Converting a Biology Course Into a Writing-Intensive Capstone Course: Using Collaboration Between a Professor and Graduate Teaching Assistant

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In order to be effective competitors in the marketplace, students must be able to think critically, communicate complex ideas through writing, collaborate with peers, and apply their knowledge of biological science to generate solutions for issues facing society. In this paper we examine the nature of the instructional tools, strategies, and assessments we developed to convert a traditional senior-level biology course into a writing-intensive, capstone biology course. Key course objectives include (a) using writing as a learning strategy, (b) stimulating critical thinking through problem solving, (c) engaging students with primary scientific literature, (d) enhancing collaboration among students, and (e) using peer review and formative assessments to focus student thinking on learning and writing about biology. All students enrolled in the course are senior-level biology majors. Typically a third of our students plan to pursue a professional degree (veterinary, dental, or medical schools) and the remaining students plan to pursue an advanced degree in biology. The instructional strategies and assessments we developed will serve to inform others with the writing-intensive course design and assessments.

In the professional world, essential attributes for success include the ability to think critically, synthesize knowledge, solve problems effectively, and communicate information in writing that is focused, well organized, and grammatically correct. We found that even though senior-level biology majors hold significant knowledge, their knowledge often exists in discrete units without a coherent understanding of biology. Furthermore, students are often unprepared to provide explanations requiring the integration of knowledge covered in other courses. Research has shown that in the sciences, course focus is narrow (e.g., genetics, systems physiology, ecology), and students often perceive knowledge as disparate chunks of information from each content area (Brown & Benson, 2005; Spurrier, 2001). Eves, Davis, Brown, and Lamberts (2007) posited that students must have the opportunity to integrate scientific knowledge learned while completing their degree to gain an understanding of how scientific knowledge is developed, validated, and applied to meet the needs of society. Our goal is to provide an opportunity for students to integrate information from prior coursework (across all levels of biological investigation) while learning about human reproductive physiology and the factors that impact reproductive diseases.

Two key objectives for student learning guide the course curriculum. First, we sought to create a cap-

stone course challenging students to integrate their knowledge of cell biology, physiology, anatomy, and chemistry. The course curriculum explores human reproduction beginning with basic endocrinology (e.g., molecular structure and mechanism of action of lipid and protein hormones), followed by an examination of fetal development, birth, maturation, adult functioning, aging of the male and female reproductive system, and diseases of reproductive structures. For each topic the emphasis is on integrating information from molecular, cellular, and physiological mechanisms as well as behaviors related to reproduction. Second, we formulated multiple writing assignments challenging students to work independently on out-of-class writing assignments and collaboratively with their peers to resolve issues associated with in-class case study assignments. Our overarching goal is to support students' learning as they express their understanding of complex biological concepts in writing. A study by Boyce (1990) emphasized the importance of integrating writing into instruction and posited that through writing, students learn to think critically and integrate their knowledge to organize and express complex ideas with clarity. In this course we sought to accomplish these goals by using a combination of approaches that involved both individual and collaborative assignments.

Course description

Content

This is a three-hour course with 75-minute classes meeting twice per week with an enrollment of 36 students. The students have completed the core curriculum for biology majors, and we require them to draw on knowledge gained from other biology courses. We build on students' knowledge of the molecular structure of hormones and hormone receptors to emphasize hormonal regulation of cellular function, male and female reproductive systems, and the cycle of life from conception through birth and adulthood senescence of reproductive function. Also included are the new fields of "endocrine disrupting chemicals," focusing concern on the use of products containing chemicals that mimic or interfere with hormonal signals and thus disrupt reproductive processes, and "the developmental origin of adult health and disease." We use research findings in the primary scientific literature to support explanations using a lecture/discussion format. Scientific knowledge is presented as evidence rather than facts; from the beginning of the course, students are reminded that today's facts may be tomorrow's fallacies.

