

DETERMINING THE EFFECTIVENESS OF LA SALLE UNIVERSITY'S WRITING-ACROSS-THE-CURRICULUM REQUIREMENT IN THE BIOLOGY MAJOR

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In 1988, LaSalle University incorporated a writing emphasis requirement within each major to provide more effective writing instruction in every discipline. By 1991, La Salle's biology curriculum required all biology majors to complete a writing component consisting of two assignments. The first required students to write a scientific review article on a topic of personal interest. The biology faculty expected students to use about thirty primary sources from contemporary journals to compose this twenty- to twenty-five-page paper. The second assignment entailed condensing the information discussed in the review paper into a shorter, popular science format that would convey the same scientific information to the general public. In 1996, Margot Soven and Craig Franz evaluated the biology writing component in a descriptive study to determine if the goals of the requirement had been met and whether the assignment was effective. The evaluators at the time concluded that the writing component was, indeed, an effective means of teaching biology students how to write well within their discipline.

Since the 1996 evaluation, the biology writing component has changed slightly, because the department has altered the course curriculum. The assignment had originally been incorporated into a two-semester biochemistry class, providing students with an entire academic year to work on these two essays. This modification in the curriculum resulted in a one-semester condensed biochemistry course and an independent one-semester molecular biology course into which the professors decided to transfer the writing assignment requirements. The faculty then removed the second assignment designed for the general public from the curriculum because of the shortened timeline for completion. The longer review paper, however, remained generally the same.

The authors of this article designed and conducted a new study to assess the effectiveness of the current biology writing component based on the perspectives of both students and professors of the La Salle biology department, as well as scholars in the field of writing-across-the-curriculum (WAC) assignment design and implementation. The investigators in this study determined that the current biology writing assignment meets the criteria of a quality assignment according to WAC scholars. It can also be classified as an effective assignment that meets the needs of biology students and professors at La Salle University. While the assignment is effective in its current form, it deviates from the original goals instituted in 1988. The new assignment excludes other biological writing styles, such as the popular science essay, from the for-

mer assignment. This study explores possible shortcomings of the new assignment's lack of representation of the variety of biological writing styles, and the investigators have provided some suggestions for the biology department to consider when reviewing the assignment for aspects that can be improved.

The Importance of Writing in Science

In order to be successful as professionals, students must learn the basic inquiry strategies common to most disciplines and incorporate these into their writing. Such strategies include examining assumptions and prior knowledge, posing questions, making and interpreting inferences, establishing working hypotheses, testing interpretations, and imagining. In fact, imagining is perhaps the most powerful gateway of all, the foundation for original discovery and insight (Nagin 55). These strategies lie at the core of the critical thinking that students must practice in academia, in a profession, and as adult citizens beyond school.

In addition to acquiring communication skills required of successful professionals, students can also utilize writing to learn the subject matter of the discipline. A complex educational tool, writing is a means of inquiry and expression for learning in all disciplines (Nagin 3). For example, clear, precise statements, closely reasoned arguments, and unambiguous language are valued among scientists. Practitioners argue that problem solving through writing leads students to come to grips with their incomplete understanding in an active and self-stimulating fashion (Tobias 48). Moreover, instructors intend for students to construct a personalized understanding of the subject by means of the written or spoken phrase. Writing as a means of self-exploration in mathematics and science learning achieves two important goals: it provides classroom-based specific feedback, and it gives students the opportunity to identify and to unravel their own misconceptions (54). If students write about the material, especially from some personal vantage point, they come to own the material. Open-ended writing assignments in the sciences allow for individuality and creativity, while more specific assignments ensure that certain concepts are understood. Research demonstrates that students who associate the material with images or ideas of their own creation increase their recall. Furthermore, a case study by Kathryn Martin indicated that writing on a daily basis encourages students to review biological concepts (114).

Scientists' composition processes typically involve the discovery of new ideas and information about their research and its meaning. When instructors assign research papers, they intend for the students to experience the satisfaction that comes from discovering new ideas and the exhilaration that comes from exploring the sources. These educators also hope that students will discover that sifting through the information and organizing it into coherent statements, though difficult and often frustrating, in the end can be a rewarding experience (Lutzker 1).

Description of Writing in the Sciences

Writing in the sciences may not differ radically from the writing processes of other kinds

of professionals. The conventional notion of nonscientists is that the writing task is one in which scientists simply record laboratory procedures and results. Those outside of the field assume that scientists' perspectives are developed from a preconceived frame of reference, which determines the observations they make about the world. Contrarily, scientists regard the experimental paper as the vehicle both for giving meaning to their observations and for persuading the scientific community that those observations are truths (Rymer 212).

