Professor Created On-line General Biology Laboratory Course

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Abstract. This paper will share the creation, implementation, and modification of an online college level general biology laboratory course offered for non-science majors as a part of a General Education Curriculum. The ability of professors to develop quality online laboratories will address a growing need in Higher Education as more institutions combine course sections and look for suitable alternative course delivery formats due to declining departmental budgets requiring reductions in staffing, equipment, and supplies. Also, there is an equal or greater need for more professors to develop the ability to create online laboratory experiences because many of the currently available online laboratory course packages from publishers do not always adequately parallel on-campus laboratory courses, or are not as aligned with the companion lecture sections. From a variety of scientific simulation and animation web sites, professors can easily identify material that closely fit the specific needs of their courses, instructional environment, and students that they serve. All too often, on-campus laboratory courses in the sciences provide what are termed confirmation experiences that do NOT allow students to experience science as would be carried out by scientists. Creatively developed online laboratory experiences can often provide the type of authentic investigative experiences that are not possible on-campus due to the time constraints of a typical two-hour, once-per-week-meeting laboratory course. In addition, online laboratory courses can address issues related to the need for students to more easily complete missing laboratory assignments, and to have opportunities to extend introductory exercises into more advanced undertakings where a greater sense of scientific discovery can be experienced. Professors are strongly encourages to begin creating online laboratory exercises for their courses, and to consider issues regarding assessment, copyrights, and Intellectual Property concerns.

1.0 Introduction

In recent years, many institutions have begun to make more of their course offerings available online. This abundant availability of online courses is easily verifiable from even the most casual search for and perusal of such sites [1]. A few institutions have been offering such online courses and degrees for over twenty years, with one example being Phoenix Online. The majority of earlier online course and curricula offerings were designed for those seeking business degrees and career advancement training in technical fields. However, today there is hardly a discipline that does not have available online courses and degree programs, some even offering graduate and professional degrees. With this increased availability of online courses and degrees, nearly every intuition of Higher Learning must also provide online access to their academic programs so that they can try to meet the rapidly changing educational needs of both the non-traditional and traditional students. Resultantly, in order to remain competitive, the need to have an online availability appears to be an absolute requirement [2]. In this regard, many smaller institutions, along with those that do not have what might be considered to be an optimum and/or robust infrastructure to support their educational technological need, must find expedient means of entering the online market that are not restricted by prohibitive cost and the need to have a large number of faculty members to develop and teach [3].

Typically, online offerings are organized and implemented through a college's office for distance learning or electronic learning. In that instruction of online courses can be very labor intensive, incongruence between the number of courses that are desired to be offered and the number of faculty members prepared to teach such courses can become a significant rate limiting factor for an institution's entry into and growth in the online market. As to be expected, most of the publishers of college textbooks have begun to provide a wider range of online ancillary materials, with some now offering versions of their curriculum materials and even course cartridges that approach what might be considered as a complete online version of the course(s) for which they publish text. Even though these materials are typically of high quality, they are also subject to limitations due to the fact that most of the authors have created materials that are

intended for the traditional print versions of their work. The author has noted that this is often addressed most immediately by having persons with expertise in creating educational technologies convert the more traditional formats into ones that are suitable for electronic distribution and engagement. Professors should be very careful not to have a too heavy reliance upon individuals having adequate technological capability but limited specific discipline background as they develop their online courses.

The author has found that course development considerations are driven in part by student demographics, the institutional setting, and the instructor's concept as to what the course's scope, sequence, and weighted emphasis areas should be. With a growing pressure to provide an increased number of online courses, there could be a natural tendency to opt for a utilitarian remedy by relegating the primary responsibility for creating and implementing online courses to entities other than those that are affiliated with the particular institution offering the online program. This approach raises questions of quality control, and the ability to create an educational environment that genuinely reflects the educational philosophy, mission, and objects of the institution, department, and faculty member. This paper addresses this particular circumstance by explaining how an online general biology laboratory course might be created via use of the instructor's existing technological skill set coupled with a relatively easy access to existing instructional resources such as animations, simulations, and video clips that are abundantly available without restrictions via the Internet

What this author has found is that two major logistical determinants in the delivery of an online laboratory course, or any other type of online course, are the faculty member's instructional philosophy or conceptual basis relative to how the entire online course will be approached, and the amount of time that can be dedicated to creating and implementing the course. In addition, it is also most helpful if the faculty member has at least a minimum familiarity with using an instructional support platform such as Blackboard. This paper will present the underpinning course philosophy, a description of the course's design, the process for identifying and selecting curriculum materials, a description as to how the web sites were identified and selected, a listing of useful web sites, mechanisms of enhancing the students' course engagement, how student performance and course effectiveness were assessed, and a conclusion.