Collaboration

Cooperative learning is a key aspect of this course, and we use peer collaboration as a learning tool. The peer groups are responsible for key tasks throughout the course. First, at the close of each class, peer groups develop review questions (three multiple-choice and two short-essay questions—including answers) on the basis of lecture content; exam questions are developed from student questions. Second, peer groups respond to in-class collaborative assignments (case studies involve integration of students' knowledge of biology and chemistry to address realistic reproductive issues). Students share knowledge, negotiate meaning, and achieve consensus in the preparation of a viable solution and incorporate their ideas into a written response supported by evidence taken from course readings and lecture notes. Third, student groups function as peer reviewers and use a prepared scoring guide to review the first draft of a formal research paper focused on a topic chosen by each student. This allows each student to receive three peer reviews of his or her work, one from each group member, and encourages students to reflect on their own work as they review the work of their peers. Peer reviews of the first draft do not impact the grade of other group members. Instead, we evaluate peer reviews for the quality of the evaluations to ensure appropriate and effective feedback. We found that when writing is an important aspect of the curriculum and incorporated into instruction, students expect to write and respond to each other's work.

Emphasis on critical thinking and writing

Science education literature has emphasized the importance of writing in the science curriculum. Bangert-Drowns, Hurley, and Wilkinson (2004) reported that engaging students in learning through writing supports and promotes students' use of cognitive learning strategies. Weinstein and Mayer (1986) identified four cognitive learning strategies that emerged when students learn through writing. These strategies range from simple recall to critical thinking and problem solving. We developed an array of collaborative in-class and independent out-of-class assignments to support student learning through writing. First, lecture summaries engage students in reviewing content knowledge from the lecture while interpreting and explaining concepts in their own words. Lecture summaries serve as a learning tool, engaging students in organizing knowledge into coherent explanations. Furthermore, we noted that students' ability to convey complex concepts through writing improved with experience. Second, students build connections between prior knowledge and new knowledge through writing; writing engages students in exploring new knowledge, comparing new ideas with their existing ideas, and considering potential implications. In

our course, students read and write critiques of articles taken from primary scientific literature to gain an understanding of how environmental pollutants (e.g., bisphenol) impact fetal development and adult health. Third, writing stimulates self-assessment of students' own thinking and learning as they review, organize, and explain concepts. We require students to review, critique, and provide written feedback on writing assignments completed by members of their peer groups. Peer review of student writing focuses students on responding to the work of others and also encourages students to think critically about their own writing. Fourth, writing assignments are designed to stimulate the integration of knowledge. We use a formal research paper as a vehicle for students to develop familiarity with primary scientific literature, pose questions, conduct literature reviews, formulate explanations supported with evidence, and convey their thoughts in a well-written research paper.

Swanson-Owens (1986) and Durst and Newell (1989) posited that when students are engaged in writing, they explore new ideas and make connections to their prior knowledge and experience. Hence, we developed a two-part course design that follows the view of two forms of scientific knowledge presented by Ryder, Leach, and Driver (1999). First, we rely on primary scientific literature identifying scientific research as the source of knowledge validated through replication and peer review. Second, we emphasize practical applications for scientific knowledge, encouraging students to incorporate course content into their writing while considering the impact of this new knowledge on their lives and the needs of society (Ryder et al., 1999). We developed a series of in-class and out-of-class writing assignments focused on key concepts in mammalian reproduction with increasing emphasis on clarity, organization, and grammar usage. The following sections further characterize the nature of writing assignments implemented in our course.

FIGURE 1

Human fertility case study.

Frank's story
Frank Calhoun sat quietly in Dr. Jackson's office; the purpose of his visit was to further explore the couple's problems with fertility. Frank, an accountant, and Zoey, a financial manager with the same firm, had married eight years ago. Three years ago, the couple had purchased their first home and filled it with furniture. At last they finally felt settled and ready to start their family. For the past three years, Frank and Zoey had been actively trying to conceive with no results. During the past year Zoey's fertility had been carefully evaluated by her gynecologist, and she was given a clean bill of reproductive health; now Frank was seeing Dr. Jackson, a urologist, to determine his health status in terms of fertility.