Scholars have observed routine laboratory practices and shown how a scientist's writing imposes a logical structure on the mass of confusion in the lab. Thus, the written works of scientists establish their credibility and persuade the community that the claims asserted in their works should be accepted as facts (Rymer 212). Additionally, as Harrington and Rivers identify, the scientist is ever seeking to systematize knowledge by stating general laws; some may be amended by new discoveries, but the substance of science is a body of general propositions (11). The professional scientist selects all the relevant information, tests deductions, and evaluates the results in the light of many facts or general propositions that bear upon the issue (12). Geller adds that scientists also write to show nonscientists what is important about their work, no matter how specialized the subject material (84).

Scientists choose to represent their actions and beliefs in discourse using a wide array of genres and styles. However, the depersonalized, objective, scientific style of experimental papers plays a significant role in the discussion of material expected to be accepted as scientific knowledge (Rymer 212). Rymer illuminates how the conventions of scientific texts operate, explaining that the genre dictates certain choices of form and content while serving to justify the writer's belief that the scientific enterprise leads to reliable and valuable knowledge about the natural world (213). However, Rymer also presents evidence that scientists use multiple approaches in writing experimental papers. In addition to linear models focused on detailed planning, scientists use a full range of strategies, including recursive models focused on revision. Rymer's study also suggests that scientists frequently discover new ideas about their experimental results and what the underlying science means while composing their journal submissions (244). An undergraduate writing assignment in the sciences must be representative of these aspects of scientific writing without overwhelming students.

Using WAC Ideology to Develop Effective Writing Assignments

In the 1970s, WAC programs appeared in reaction to the dominant view that language has only one function—to inform. The precedent at the time suggested that the only language activity useful to education is the finished report or essay. WAC programs challenged this idea and sought to use writing to improve the teaching techniques of faculty members and expand the realm of learning activities for students. Learning to write in new ways allows students to intensify their involvement with the different areas of study in their educational program. Similarly, faculty members believe WAC is ultimately about finding textual pathways to help students

enter and eventually transform powerful organizations of people (Russell 331). Other premises of WAC programs include writing to promote learning, writing as a complex developmental process, and the idea that the universe of discourse includes a broad range of writing functions and audiences (Freisinger 3).

The writing assignment quickly became a major tool for transforming teaching practices at the undergraduate level. However, promoters of WAC programs now faced the challenging project of creating quality writing assignments for a diverse range of disciplines. After years of planning and trial and error, WAC advocates established some requirements for designing an effective writing assignment. According to these standards, developed over time, an effective writing assignment does more than ask students to write about what they have read. Rather, such an assignment engages students in a series of cognitive processes, such as reflection, analysis, and synthesis, so that they are required to transform the information from the reading material (Nagin 47). Furthermore, an effective assignment gives students a framework for developing ideas and organizational guidelines that help them analyze and synthesize the information with which they are working. The most successful assignments offer the student a genuine opportunity to communicate with a real audience (48).

Marilyn Lutzker has also contributed helpful guidelines for designing effective writing assignments. Lutzker suggests that most educators now realize that learning takes place during the process of researching and writing a paper, and the final product is, at best, a report of that learning. Professors also increasingly recognize that more will be learned during the writing process if they actively monitor and review each stage of students' writing. As a result, Lutzker concludes that structured assignments are vital to WAC programs. The best format seems to involve a number of small, interrelated projects completed sequentially to culminate in a larger product. Such an assignment is valuable because it permits multiple deadlines as well as early and frequent feedback so that teachers can identify flaws in the writing and research early. In addition, such a process takes advantage of the recognized efficacy of incremental learning (9). Finally, Lutzker believes instructors should also build opportunities for students to practice several different types of writing, such as analysis, classification, comparison, criticism, evaluation, justification, and summarization (10). In 1988, La Salle instructors took on the challenge of developing a biology writing assignment that meets these criteria.

Initial Goals and Expectations of the Biology WAC Assignment at La Salle University

Previous research shows that WAC programs seek to enhance students' higher-order thinking or habits of mind, to make students more active learners, and to evaluate student work more effectively (Dowling et al. 50; Russell 264-69). Prior to the institution of writing emphasis requirements at various colleges, most science students across the nation had very little experience in thinking about how to communicate scientific information to nonspecialists. Although some of these students had previously completed creative science projects meant to encourage

writing to learn, and most of them had composed some form of research paper in the humanities, science students had virtually no experience writing scientific research articles (Geller 84). At La Salle specifically, laboratory reports were the primary writing activity of biology majors. Some biology students also had experience in answering essay questions, but they had almost no experience in writing lengthy research papers. Furthermore, professors rarely required students to translate highly technical material into popular science terms to prove their understanding of the material and show that they could convey this knowledge to others. Clearly, the students needed more specific instruction in writing scientific papers as well as experience writing for a nontechnical audience (Franz and Soven).