2.0 COURSE PHILOSOPHY

This course that was developed, a general biological science laboratory course (BIO 100L-90) for non-science majors was established on the principle that students should be provided with an experience that would assess their knowledge, skills, and attitude regarding the course. In addition, it was also believed that their critical thinking skills should also be enhanced. Except for the S of KSA their knowledge (cognitive domain) and attitude (affective domain) were fairly easy to gauge. The skills component (psychomotor) was more difficult to assess because the majority of exercises use computer simulations and animations to provide the required laboratory experiences. Further, the author had as an additional objective the provision of opportunities for lessons to be extended past the classroom setting so that course information could be more connected to the students' lives. Other important aspects of the course philosophy are the belief that the course content has an importance to the students greater than just fulfillment of one science requirement within the University's General Education Requirements and that all of the students are capable of understanding the concepts to be taught. These last two philosophical considerations are felt to be important because they drive the inclusion of activities and information designed to make the students' reflect on the relationship of the course to their lives and develop the necessary confidence so that they can achieve at a high level. Confidence building and personal course relevancy are necessary because the majority of non-science majors frequently do have the necessary level of interest in the course that will allow them to learn maximally and to earn a good grade. It was also desired that the online course's activities would parallel, to the greatest extent possible, those exercises being conducted in the comparable on-campus general biology laboratory course. This was felt necessary because the on-campus laboratories are structured in such a manner that they accompany and complement the on-campus lecture component of the general biology course. An additional but somewhat less important consideration was the belief that the majority, if not all, of the students have the necessary computer access and skills to allow them to optimally navigate the Blackboard site used by the course and to successfully interact with the recommended Internet sites. This part of the course philosophy was relegated to a lower significance because any students seeking to enroll in any of the online courses are required to complete a survey that

indicates their level of preparedness to take the course from both computer access and skill capability standpoints. In addition, perspective students are directed to web sites that can serve as a guide for their entry into the online learning environment.

3.0 COURSE DEVELOPMENT & DESIGN

3.1 Development

This particular course was not initially developed in the manner that is recommended by experts on Electronic Learning (E-Learning)/Distance Education because the author was recruited to create and teach this course nearly simultaneous with the beginning of the semester. The author was offered the opportunity to work with the course due to his history of teaching blended courses and frequent use of a variety of Internet sites to support the face-to-face courses that he taught on campus. Ideally, an online course would be developed well in advance of when it would be taught and not just prior to or during the course's implementation.

In an effort to facilitate the development of the course, those at the university responsible for E-Learning, working in consultation with the original professor that was to have taught the course, quickly reviewed a variety of commercially available virtual general biology laboratory course materials, selected one, and had its course cartridge installed on our Blackboard site. The materials selected were of high quality and were moderately user friendly in regard to site navigation and the clarity of instructions for their exercises; however, they were not topically aligned with our general biology curriculum. What is meant by not being aligned is that we were not able to find laboratory exercises in the virtual lab manual that cover the same topics covered in the on-campus laboratory. Not being user friendly meant that some of the exercises had insufficient directions and/or activities that did not work as designed. A third problem was that suitable worksheets to accompany the exercises were not always available. Therefore, the students could possibly successfully complete an exercise and yet still not grasp the full significance of what had been observed without adequate guided reflection. Due to the author's previous experience with curriculum design and engagement with students via the Internet, he was able to quickly develop a suitable curriculum for the online general biology course. The course syllabus is a blend of what is used for the on-campus laboratory, what is available from various Internet sites, and what the author has created.

3.2 Design

The course was designed to provide three consistent components for all of the laboratory exercises: (1) background information (referencing the lecture course information); (2) simulations and animations; and (3) worksheets with questions that reinforced the concepts presented in the simulations and animations that connect the lesson to the students' everyday life experiences and that stimulated critical thinking. In that the author has taught the on-campus laboratory and lecture courses at Norfolk State University for approximately five years, he is very aware of how the Internet resources and other aspects of the laboratory should mirror the on-campus version of this course.

Usually, the first component of every laboratory exercise is the background, which is built upon the background information presented in the laboratory manual used for the on-campus course. The author modified the laboratory manual's introductory information so that it could provide additional insight about the exercise for students not present in the physical laboratory. Also, these modifications allowed for the inclusion of more information supporting the development of critical thinking skills. Table 1 presents the scope and sequence for the online laboratory exercises, all of which are aligned with those used for the on-campus laboratory course.