Dr. Jackson
Frank seemed nervous, and during the consultation we spoke about various aspects of male fertility and what made sperm viable and fertile. Frank was interested in everything I could tell him about male fertility and conception. I told him the lab would evaluate many aspects of his reproductive health. Frank is like many other men in this situation; he is very concerned about his ability to father a child. Hopefully, I will be able to answer many of his questions, provide an accurate diagnosis, and enact appropriate treatment to address his concerns.

Team challenge
Work with your team to determine major issues associated with male fertility and conception. Respond to the scenario presented in the case study using class notes, the text, and outside readings. Your team should include the following issues in their response:

1. Identify issues in male fertility (take time to be thorough).

2. What aspects of male fertility are likely to be investigated to establish Frank's reproductive health?

3. Why are the aspects of male fertility identified in your response to Prompt #2 important in terms of male reproductive health?

4. How do normal sperm change in the female reproductive tract and how does this change(s) result in the fertilization of the ovum?

5. Your team must provide support for all claims and conclusions.

Assessment
Your work will be assessed with the rubric provided. Use it to guide your work. Remember, your response must be accurate, thorough, referenced, and well written.

In-class writing

Lecture summaries

Nine, one-page lecture summaries are assigned randomly during the semester and make up 1% of the course grade. Students write lecture summaries using only their notes as a reference. We found lecture summaries to be an effective instructional tool, enhancing conceptual understanding of complex concepts, emphasizing note taking, and encouraging attendance. Initially lecture summaries are assessed only on accuracy; as the semester progresses, we expand our assessment to include writing clarity, organization, word usage, and grammar. The emphasis on accuracy and writing proficiency prepares students for more demanding writing assignments as the course progresses.

Case studies

Students work collaboratively with peers to propose solutions for cases

focused on clinical issues relevant to course content. Herreid (2007) described a case study as "a story with an educational message" (p. 27). Cases are written as realistic dilemmas related to concepts presented during lecture. Student teams are challenged to analyze the problem, consider the course content, and synthesize an evidence-based solution (Chamany, Allen, & Tanner, 2008; Herreid, 2007). Research examining science learning and teaching by the National Research Council (2005) has supported the implementation of instructional tools (e.g., case studies) that rely on critical thinking, problem solving, and collaboration to prepare students to grapple with the increasing emphasis on science, collaboration, and technology in the workplace. We found that the collaborative nature of case studies supports the development of conceptual understanding as students share their ideas, negotiate meaning, achieve consensus, and write their proposed solutions. We take exam questions from case studies to evaluate student understanding of the concepts presented in the case. Test results consistently indicate students gained a strong understanding of the concepts. An example of a case study is shown in Figure 1.

TABLE 1

Scoring rubric for human fertility case study.