Each scientific discipline has rhetorical conventions specific to its subject, so the importance of discipline-specific writing instruction in biology was evident. The university recognized this need because students were not learning specific discipline-related writing in undergraduate first-year composition classes (Franz and Soven). Also, in the past, science professors were often more concerned with the interpretation and presentation of scientific data than the style in which it was written. This deficit led to the 1988 implementation of a writing emphasis requirement at La Salle University. The establishment of a WAC program at the University was undoubtedly beneficial, but a discussion of its specific goals is necessary to gauge its success.

Realizing that successful scientific writing develops from experience and guidance, La Salle faculty sought to incorporate writing projects into the biology curriculum to encourage students to develop and improve the skills needed to write within their discipline. Faculty members worked together to create a common writing experience for students based on typical writing in the biological field. By 1991, La Salle faculty had developed a writing component, which all biology majors were required to complete regardless of concentration within the major. The writing component consisted of two assignments: a scientific review article twenty- to twenty-five pages in length with approximately thirty primary source references from contemporary journals and a shorter summary of the review written for the general public. The first essay was to be an in-depth exploration of a topic that interested the student. The second paper involved adapting the content of the first essay to a shorter, popular science format. Biology professors served as faculty mentors to assist students with organization and scheduling of the project. The department chairperson assigned students to their mentors according to their topic choices, so that each student would have access to a specialist in the subdiscipline he or she chose with whom to discuss the research process as well as subject matter. Writing fellows reviewed the rough drafts, and the biology department archived the final copies for future student reference (Franz and Soven).¹

The 1996 Franz and Soven study evaluated the goals of the senior writing component in biology and concluded that the program was effective. The former writing requirement gave La Salle biology students the valuable opportunity to communicate with experts in their field of interest and to discuss the technicalities of scientific topics. Students also learned ancillary skills

such as techniques for searching electronic databases, organizational schemas for preparation of major papers, and editorial skills for the improvement of written presentation. In addition, students learned how to translate technical terms and explain complicated processes in simpler terminology in the second assignment. The senior writing project in biology enabled students to see the connection between biology and rhetoric, to learn how to synthesize complex material into a coherent research essay, and to develop capacities for translating technical knowledge into information understandable to the general public.

The changes made to the initial writing assignment instituted in 1988 motivated the student authors of this work to conduct a small-scale research study examining the revised biology writing requirement. Expanding on the 1996 descriptive study of Franz and Soven, which confirmed that the original assignment implemented was effective, the investigators studied student surveys and professor interviews to explore the perspectives of La Salle biology majors and professors to determine if these groups find the revised assignment effective.

Assessing WAC Programs

Assessment is a valuable tool for the development and implementation of instructional programs. Focusing on the big picture, effective assessment relies on a set of guidelines that motivates inquiry, employs diverse methods, focuses on learning and teaching and how the two interact, and needs to be regular, systematic, and coherent (Beason and Darrow 7-8). Helpful questions to consider when assessing WAC programs are: Did the strategy help build engagement and community in the classroom? Did the strategy lead to enhanced student learning? Was the strategy consistent with teachers' time pressures and other constraints? Did the strategy fit teachers' philosophies, priorities, and styles of teaching (Dowling et al. 93)? Do students and teachers perceive an improvement in students' writing abilities because of the writing activities done in a WAC classroom? Do students and teachers perceive that these writing activities improved students' ability to understand course content? How do various writing activities compare in terms of improving either students' writing or their understanding of course content (Beason and Darrow 99)? These questions will be useful in examining the new biology writing requirement at La Salle.

When assessing WAC programs, there are several types of analysis to consider. One focuses on the writing program itself, such as the interaction among social context, institutional context, and program structure. This analysis takes into account the attitude of the general society toward the students in the program, the learning institution's commitment to the education of those students, and the organization of a writing program that distinguishes between developmental and nondevelopmental students. Another type of analysis focuses on evaluation—for example, the evaluation of the effects of writing on the society. Does the writing program affect the value its students place on written language once they leave college? Does it make the public aware of the different uses of language for different purposes? Does it send students into the

world better able to adapt the processes and products of writing to novel situations? Do the theoretical underpinnings of a curriculum affect what students learn? Do students' attitudes toward writing change as a result of the program? (Faigley and White 64-65). In evaluating the current WAC biology requirement, finding answers to many of these questions is crucial to assess accurately whether or not this writing assignment is a productive and useful tool from the perspective of both students and teachers.

Methodology

To assess the effectiveness of the writing-across-the-curriculum assignment for biology majors, the investigators constructed a student survey. The survey consists of nine statements referencing writing in biology, writing in English, preparation for writing in a variety of disciplines, and the biology writing component itself. The authors asked students to rate their opinion of each statement on a scale of 1 to 5 (1—strongly disagree, 2—somewhat disagree, 3—neither agree nor disagree, 4—somewhat agree, 5—strongly agree). The researchers also asked students to complete three open-ended questions to determine the level of importance writing holds for each particular student, whether or not the purpose of the biology writing component was effectively conveyed to students, and what students learned from the biology review paper. (See appendix A for the full survey.)

