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Inter-institutional Development of a Poster-Based Cancer Biology Learning Tool

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Abstract

There is a paucity of African-American Cancer researchers. To help address this, an educational collaboration was developed between a Comprehensive Cancer Center and a distant undergraduate biology department at a minority institution that sought to teach students introductory cancer biology while modeling research culture. A student-centered active learning curriculum was established that incorporated scientific poster presentations and simulated research exercises to foster learning of cancer biology. Students successfully mined primary literature for supportive data to test cancer-related hypotheses. Student feedback indicated that the poster project substantially enhanced depth of understanding of cancer biology and laid the groundwork for subsequent laboratory work. This inter-institutional collaboration modeled the research process while conveying facts and concepts about cancer.

Keywords

Active learning; African-American; Cancer; Scientific posters; Undergraduate student

Introduction

This paper reports on an active learning program to enhance undergraduate students' knowledge and understanding of cancer biology. Significant gaps in knowledge about cancer have been documented in college students (1). This intervention was designed and refined as part of a 4-year educational partnership between Hampton University, a minority-serving institution in Virginia, and the University of Pittsburgh Cancer Institute. This partnership entailed several components, including a semester-long cancer biology course and a semester-long cancer laboratory course at the Junior/Senior level. These courses were co-taught by faculty from both institutions using videoconferencing technology and campus visits. For a subset of students designated Cancer Fellows, the partnership program involved intensive summer research in Pittsburgh. Educational activities were structured to reinforce each other in building a core knowledge base, challenging students to generate and defend hypotheses,

exposing students to scientific role models, and empowering them to generate realistic visions of themselves in biomedical careers. The overall goal of this partnership was to frame interventions that might increase the likelihood that minority students would choose careers in scientific cancer research and that would build the skills needed to ground a cancer career. This goal was driven in part by the excess morbidity and mortality from cancer among African-Americans in the USA.

One aim of this collaboration was to convey an understanding of the scientific research endeavor that forms the basis of biomedical knowledge. Whereas most scientific classes at Hampton University focused on knowledge acquisition using a teacher-centered lecture format, the collaborative classes were student-centered and modeled the process of scientific discovery and presentation. Students investigated novel hypotheses by mining data in primary literature and using it to formulate and evaluate experimental strategies that they relayed in poster presentations. In this exercise they synthesized their argument using figures (with attribution) drawn from diverse primary articles.

The generation and presentation of student posters focused on hypothetical cancer-related problems that were related to concepts under discussion in the Cancer Biology course. This semester-long ‘poster project’ was designed to engage the students in problem-based learning, to build their skills in analyzing and using the data from primary literature, and to build a culture of science and inquiry in the classroom setting. This report describes the adoption, acceptance, and outcome of this teaching tool.

Methods

This project represented a challenging educational collaboration between a research-focused institution and a traditional teaching institution located roughly 400 mi apart. The Cancer Biology course offered each fall was an interactive/problem-based learning experience. It was offered as an elective at the junior–senior level, enrolling primarily junior-level Biology majors. The course was team-taught by professors at Hampton University and University of Pittsburgh Cancer Institute via videoconferencing. The class was unique in several ways in comparison to traditional biology courses at Hampton University. Novel components included the integration of distance technology, the multi-professor format including two medical school professors and the creation and presentation of a scientific poster in lieu of a final exam. Forty-six students took the course from 2004 to 2007 (13, 16, seven, and nine in successive years), with one withdrawal from the course concurrent with withdrawal from school. One sophomore, 13 juniors, and 32 seniors enrolled. Few students had previous exposure to scientific posters and none had prior exposure to a cancer biology class. Students had no previous exposure to team teaching or long-distance teaching via videoconferencing.

Course Goals

This introductory course had both cognitive and skill-based objectives (available on request from the authors). The attainment of these objectives was measured through weekly quizzes, a mid-term exam, classroom discussion, and poster generation and presentation.

On 2 days each week, videoconferences focused on building students’ knowledge base. Following an overview on cancer biology and a review of basic DNA and protein biology, class sessions highlighted carcinogenesis at the cellular level (tumor suppressor and oncogene structure and function, cell cycling, cell survival control) followed by a series of classes that tied those basic concepts together with clinical facets of cancer care, using breast cancer as a focus. One day each week was directed by Hampton faculty and was devoted to in-class exercises and discussion of students’ independent research projects. In successive years, more

classes were taught by the Hampton faculty member and fewer by University of Pittsburgh faculty.