Criteria	Excellent	Good	Fair	Poor
Identification of main issues/ problems	The team clearly identified major issues associated with the case study.	The team identified most of the issues associated with the case study.	There was limited identification of the issues associated with the case study.	The team appeared confused and was not able to identify the main issues associated with the case study.
Accuracy	The team provided clear and accurate explanations of the main issues associated with the case study.	Explanations of the issues provided by the team were mostly accurate.	Only some of the explanations were accurate; accuracy of the explanations cited by the team was an issue.	Overall, the explanations provided by the team were inaccurate and seriously detracted from the team response.
Analysis of the issues	The team demonstrated a well-documented and well-reasoned solution for each of the issues in the case study.	The team demonstrated appropriate, well-thought-out responses to most of the issues identified in the case study.	Superficial solutions were given by the team in response to most of the issues in the case study.	Solutions for issues in the case study provided by the team lacked clear explanations and were not well thought out.
Terminology	The team clearly understands the vocabulary introduced with these concepts; vocabulary terms were used accurately and appropriately.	The team used terminology well. There were some minor issues associated with the accurate and appropriate usage of terminology.	Terminology was determined to be a challenge for the team. Terminology usage was limited.	Appropriate usage of terminology was largely absent from the team response to the case study.
Support for explanations	The team supported all claims and conclusions with evidence taken from outside readings, class notes, and/or the text.	Most of the claims and conclusions proposed by the team were supported with evidence taken from outside readings, class notes, and/or the text.	Limited support for claims and conclusions was taken from outside readings, class notes, and/or the text.	The team did not cite resources in their explanations and made no reference to evidence supporting their claims and conclusions.
Writing skills clarity	The writing submitted by the team is well organized, logically sequenced, and easy to read.	Team writing is clear and easy to read. The sequence is logical.	Overall the writing demonstrated by the team is good and the quality of writing is passable.	Team writing is poor. There is little organization and the sequence of ideas is sometimes confusing.
Grammar and spelling errors	The document is free of grammar and spelling errors.	There are limited grammar and spelling errors in the document; however, the errors do not detract from the readability of the document.	There are more grammar and spelling errors than one would expect in a collegiate paper.	The number and nature of grammar and spelling errors detract from the readability of the document.

One of the challenges associated with case studies is assessment. We developed a scoring rubric to focus student attention on key elements of their solution. The rubric assesses key expectations for student thinking and writing in the completion of a case study and is shown in Table 1.

Out-of-class writing

Original research article critique

Most students entering the course have minimal familiarity with primary scientific literature. We address this concern by challenging students to read and critique scientific articles taken from the *Proceedings of the National Academy of Science*, examining the impact of environmental endocrine disruptors on fetal development and adult disease of reproductive organs. After reading the articles, students follow a rubric to identify the hypothesis and explain the relevance of tables and charts as well as the potential significance of the research in terms of fetal and adult health. Additional scientific articles taken from peer-reviewed, scientific journals are posted on the course web page and serve as assigned reading throughout the course. Scientific literature is referenced during lectures, and questions taken from the articles are included in each exam. The scoring rubric

TABLE 2

Scoring rubric for research article critique.

Criteria	Excellent	Good	Poor	Score
Introduction *Identifies the problem being studied through the research.*	The student has clearly identified and discussed the question addressed by the research. The significance of the research is clearly identified as it applies to human health.	The student has provided a limited discussion of the purpose of the research. There is only a limited discussion of the significance of the research.	The student has provided a very limited discussion of the purpose of the research. The significance of the research is not clearly understood by the student.	
Methodology *Provides insight into the methods employed by researchers.*	The student provides an accurate explanation of how the research was conducted in terms of the methods used by the researchers.	The student provides a limited explanation of how the research was conducted in terms of the methods used.	The student does not address the methods used by the researchers.	
Results *Provides clear description of the processes.*	The results of the experiment(s) are clearly explained by the reader. The student also relates findings to current issues in human health.	There is a limited explanation of the results of the experiment(s). The student provides a limited correlation between the findings and current issues in human reproduction.	The results of the experiment(s) are not clearly discussed. The student provides little or no correlation between the findings and current issues in human reproduction.	
Discussion *How did the researchers interpret the results of their research and its relevance to current issues in human health?*	The student provides an accurate discussion of the conclusions drawn by the researchers and discusses the relevance of the research in terms of current issues in human reproduction. The student includes data tables and figures in the discussion.	The student provides a limited discussion of the conclusions drawn by the researchers and provides limited insight to the relevance of the research in terms of current issues in human reproduction. The student provides limited discussion of data tables and figures cited in the paper.	The student provides a very limited discussion of the conclusions drawn by the researchers and fails to provide clear insight into the relevance of the research in terms of current issues in human reproduction. The student does not reference data tables or figures cited in the paper.	
Neatness and organization.	The paper is neat and well organized. The paper is two pages in length and double spaced with one-inch margins.	The paper is neat and fairly well organized. The paper is two pages in length and double spaced with one-inch margins.	The paper is neat but lacks clear organization. The paper is two pages in length and double spaced with one-inch margins.	

