper as a model that may provide assistance to other biology instructors who are new to the world of online education. We hope that our study will assist others in making informed, reflective decisions about their own courses of actions in the growing world of online biology instruction. Continued research regarding the situation described in this paper will be pursued. For example, studies are needed that compare other goals of scientific literacy and mastery (such as inquiry skills) between these alternative instructional formats.

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