Table 1: Schedule of Activities

Ex. 1 Scientific Articles assigned
Pre-Assessment Test
MLK Holiday (Monday)
Scientific Articles' Summaries Due
Ex. 2 Scientific Tools
Ex. 3 Scientific Measurements
Ex. 4 Illustrating Scientific Data
Ex. 5 Scientific Method
Ex. 6 Microscopy
Mid- Semester Assessment
Ex. 7 Cells and Tissues
Ex. 9 Cell Division (Mitosis)
Ex. 16 Principles of Heredity
Body Systems Overview: Ex. 11 Skeletal Ex. 12 Digestive and Respiratory Ex. 13 Urogenital Ex. 14 Circulatory
Organisms and the Environment: Food Webs
Environmental Issues Part I
Environmental Issues Part II
Posttest / Final Exam

This fall's version of the laboratory course will incorporate a set of hands-on activities that the online students can conduct in their homes. These activities will consist of observations and simple experiments that can be conducted with materials that are readily available in nearly every household. Previously, a few such activities have been used as a means to gauge students' willingness to carry out such inquiry actives. Examples of such activities was their using Metric and English measurement standards to determine how much water was used during a 5 minute shower as well as measuring the physical dimensions of various objects like compact discs, sandwiches, and articles of clothing. Another example was their investigation of enzyme activity by examining the influence of various physical and chemical variables on the activity of catalase, a ubiquitous enzyme that they can be easily obtained from raw white potatoes and different types of raw meats, especially liver. Catalase's substrate, hydrogen peroxide, is inexpensively obtained from any drug store. Many households typically have hydrogen peroxide in their medicine cabinets for use as an antiseptic on minor injuries to the skin. In that that no students expressed a lack of willingness or ability to carryout such simple hands-on activities, more will be included as a required part of selected exercises. Of course, any students that can not complete the hands-on activities will be provided with options that rely completely on computer access. One possible reason for a student's exemption from the requirement of conducting the hands-on activities might be their having special needs associated with a disability.

All exercises required the submission of completed worksheets within a set time frame. However, due to variety of reasons related to computer access and the students' schedules, the window for submitting competed exercises was usually extended until all of the students had submitted the assignments. In that the compilation of all completed exercises constituted a formal lab folder that was submitted at the end of the course, the ultimate deadline for completing the exercises was the due date for this lab folder. The primary impetus for their completing the exercises in a timely manner was created by their preparation for the online quizzes and exams that were required in a much more time stringent manner.

In some instances, after the successful completion of a few introductory assignments, students were given an opportunity to find, complete, and report on laboratory activities that they discovered for themselves on the Internet. Allowing students to find suitable web sites to accompany the assigned laboratory exercises proved to be another means of getting the students to extend the assigned exercises. Having to critique the value of the site(s) was a critical thinking activity. Their selection and critiques of the web sites also provided another valuable means to assess student learning. In some instances, their recommended sites could be suitable for inclusion as a formal part of the course's exercises.

4.0 SELECTING WEB SITES

Web sites used for the exercises were located by using different search engines and were guided by key terminology and concepts associated with the weekly exercises. An abundance of web sites offering animations and simulations of varying degrees of sophistication were easily located. Information on the design of virtual courseware is also readily available [3]. The author, along with a few student volunteers, explored those web sites showing the most promise for use as course exercises. Once selected, the sites' accessibility via Blackboard was evaluated. Only those sites that presented the least amount navigational difficulty and the greatest amount of information were considered. Sites that would not be generally available to anyone searching the Internet or required and special permission for use were not selected. In that we did not bundle the exercises, or in any way use them for financial gain, issues of intellectual property violation were avoided. All sites referenced were presented as suitable recommendations for review in order for the students to complete the associated worksheets that were created by the author. Immediately upon visitation, the students could determine the authorship/development responsibility for the site(s). As mentioned previously, students were given the liberty to find other sites that supported fulfillment of a particular exercise's objectives. In that the quizzes and exams were focused primarily on the objective(s) of the exercises, the use of a wide range of animations and simulations could adequately prepare them for the assessments.