TABLE 3

Peer evaluation scoring guide for the first draft of the research paper.

Directions	You will be assessing the quality of each other's work using the following scoring guide. The purpose is to provide quality feedback to assist in the improvement of the paper. Carefully read each of the evaluations and indicate the appropriate descriptor. Also use the space provided to write suggestions for improvement to the author of the paper.
Your evaluation is designed to provide quality feedback to the author of the paper and will not have any impact upon the grade the paper receives following evaluation by instructors.	Assign a grade for the paper you evaluate based on the scale below: ***1 – 2***: The paper is not acceptable as written. There is not enough information to understand the central topic of the paper and to discern the hypothesis of the author. There are also serious problems with organization and grammar. ***3 – 4***: The paper is acceptable in terms of the basic information provided by the author. The paper is not well organized and lacks clarity. The author has not developed support for his/her ideas. ***5 – 6***: The paper is well written. There are no major problems with organization and grammar. The author has developed support for his/her ideas through references relevant to the original literature.

Grade: 1 2 3 4 5 6 Grader: _____ Author: _____

	Evaluation	**Suggestions**
1	Where is the topic introduced so that you have a clear understanding to exactly what will be discussed? a. at the beginning of the paper b. after the first paragraph c. there is not a clear statement of the topic	
2	Is there a research question identified within the topic of the paper? a. the question is clearly stated and introduced with the topic of the paper b. the question is not clearly stated and the purpose of the paper is unclear c. there is no research question, there is no focus for the paper	
3	Is the topic covered in the body of the paper what you expected based upon the stated topic? a. yes, exactly as stated b. the topic was a little different than expected based upon introduction c. the actual topic was quite different from the stated topic	
4	Does the author support his/her ideas with reference citations from primary scientific research? a. yes b. somewhat c. not at all	
5	Is the paper well organized in terms of Introduction, Question to be investigated, Discussion of research, Conclusions drawn from research, and Presentation of one's own ideas)? a. yes—well organized, logical sequence, easy to follow b. somewhat organized—ideas are not clearly explained c. very poor organization—difficult to understand	
6	Does the writer support his/her ideas with support from appropriate references (primary scientific research)? a. always b. sometimes c. very little	
7	Do grammar and spelling errors distract from the clarity of the paper? a. no, only minor errors are present b. some errors need correction to clarify the ideas of the author c. grammar problems are a significant impediment to the clarity of the paper	
8	Was the paper interesting and worth reading? a. very interesting b. somewhat interesting c. confusing and difficult to read; also did not hold my interest	

General comments and suggestions for improvement
Use this space to provide your suggestions to the author:

used to assess the research article critique is shown in Table 2.

Research paper: Preliminary and final versions

Each student identifies a research question exploring an aspect of mammalian reproduction as the focus for a formal research paper. The writing task challenges students to integrate their knowledge of science, primary scientific literature, and formal writing skills. Supporting evidence for student claims must be taken from primary scientific literature and cited using the style typical of a published scientific article. The paper, a final writing assignment, is completed in two steps. In step 1, students conduct a review of relevant scientific literature using library and online resources and generate a preliminary draft approximately 700 words in length. Students submit their first draft for peer review (conducted within teams of four students each) and formative evaluation by instructors. Peer reviewers and instructors use the same scoring guide to assess student writing for clarity, focus, organization, grammar, and spelling. The peer-review scoring guide is shown in Table 3.

During step 2, students use feedback from peers and instructors to reflect on and assess their work; the final scoring rubric for the paper provides guidance for the final draft. The final draft has a minimum requirement

TABLE 4

Scoring rubric for final draft of the research paper.