The study developers distributed this student survey to thirteen of the twenty-seven students who completed the writing component in the Spring 2005 semester. (The other fourteen students were not surveyed because they had already graduated or could not be contacted to participate.) The researchers also distributed the survey to the eleven students currently involved in writing the assignment for the Fall 2005 semester. These students had already submitted a rough draft whose return they were awaiting at the time of the survey. These students had yet to review their mentors' comments and complete the revision process. The investigators separated these surveys from the surveys of students who had already completed the course and assignment to see if there were any major differences between students commenting retrospectively on the assignment and students commenting while undergoing the writing process. Out of these eleven students, seven chose to participate in the survey, making a total of twenty student surveys from which the authors tabulated results.

To evaluate the biology writing component through the perspective of biology professors who are actively involved in the scientific field, the study creators constructed a questionnaire consisting of ten questions. Out of the seven biology professors who serve as mentors in this writing program, four chose to participate. Two of these professors chose to complete the survey in interview format and the other two provided written responses to the questions listed in the questionnaire. (See appendix B for a complete copy of the mentor questionnaire.) After compiling the information from the surveys and the questionnaires, the researchers then

reviewed and analyzed the data to determine whether or not the current biology writing component is an effective requirement.

Results

Student Survey Summary

Of the twenty biology students surveyed, 95% somewhat or strongly agreed that the necessity of writing well is not limited to English and literature courses. To further ascertain the writing experience of biology majors in English courses, one statement in the survey required students to rank whether or not they agreed that they learned everything they need to know about writing from their first-year composition course at La Salle University. In response to this statement, 85% of the students strongly or somewhat disagreed, suggesting that they understand that there is more to learn about writing than the material covered in one introductory-level writing course. However, 15% of the students surveyed somewhat or strongly agreed that they learned everything they need to know about writing from their first-year composition course. Similarly, 55% of the biology majors surveyed believe that they learned skills to prepare them for writing in other disciplines from their first-year composition course. Interestingly, however, 20% of these biology students believe they did not learn skills for writing in other disciplines from their first-year composition course, and 25% of those surveyed neither agreed nor disagreed in regard to this statement.

Furthermore, 95% of the biology majors surveyed believe that writing is a necessary skill in the biological sciences. When asked to rank how often biology majors at La Salle write within their major, the results varied significantly depending upon whether or not students considered lab reports a form of writing. Several students commented on this in their open-ended questions, noting that the lab reports for biochemistry were useful writing experiences—possibly even more effective than the current writing-across-the-curriculum requirement. Here it is important to note that biochemistry is the only required biology course at La Salle University for which the lab report must be written in a scientific format as if it were to be submitted to a scientific journal. To meet these constraints, biochemistry lab reports cannot exceed five pages, but require students to very thoroughly address the subtopics Introduction, Methods, Results, and Discussion and to include diagrams, graphs, and charts that are relevant to convey the results of the experiment. In order to condense all of this pertinent information into only five pages, the writer must be very concise and make use of formatting tools that will make the final work as brief, yet thorough, as possible. Some of the other biology electives require lab reports of the same structure (e.g., cell biology), but these lab reports have no page limit, and not all biology majors take these elective courses.

Of all the biology majors surveyed, 55% somewhat or strongly agreed that the WAC requirement is the first academic paper they have written in their field, while 40% somewhat or strongly disagreed with this statement, indicating that they have had other academic writing

experiences within La Salle's biology department. This discrepancy can be attributed to the decision of some students to include lab reports as writing assignments when responding to the statement. The survey also required students to rank whether or not they found the biology WAC requirement helpful. The majority of students somewhat or strongly agreed, indicating that most students extracted a valuable learning experience from this writing process. Out of the twenty surveys completed, 60% of the students felt that the WAC requirement taught them a lot about writing in the discipline of biology, while 20% felt the writing assignment did not. Also, 20% of the students neither agreed nor disagreed with the statement. This variation can be attributed to several factors, including whether or not students had learned the same skills in their first-year composition course, and whether or not the biology students surveyed learned how to write in the biological field from other writing assignments at La Salle or even from outside experiences, such as research.

Of the students surveyed, 70% did not find it difficult to write in courses outside of their major, 15% did find it difficult to write in nonbiology courses, and the remaining 15% neither agreed nor disagreed that they struggle to write in courses outside of their major. The investigators designed this statement to determine if the styles of writing for biology are too drastically different from the writing styles of other disciplines for students to excel in writing outside of their major. It appears, from the survey results, that most students do not come across a problem when asked to write for their courses in other disciplines.