Distinctive Aspects of Poster Project

Initiation of Poster Project: After the second week of the course, students were presented with eight to 12 topics that they would rank by preference as a research/poster topic. New listings were generated each year. After they conducted preliminary literature review, students were permitted to modify their topic if approved by the instructor. Two examples of listed topics were:

- A recent treatment for lung cancer uses a protein that blocks signals from the EGF receptor. Only ~10% of the patients receiving this treatment respond to it. Discuss how and why this treatment actually works in this small percentage of patients.
- Your laboratory has invented a small protein (a peptide) that can go inside cancer cells, activate the p53 tumor suppressor protein, and cause the cancer cells to die. Millions of mice are grateful that you can cure cancer in small lab animals. Before starting to test this in people you must explain exactly how the peptide works. Describe such a peptide and how it works in your poster.

Having indicated their top topic preferences, students were paired by topic to research and prepare posters. Students were given short review articles to familiarize themselves with their research area and help to frame their search of the primary literature. The students proceeded through the following phases in developing their work over the next 10 weeks:

- Generation of questions and hypotheses related to topic
- Research of the literature leading to generation of annotated bibliographies
- Refinement of hypotheses
- Selection of data to use from referenced papers
- Turning in successive drafts of hypothesis (text and schematic model), introduction, materials and methods, results (appropriate results culled from primary literature, with attribution), discussion, and abstract

Feedback during each phase was provided by the instructors. Classmates offered feedback at scheduled “work-in-progress” class meetings. The culmination of each team’s effort was realized with an oral presentation of their completed poster at a conference attended by both HU and UPCI faculty, who collectively graded the posters on content and on oral defense by the team.

Active Learning Components

The poster project, as well as problem-solving challenges during interactive videoconferences were intended to set the stage for active, student-directed learning. Because cancer had not been explored in the students’ classes hitherto, the students had the opportunity to learn on several fronts:

1. Reconciliation of beliefs about cancer with biomedical paradigms through learning of core facts and principles.
2. Learning how to read and interpret primary literature.
3. Learning how to read and to create diagrams that model cancer cell behavior.
4. Learning how to extract information from literature and use it to support or to refute a hypothesis.

Results

Students had the opportunity to demonstrate their growing fund of knowledge as well as their analytic and synthetic skills both during the process of poster creation and during their presentation of the final product. Students presented their posters in a formal venue to Pittsburgh and Hampton course directors and to guest faculty from the Biology Department and Administration. A 5-point Likert evaluation form given to students immediately after their presentations determined how the process of presenting their work impacted them (example in Table 1).

Students unanimously preferred the poster project to a more traditional examination. They noted that this active learning approach challenged them to analyze scientific information rather than to simply “memorize it”.

Students manifested a deeper understanding and synthesis of concepts than might be expected in an introductory class. A number of students proposed cancer therapeutic strategies that demonstrated understanding of literature and proposed a creative next step. For example, one student pair confronted the finding that when tumor cells are starved of oxygen (through blood-vessel killing, or “antiangiogenic” therapy), most tumor cells die but the surviving cells respond to low oxygen by becoming more aggressive. They proposed combining an antiangiogenic therapy (endostatin) with an agent (YC-1) that would prevent surviving cells from sensing that oxygen levels were low.

Student feedback on the course as a whole was quite positive, including several noting it as “the best course I have taken so far” and a composite rating of 9.3 out of 10 (year2). Examples of comments were: “The teaching style is great. I’ve never been in a class where discussion took up a bulk of learning. It helps students understand more of the subject matter through the interaction”; “the style of teaching works well for me. It’s easy to retain information because the class is more interactive.” Every student agreed that “this class improved my skills in researching and understanding science literature.”

A survey of participants in 2005 indicated that students spend more time on the following activities in comparison to other science classes at Hampton:

- Time spent doing library-based research
- Time spent in classroom discussion
- Time spent outside of class with other students from this course
- Personal interaction with faculty
- Demand for critical thinking
- Being challenged to move outside my comfort zone

Durability of Skill Set

Eighteen students who had taken the Cancer Biology Course were participants in a 2-year longitudinal undergraduate research development track (“Hampton Cancer Fellows”). This provided an opportunity to assess the durability of the skill set engendered through the poster project.

The “Cancer Fellow” students had been selected on the basis of classroom performance and application essays supportive of their interest in cancer research. After taking the Cancer Biology course, they participated in a Hampton-based introductory laboratory course and then performed a summer research rotation at the University of Pittsburgh Cancer Institute. The

summer rotation afforded them an opportunity to critically evaluate posters by scientists at the University of Pittsburgh Cancer Institute's annual scientific meeting. In addition, each of these students had an independent summer research project for which they developed posters that they presented to University of Pittsburgh faculty and at national meetings. The students performed well in these settings and stated that their production and presentation of their work in poster format had been much easier as a result of their experience in the Cancer Biology class.

Lastly, this subset of students returned to guest teach sessions of the Cancer Biology class, focusing on topics related to their summer research (Fig. 1). A benefit of the involvement of student alumnae of the poster project in the following year's classroom teaching sessions was that they validated the importance of posters as an element of scientific culture, and served as peer-models of student engagement in high-caliber cancer research.