Criteria	Excellent	Good	Poor
Research question	The student has identified a relevant question to guide his/her research. The question contributes to scientific knowledge in a focused and specific area of human health and reproduction. The question is clearly stated and explained in the introduction of the paper.	The student has identified a question to guide his/her research. The question contributes to scientific knowledge in a specific area of human health and reproduction. The question is explained but the explanation is limited.	The student has not clearly identified a question to guide his/her research. The question is not clearly stated or explained.
Content and accuracy of paper content	The body of the paper clearly supports, elaborates, defines, and explains the main points of the paper's main topic. The body of the paper clearly addresses the research question.	The body of the paper provides a limited exploration, elaboration, and explanation of the paper's topic. The research question is addressed.	The body of the paper is confusing and provides little in terms of identification and explanation of a topic for the paper. The research question is not clearly addressed.
Primary literature references	The student gathered information from primary research in both electronic and print peer-review, scientific journals. Sources are relevant, current, and include critical readings relating to the focus of the paper. The student carefully analyzed information from primary scientific literature and drew appropriate and inventive conclusions supported by evidence.	The student gathered information from primary research in both electronic and print peer-review, scientific journals. Sources are relevant, current, and include critical readings relating to the focus of the paper. The student analyzed information from primary scientific literature and drew appropriate conclusions with limited supporting evidence.	The student gathered information from resources other than primary research. Sources lacked relevance, were not current, and did not include critical readings relating to the focus of the paper. The student's analysis of information from his or her resources was very limited. Student conclusions lacked supporting evidence.
Accuracy of examples and explanations	The student included accurate examples and explanations to develop support for his/her ideas.	The student included limited examples and explanations to support his/her ideas.	Key examples and explanations to support the student's ideas are absent from the body of the paper.
Citations	References are accurately cited throughout the text of the paper and a complete bibliography is also included in the proper format.	References are accurately cited throughout the text of the paper and a complete bibliography is also included in the proper format.	References are not cited in the text of the paper and the bibliography is limited at best and references are not written in the proper format.
Writing	Errors in grammar and spelling are not present. The paper is well organized, logically sequenced, and easy to read.	Errors in grammar and spelling are minimally present but do not significantly interfere with the clarity.	Errors in grammar and spelling are present and seriously detract from the clarity of the paper.

of 2,000 words and is submitted approximately two weeks prior to the final exam. An important aspect of this approach is that the final draft is expected to be free of grammatical or conceptual errors as a result of incorporating changes that are based on peer and instructor reviews of the preliminary draft. The final scoring rubric for the research paper is shown in Table 4.

Graduate teaching assistant

A graduate teaching assistant (GTA) appointment provides a stipend for graduate students in exchange for working 10 to 20 hours per week to assist and support instruction within an academic program. The simplicity of the description belies the importance of the task. GTAs can bring a good deal of knowledge and experience into their supporting role within the university setting; this is especially true of nontraditional students earning a doctorate after a career in education or industry. This GTA held extensive experience as a former high school biology teacher and collaborated with the instructor to (a) construct the course syllabus, (b) develop assignments, (c) generate assessment tools (e.g., rubrics and scoring guides for all assignments), (d) grade student work, and (e) transcribe and post student questions from each lecture. The nature of student questions (and answers) provided important insight into students' conceptual understanding of lecture content. The questions also served as study guides for course exams. Guided by the learning objectives for the course, we collaborated on the development of multiple writing assignments enhancing the relevance of course content. Scoring guides and rubrics clarify expectations for writing assignments. Furthermore, scoring guides and rubrics are posted on the course website to inform students of our expectations for their work and serve as authentic assessment tools capable of measuring student performance within the context of multiple criteria (Arter & McTighe, 2001).

TABLE 5

Sampling of student comments taken from 2007 through 2010 course evaluations.