Student Open-Ended Responses

The authors designed the open-ended questions of the student survey to determine if students accurately understand the purpose and objective of the biology writing assignment, what value each student attributes to the importance of writing, and what specifically this writing assignment has taught the students about writing in the discipline of biology. The majority of students questioned understood that this writing assignment is geared toward helping students become familiar with writing in the discipline of biology by giving them experience in researching and reviewing scientific papers, learning the format for scientific review papers, learning scientific citation conventions, and becoming familiar with a complex scientific topic that students may not have studied otherwise. However, one response—"pass molecular and graduate"—revealed that some students can go through the entire writing process and never understand the preparatory implications of the WAC biology requirement.

When questioned on the importance of writing, most students concurred that writing is a necessary communication tool used to express thoughts, opinions, experiences, and knowledge. Several students also agreed that writing is a powerful skill for all disciplines that gives authority to the writer's ideas and is crucial in many careers. The question of what the WAC biology requirement at La Salle taught students about writing in their discipline brought a variety of answers. One student learned the necessity of the revision process, while several other students

learned that academic writing in the biological field must be short and concise, yet still complete. Many students learned the scientific citation convention, and one student noted the difference between a review and a research paper. Students also learned the importance of finding credible sources and being able to comprehend the material in the resources in order to write about this information effectively. Biology majors also noted that the format and style of this paper was somewhat different from their English research papers, but they were still able to make use of English skills such as word choice and sentence structure to make their arguments clearer and stronger. Some students noted that lab reports are more helpful in preparing students for their future careers than this particular assignment, because biological research papers and review papers are generally much shorter than the WAC assignment. One student found the short and concise nature of scientific writing to be a flaw, stating, “The problem is that general understanding is often sacrificed for this brevity. Contrary to other fields, scientific writers assume their audience can interpret data on their own. Failing to thoroughly explain their research, however, scientists widen the gap between the scientific and nonscientific communities.” Another student less eloquently criticized the assignment, complaining, “Academic writing in Biology is very boring and has no leeway for emotion or style—and —I’ll never use it again.”

Professor Questionnaire Responses

The questionnaires distributed to the professors in the biology department consisted of ten open-ended questions. The professors responded to these questions in written form or verbally via an interview. When the professors were asked if writing is an important skill for biologists, the response was a unanimous “Absolutely!” or “Yes!” Stefan Samulewicz affirmed that writing is “the best way to reach the widest audience with their [biologists’] ideas, research, results, and arguments.” Also, as Norbert Belzer noted, “if one cannot convey his or her work in writing, regardless of the field, the work becomes useless because no one else can benefit from it.”

Next, the questionnaire asked the professors what types of writing are typical in biological fields of study. To this question, the professors provided a variety of responses, including primary research articles (typically three to five pages in length); textbooks; review books; articles for nonscience journals, magazines, or newspapers; review articles; grant applications; and laboratory notebooks.

The final question in the first segment of the questionnaire asked professors to describe which of these types of writing the current WAC requirement most resembles. To this each professor had similar yet slightly different responses. O’Connor believed: “It most resembles a chapter in a text or a review article for a science journal.” Belzer found it to be most like a research article except that the paper requires students to review primary research articles and synthesize them into a longer review instead of conducting and writing about their own research. Similarly, Samulewicz found the WAC biology requirement to fall between the

extremes of a primary research article and an article designed for a lay audience, because while “it should be written in the language of experts,” the paper is composed of a review of primary research, not the research itself—similar to a newspaper or magazine article.

All four professors agreed that the goals of the biology WAC requirement are to learn to read scientific material, put this information into one’s own words while still maintaining a scientific voice, learn proper documentation for scientific papers, and allow students to explore a topic that may not be covered in the typical classroom setting. As mentors for this program, all four professors believe that the students they advise, for the most part, typically meet these goals. O’Connor stated, “students take their assignment seriously and put forth the effort to do a good job. The procedure that is in place gives students the opportunity to be successful.” Belzer agreed, because the first drafts, though complete, often have many errors in grammar, spelling, syntax, style, and other writing skills. Once students correct these errors, Belzer believes the scientific content of the papers is generally very successful at meeting the goals of the requirement. Gerald Ballough concurred, stating, “the only deficit is the students are not required to describe the empirical methodologies at the same level that is necessary in the future. To that end,” he agreed with some of the students that “laboratory reports might be more effective.”

The next question asked professors to describe their expectations of biology students’ writing skills. O’Connor, Belzer, and Ballough expect biology students to be “competent writers,” have “the same skills as [students in] any other major,” and show “a willingness to improve,” respectively. Samulewicz emphasized, “I expect the papers to be an effective synthesis of multiple aspects of a topic, taking into account different points of view and different lines of research. I expect the sentence structure to be complex, similar to the articles the students are referencing.” When the professors were asked if students usually meet these expectations, they agreed that most often they do. If not in the first draft, then certainly by the final draft the students are able to meet these expectations and often exceed them.