Discussion and Conclusions

By adapting a simulated research experience into an introductory cancer biology course, this project sought to propel active learning of advanced content at the same time that basic material was introduced and discussed. Student feedback indicated that this process was an enjoyable and novel way to learn. Their efforts generally resulted in high-caliber posters that indicated understanding and creative use of the scientific literature. Nonetheless, there were several drawbacks and limitations to this curriculum. The course was highly labor-intensive for faculty because students required individual faculty attention to their choice of literature, their drafts of material and their foray into scientific thinking. It was challenging for the students to balance their mastery of didactic material with their commitment to researching the poster assignment and turning in drafts for comment. Often, time was overly limited for them to reflect on written feedback and revise their work. Most students initially framed their poster project in the genre of book reports and needed additional guidance to learn how to prioritize facts and questions and direct them toward hypothesis testing.

The poster project appears to have been effective in building research literacy. One measure of this, beyond the high rating of the class, is that the skills developed through this project were durable for a subset of students who proceeded through subsequent research-focused learning. These "Cancer Fellows" learned how to analyze, synthesize, and present primary literature and to frame hypotheses during the Cancer Biology course. Having mastered these steps using published reports as their data set during the course, they went on to focus on experimental methodology and results during summer research in Pittsburgh. Each student presented their posters at national venues such as the Society for Advancement of Chicanos and Native Americans in Science or Annual Biomedical Research Conference for Minority Students meeting. Subsequently, they learned how to guide their classmates and put their summer research in the context of current knowledge when they guest taught a Cancer Biology class the next year. Most of these students went on to graduate or professional school and two-thirds continued clinical or basic research (Table 2).

The execution of this classroom initiative merged two pedagogic cultures. Hampton faculty were highly experienced in undergraduate teaching, primarily using textbook-based courses to convey facts and concepts. The medical school faculty had previously taught only information-dense medical school classes and discursive research seminars. While the medical faculty adapted to the level of undergraduate learning, the Hampton professor augmented her expertise in teaching cancer biology. Interviews with Hampton faculty noted that this class and the collaboration with Pittsburgh broadened their own exposure to cutting-edge science. Nonetheless, the poster project was not adopted by other courses during the span of this program.

Several reports have underscored the value of experiential research projects to promote learning in the undergraduate setting. DeBurman has reported on the effectiveness of integrating standard elements of scientific reportage into an undergraduate cell biology course². Required projects included a journal club, medical news journalism, writing a disease-focused review article coupled with a seminar, and modeling primary articles in writing lab reports. Postcourse survey assessment indicated that these interventions significantly augmented students' process skills in communicating contemporary research and in comprehension and communication of primary literature. Research externships have also been shown to enhance learning³. Another model for undergraduate experiential learning has involved poster preparation and presentation of work conducted in class⁴.

Poster presentations have been used as tools to reinforce embedded research projects in the undergraduate setting, particularly at the end of laboratory- or community-based projects or courses^{5–8}. Several studies have incorporated poster presentations as didactic aids through which undergraduate or medical students research and present topics relevant to the course^{9–11}, including information culled from the primary scientific literature⁹. In each of these reports, benefits of collaborative or active learning were cited, as well as the advantage of poster sessions in modeling a professional forum. Poster reports on student or faculty research projects have been particularly helpful in courses examining nursing research methods^{7,12,13}.

Our approach differed from standard usage of the poster in laboratory or didactic reportage because it was focused on a simulated research experience in which students identified and used published data to frame, critically evaluate and present new hypotheses. As in Krilowicz and Downs' study⁹, students learn to critique primary literature and present it to their peers. In our course, however, this literature review framed the background context for the selection and synthesis of data from disparate cancer-related reports in order to test a hypothesis. To our knowledge this represents a novel usage of the poster-based pedagogic model in undergraduate biology teaching.

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Fig. 1.
chematic of progression through the Cancer Biology program

Table 1

Student evaluation of poster presentation

Poster presentation evaluation (1 = not at all; 5 = very much), n=16	
Knowing that I would be presenting my work to classmates and professors made me work harder	4.4±0.8
I prepared for the presentation in addition to researching and creating the poster	4.5±0.7
While explaining my research and conclusions, I began to sense weaknesses in my work	3.6±1.2
I felt very prepared for the questions that my classmates and professors poised to me	4.0±0.8
I learned more from listening to my peers' presentations than from just looking at their posters	4.1±1.2
Based on this experience I would be interested to hear professional scientists present their work	4.3±1.0

Table 2

Early career path of Cancer Fellows

Program year	First	Second	Third	Fourth
Total Cancer Fellows	3	4	5	6
Medical school	1	2	2	3
Graduate school	2		1	1
Other health profession school			1	1
Public health employment		1	1	

The number of students accepted into or matriculating at each type of school is indicated