5.0 ASSESSMENT

The assessments consisted of graded submitted work sheets and the completion of quizzes and exams administered on Blackboard. The quizzes were made available following the completion of the weekly exercises with the two exams occurring at the midterm and end of the course. The quizzes consisted of 10 to 15 multiple choice questions with the exams given in a similar format and reflecting the same level of comprehension as the quizzes. As mentioned previously in regard to the submission of the completed worksheets, the

quizzes had some degree of flexibility in regard to their absolute completion deadlines. Due to the university's grade reporting requirements, students completed the two exams as scheduled. Fifteen minutes were allowed to complete each quiz, with exams having a one hour and fifty minute access time. These times were selected so that they would parallel those used for the on-campus laboratory courses. If the laboratory course was conducted as an independent experience without the need to be a mirror cohort, a different assessment protocol might have been used.

6.0 STUDENT PERFORMANCE

Overall, the performance of the students in the online course exceeded that of the students in the on-campus course. Like other undergraduates [4], the students in this online course indicated on an end-of-course survey that they enjoyed the course and held the perception that it was effective. Somewhat to the students' surprise they reported that they spent considerably more time on the exercises that they would have for the on-campus course. In addition, students reported that they involved the family members in completing some of the activities. Also, in that the online assignments required more time to complete the assignments, the students tended to complete their work over several sessions. This is a good finding because it is indicates the students were becoming more immersed in the course and extending their learning in such a manner that the input and thinking of others helped them establish their own authentic "home grown" community of learners. It was not unusual for some of the older and more "non-traditional" students to report that some of the class assignments were similar to those being carried out by their school-aged children. All reporting such a situation of family involvement spoke in very positive terms that seemed to indicate their interactions were benefiting both their children and themselves.

The relaxation of the deadlines for submitting completed exercises and assessments is thought to account for the apparent improved student performance because it allowed more time for course preparation. In contrast, the typical on-campus laboratory course finds students not fully engaged in the exercises but rather performing the exercises in a perfunctory manner. Also, the time limitation for the on-campus class period does not usually allow adequate time to fully complete all that would be desired for the laboratory period. For instance, the on-campus course must allow 10 to 15 minutes for the weekly quizzes, 10 to 15 minutes for introductory instruction, and approximately 90 minutes to complete the exercises. Because materials must be gathered and returned at the beginning and end of the laboratory period, little time is available for reflection and discussion of what has transpired during the period. If such reflection and discussions are deferred until the following laboratory period, that particular class meeting would have even less time for its required activities. Also, logistically, the on-campus course presents obstacles to the completion of missed assessments and exercise performance, especially for those labs where there is a moderate to extensive amount of laboratory preparation required. The on-line course provides many opportunities to complete missed assessments and exercises. Also, the on-line course exercises can easily and conveniently be repeated if a student lacks adequate understanding of the lesson or if problems arise as they attempt to complete the activities. Since students appear to be more willing to ask questions about the assignments there is a greater possibility that a more lasting understanding of the course content obtained. As is true with any course, there is a percentage of students that procrastinate and, in spite of extended opportunities, fail to complete the assignments. With the online course, the number of such delinquent students is significantly reduced due in part to the pre-qualifying that students attempting to enroll in the online course must undergo. We are currently conducting a quantitative analysis of assessment results and other course metrics that can provide a more objective comparison of the online and on-campus general laboratory biology courses. Findings will be used to make necessary modification to the online laboratory course that will be taught by the author this fall.

7.0 CONCLUSION

The development and introduction of an online general biology laboratory course that parallels a comparable on-campus course has been successfully achieved by a professor in the NSU Biology Department working with assistance form the University's Office of E-Learning. The professor was not unusually adept with the use of educational technologies but his in-depth familiarity with the on-campus version of the course, along with his experience with curriculum development and use of Blackboard, has allowed him to create his department's first online biology course. By blending information from the currently adopted laboratory manual and from Internet web sites having ready access to scientific animation and simulations with the curriculum materials he has created a coherent course that closely mirrors the on-campus course already being offered. The

ready availability of technical support form the University's Office of E-Learning has allowed appropriate technological logistics to be applied and problems to be solved quickly. Formal The findings from this professor's experience can be of value to others seeking to develop quality, online laboratory courses that are tailored to their particular institutional setting. The course development was low cost to both the university and the students and was without many of the enrollment/access and operational imitations that are frequently experiences when trying to adopt published online curriculum materials. Though not optimal, and to some most objectionable [5], the development and implementation of this course by an individual professor was both effective and timely. Again, the cooperative relationship with the University's Office of E-Learning greatly benefited this effort. Also, interactions with professors in other disciplines that have experience in developing and teaching online courses were a positive influence.

8.0 REFERENCES

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assessments and anecdotal comments from the students indicate that an enjoyable and relevant high quality laboratory experience was provided.