Next, the professors were asked if the WAC biology requirement is useful to the future careers of students. All four professors agreed that this is a very useful assignment. O’Connor stated, “There is almost no way they [biology majors] will go through life without using writing skills developed here [LaSalle University].” Samulewicz also noted “the value of the reading that goes into this paper.” On this topic he wrote, “It’s the most concentrated scientific reading assignment they [biology students] have in college, so they learn to read as well as write.” Most of the professors did not find anything about the WAC biology requirement ineffective when questioned about this. However, Samulewicz mentioned, “Sometimes the topics chosen are not supported by a great deal of literature. This makes it frustrating for the students, but it’s still a good learning experience of how science works.”

Finally, the professors were asked if they had any suggestions for improving the WAC requirement in the biology major. O’Connor suggested shortening the length of the paper to

allow the faculty mentors to dedicate more time to reviewing the first drafts of their students. Similarly, Belzer wished the semester were longer, so there would be more time for the writing process. Samulewicz thought the deadlines should be earlier, “so there’s more time for revision. A real scientific report goes through numerous revisions—this should as well.” Ballough added,

While the molecular paper is a very good exercise, I think it is more similar to a review paper or a scientific term paper and does not require the absolute highest level of a student’s critical thinking. Perhaps if a laboratory report were to be presented as a scientific research paper, students would have a better opportunity to precisely describe methodologies, and more importantly, write a research discussion that requires their highest ability for conjecture.

Consensus of Results

Overall, this study determined that, for the majority of biology students, the WAC requirement effectively reaches the goals of the WAC program. Students learn how to write a paper that reflects a range of typical biological writings, they learn the proper documentation style of scientific papers, and they learn to write in the style of a scientist, in a short, concise manner such as will be expected of these students in their professional careers. It is interesting that all professors interviewed and the majority of students surveyed agreed on this point. Another interesting point that several students and professors made is that this assignment is not in the format of a primary research article, a type of writing that, the consensus seems to be, students will be involved with in their future careers. This suggests that even though the writing assignment is effective, there are certainly aspects that can be improved.

Suggestions for Improvement

Although the investigators expected that professors would have a clear understanding of the importance of writing in the biological fields, it was surprising to find that a significant majority of the students surveyed effectively understood the implications and relevance this writing assignment holds for their future careers. Despite the overwhelming consensus among the biology mentors and students concerning the effectiveness of the research assignment, several faculty members and students hinted at some minor problems and various ways to improve the guidelines of this process. O’Connor suggested shortening the length of the paper so faculty members can revise and return drafts in a timely manner. Belzer recognized the stressful time constraints as well, wishing for a longer semester. Similarly, Samulewicz recommended setting earlier and more frequent deadlines so students experience the arduous process of writing, submitting, revising, and resubmitting more comprehensively—and in a process more similar to what they will encounter in their future careers.

All of these suggestions deal, essentially, with the time constraints of such a large project. In addition to all their other coursework, students must find time to sift through a significant

number of primary resources to choose thirty that are most relevant to their topic of choice. Biology majors must then perform a close reading of all thirty primary resources to develop an understanding of the complex material. Students then take notes translating the complicated language of the scientific articles into their own words, and finally, they must formulate their notes into a coherent twenty- to twenty-five-page synthesis. Once mentors return the rough drafts, students are back to work with revisions to complete the final draft before the deadline.

In addition to time constraints, a number of students observed that this paper is only a review of scientific material and, therefore, does not teach students how to write a true scientific research paper. One student also noticed the contradictory nature of the paper's style, explaining that scientific research papers are typically "much shorter and require concise explanations" of laboratory research, whereas review articles tend to be "targeted more for the lay audience" in magazines and newspapers. However, this paper is a "long review of scientific studies" requiring scientific, rather than common, language. Another student explained the paper "did not teach me too much about writing in my field." This student thought, "writing for labs . . . is more helpful." Ballough recognized this flaw in the writing assignment as well, acknowledging, "laboratory reports might be more effective" for teaching students "to describe empirical methodologies." Along these lines, Ballough discussed the possibility of having students treat a traditional lab experiment as their own research, reporting the information in a short article as if it were to be submitted to a scientific journal. This would emphasize the significance of empirical data and require "the absolute highest level of a student's critical thinking" and "ability for conjecture."

While all four professors mentioned writing about science for the general public as one of the many genres of scientific writing, students and professors alike failed to recognize the lack of this experience in the current biology WAC requirement at La Salle University. Since the change in curriculum in the 1994-95 academic year, biochemistry was converted to a one-semester course, and molecular biology was added to the curriculum. The shorter popular science article was removed from the assignment and the remaining review essay was incorporated into the new course. Belzer explained that the biology department chose to eliminate the "common assignment" because the goal of the WAC program is to help students write in their own field. The faculty felt the longer review paper was more representative of a biologist's writing than the shorter popular science essay. While this may be true for students going into research or industry, a student interested in writing for a science column in a newspaper or for a popular science magazine would benefit more from the shorter essay. Even though the current review essay appears to be effective from the results of this study, it fails to represent other genres of biological writing.