Semester	Student feedback
2010	I liked that students had the chance to write possible questions for the exam.
2010	Course material is applied to everyday life.
2009	Student questions were extremely helpful in studying for exams.
2009	It was not just three tests, there were plenty of places for more points, such as the research paper and in-class writing assignments.
2008	Allowing students to write their own questions for the exams and mixing it up with lecture summaries to make sure we were listening.
2008	Course information was very relevant and the ability to contribute questions to the tests worked well.
2007	Allowing students to write questions for the exams is a very good idea.
2007	This course was extremely interesting; lots of extremely relevant and up-to-date material was presented.

Methods of assessment

We used both traditional and nontraditional assessments to gauge student understanding. Three exams serve as traditional assessments, evaluating students' conceptual understanding of course content and making up approximately 60% of the final grade. Exams consist of multiple-choice, fill-in-the-blank, short-answer (response of three sentences or less), and formal essay questions; hence, we design exams to address all learning styles. Furthermore, exam questions are generated from student questions submitted by peer groups at the close of each lecture. Hence, students have input in how they are assessed, an aspect of the course that receives very positive comments from students each year. Nontraditional assessments make up approximately 40% of the final grade and include evaluations of student writing (e.g., lecture summaries, scientific article critique, written case study responses, and preliminary and final drafts of the research paper) and clarify expectations for assignments and provide insight into how student work will be evaluated.

Implications

There is often resistance to teaching writing-intensive courses among faculty. Studies by Brown and Benson (2005) and Shaw (1994) revealed that faculty equated the time and effort required for teaching a single, writing-intensive course to teaching two courses instead of one. Faculty are required to expend additional time and energy in the development of course work designed to engage students with critical thinking, peer collaboration, formal papers, and rubric development for nontraditional assessments. A significant issue is the lack of administrative support provided for faculty teaching a writing-intensive, capstone course. Without additional support, teaching a capstone course may divert valuable time away from conducting research and earning tenure, significant concerns for young faculty. GTAs in science education have the potential to provide critical support for instructors by contributing to syllabus development, serving as tutors and as graders for student work. GTAs gain valuable teaching experience as

they work with the professor to implement a writing-intensive curriculum and provide valuable support for students. However, graduate students in the hard sciences may not possess the skills to serve as GTAs and, therefore, must be prepared to work in curriculum development, instruction, and assessment, which is beyond what is expected of a GTA in many courses. The role of the GTA in this course has the potential to inform GTA training, supporting connections between science education and instruction in the hard sciences. We suggest a GTA professional development program, working in conjunction with faculty or staff with expertise in this area (such as the Curriculum and Instruction Department) to prepare graduate students to serve as GTAs. Furthermore, such professional development experiences will serve to further develop the skills required of graduate students who are future research and teaching faculty.

From the students' perspective, our course represents a significant amount of work relative to the typical 3-credit course. When we initially introduced our writing-intensive capstone course, many students complained that the course should be worth additional credits to reflect the volume of work required. Interestingly, this complaint no longer appears on course evaluations, suggesting that our course has been accepted as an important part of the undergraduate curriculum. Student feedback on the course from spring of 2007 through spring of 2010 indicated 95% of the students rated overall teaching effectiveness as excellent or quite good. A sampling of student comments taken from 2007 through 2010 course evaluations is shown in Table 5.

In summary, the course design challenges students to apply their understanding of concepts in biology and chemistry to real-world reproductive issues. By incorporating student writing into our course curriculum, we encouraged students to build connections between their existing knowledge and new knowledge. We engaged students with problem solving through cooperative learning and requiring students to share knowledge, negotiate meaning, and think critically as they generate solutions to real-world issues. We involved students in peer assessments of one another's work, encouraging self-evaluation. Our hope is that by providing examples of instructional strategies and assessments, we can provide support to others interested in the incorporation of writing as a learning tool for students prior to pursuing postgraduate education or entering the workplace. ■

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