Since the current WAC assignment is incorporated into a one-semester course, it would be difficult to add anything else to the assignment to address other areas of science writing, especially since students and professors both feel the pressure of the current timeline in its present

form. To help relieve some of this pressure for professors and students, the investigators have three suggested options to offer La Salle's biology department. The first requires very little change in the course curriculum, but alters the assignment somewhat. The second spans the assignment over two semesters, similar to the previous requirement, but alters the assignment slightly. And the third involves the addition of a writing laboratory course to draw more attention and focus to the various aspects of writing in science.

To address the time constraints of the current assignment, one option for the biology department is to shorten the assignment from a twenty- to twenty-five-page essay referencing thirty sources to a ten- to twelve-page essay referencing fifteen sources. With a shorter essay, faculty members can develop a new timeline with earlier and more frequent deadlines, as Samulewicz suggested. Another, much shorter assignment could then be incorporated to address other areas of scientific writing. The best way to institute a second assignment is to provide several genre options, allowing students to choose the essay format that seems most representative of their personal career interests. For example, a student going into industry, research, or graduate school might be interested in treating a laboratory report as his or her own experimental investigation and writing a three- to five-page research paper modeled after those submitted to scientific journals. However, a student with goals to "interest and inform non-experts about important biological phenomena" may be more interested in writing a two- to four-page article for the general public (Samulewicz). A student struggling to understand primary research articles may be interested in using his or her second assignment to focus on closely examining such an article and writing a second, but much shorter review essay. La Salle biology faculty members can incorporate this second assignment in one of two ways: they can allow students to design their own assignment to meet their own needs (with approval and direction from their mentor), or the faculty members can work together to develop several shorter writing assignment options from which students can choose the most appealing.

If faculty members feel shortening the review essay is somehow detrimental to the effectiveness of the assignment, then another option entails spreading the assignment out over two semesters in the higher-level required courses of biochemistry and molecular biology. This will allow students an entire academic year to complete the longer paper, and a second essay can be reincorporated into the assignment. This format was shown to be effective in the previous descriptive study conducted by Soven and Franz, so the efficacy of the requirement will not be compromised. The timeline and deadlines can then be reorganized appropriately to give students time for multiple stages of revision for each writing piece. The second assignment, as described in the previous instance, can either be something students choose from a list designed by the faculty, or an assignment students design individually based on their career goals with guidance and approval from their mentors.

The final suggestion places a much larger emphasis on writing in the biological sciences than the others. The current curriculum for molecular biology includes an optional laboratory

through the chemistry department. Since the laboratory can be taken at another time for those students interested, a writing laboratory can be instituted to place more emphasis on the importance of writing in the sciences. In this laboratory, either one consistent professor or rotated faculty members can teach students about different writing styles and genres each week. Professors can also assign readings such as primary research articles, newspaper articles, magazine articles, journal essays, reviews, excerpts from textbooks, and other forms of scientific writing for class discussion. In these discussions, the professor and students can address various writing techniques and styles, discussing the similarities and differences present in these styles. Teachers can also create brief writing assignments to summarize, evaluate, analyze, criticize, replicate, or compare and contrast the styles studied. This course design would not only help students to improve their writing, but also help them to develop their reading comprehension skills. Like the molecular biology science laboratory, this writing laboratory can also be optional—students can opt to take the science lab instead or neither lab. In this circumstance, the existing curriculum, or one of the other two options suggested, would have to remain in place for students who do not choose to take this writing lab. Or the writing laboratory can be instituted as a requirement and some laboratory time can be dedicated to a peer revision process for the longer review paper, with either writing fellows or classmates. In this instance, students interested in taking the science lab would be instructed to take it at a later time. Another option would be to require an independent writing laboratory encompassing everything described above as well as the longer review paper, which could then be removed from the molecular biology curriculum altogether. Each of the three suggestions requires a different level of preparation to implement, and may work best if changed gradually from one to another, studied for efficacy, and then altered accordingly to meet the needs of biology majors. However, the ultimate decision lies within the biology department. Faculty members must consult with one another and WAC specialist Soven to determine what changes, if any, are most feasible and beneficial for both the faculty and students.

Limitations of the Study

After analyzing the data, several limitations of this study became obvious. The most prominent limitation is the small sample of students and professors surveyed in order to conduct the study. La Salle is a teaching university, so class sizes are generally small to guarantee each student a personalized educational environment and to ensure that professors can dedicate enough of their time to helping and guiding students through their coursework. The biology department itself is also relatively small, consisting of only seven full-time faculty members who serve as mentors for this writing project. Although this feature is an asset for La Salle's students and faculty, it limits this study extensively. In order to create a large enough sample size to provide accurate results, this study would need to be conducted over a period of several years. Unfortunately, the researchers were limited to one semester of research, touching base with as

many students who had previously experienced the biology writing requirement as possible in order to expand the study. While twenty students and four professors are not enough to provide a thorough and accurate analysis of the efficacy of this writing assignment, it certainly provides a glimpse into the perspectives of La Salle students and faculty, and offers an introductory review of the value of the La Salle biology department's WAC requirement.

Additional insight could also have been offered to this study had demographics been surveyed. For example, it would be interesting to know the influence of future career expectations—medical school, graduate research, education, industry—on students' perspectives of the importance of writing in biology, as well as which types of writing are most applicable to their fields of interest. It would also be interesting to examine students' GPAs in biology and English courses to determine if students who struggle or those who excel academically in either or both subjects benefit equally from the biology writing assignment.

Furthermore, results from several survey questions indicate that additional research may be necessary to learn what constitutes writing for biology students. The responses to the survey statements "I write often for my biology classes" and "The senior biology paper was the first time I wrote an academic paper in my major" illustrate the various interpretations of writing among biology students. Moreover, faculty responses indicate that future research to expand this study might include inquiries into what types of writing biology professors find most important to teach at the undergraduate level, as well as how the role of writing varies in different types of biology courses: for instance, the role of writing in introductory-level courses in comparison with upper-level courses, or the role of writing in different specialties in biology, such as ecology versus physiology.

Ultimately, this study contributes to the discussion of writing-across-the-curriculum programs. It provides an introductory inquiry into a department's major writing requirement and opens the door to continued research in La Salle's biology department. It may also lead to the examination of WAC assignments in other departments at La Salle University and in other schools as well.

Notes

¹ Writing fellows at La Salle University use the skills they learn in the course Writing and the University to review and edit student drafts for the class(es) to which they are assigned. Typically, writing fellows make written comments on the drafts and then meet with students to discuss ways to improve organization, grammar, spelling, and style for the final draft, which, after revision, is submitted to the professor by each student writer.

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Appendix A—Student Survey

Statements	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
Writing is an important skill only in English/literature courses	1 Total %: 80 S %: 84.6 F %: 71.4	2 Total %: 15 S %: 15.4 F %: 14.3	3 Total %: 0 S %: 0 F %: 0	4 Total %: 5 S %: 0 F %: 14.3	5 Total %: 0 S %: 0 F %: 0
Writing is a necessary skill for my discipline/ major course of study	1 Total %: 0 S %: 0 F %: 0	2 Total %: 5 S %: 0 F %: 14.3	3 Total %: 0 S %: 0 F %: 0	4 Total %: 35 S %: 23.1 F %: 57.1	5 Total %: 60 S %: 76.9 F %: 28.6
I write often for my biology classes	1 Total %: 15 S %: 7.7 F %: 28.6	2 Total %: 5 S %: 7.7 F %: 0	3 Total %: 25 S %: 23.1 F %: 28.6	4 Total %: 30 S %: 38.5 F %: 14.3	5 Total %: 25 S %: 23.1 F %: 28.6
The senior biology paper was a helpful experience	1 Total %: 0 S %: 0 F %: 0	2 Total %: 15 S %: 15.4 F %: 14.3	3 Total %: 20 S %: 7.7 F %: 42.9	4 Total %: 40 S %: 46.2 F %: 28.6	5 Total %: 25 S %: 30.8 F %: 14.3
All I need to know about writing I learned from my freshman English class	1 Total %: 60 S %: 61.5 F %: 57.1	2 Total %: 25 S %: 30.8 F %: 14.3	3 Total %: 0 S %: 0 F %: 0	4 Total %: 10 S %: 7.7 F %: 14.3	5 Total %: 5 S %: 0 F %: 14.3
In my freshman composition course, I learned skills that helped me write in other courses	1 Total %: 5 S %: 7.7 F %: 0	2 Total %: 15 S %: 15.4 F %: 14.3	3 Total %: 25 S %: 30.8 F %: 14.3	4 Total %: 35 S %: 30.8 F %: 42.9	5 Total %: 20 S %: 15.4 F %: 28.6
I find it difficult to write in classes other than my major	1 Total %: 45 S %: 38.5 F %: 57.1	2 Total %: 25 S %: 23.1 F %: 28.6	3 Total %: 15 S %: 15.4 F %: 14.3	4 Total %: 5 S %: 7.7 F %: 0	5 Total %: 10 S %: 15.4 F %: 0
The senior biology paper was the first time I wrote an academic paper in my major	1 Total %: 20 S %: 23.1 F %: 14.3	2 Total %: 20 S %: 23.1 F %: 14.3	3 Total %: 5 S %: 0 F %: 14.3	4 Total %: 25 S %: 23.1 F %: 28.6	5 Total %: 30 S %: 30.8 F %: 28.6
The senior biology paper taught me a lot about writing in my discipline	1 Total %: 5 S %: 0 F %: 14.3	2 Total %: 15 S %: 15.4 F %: 14.3	3 Total %: 20 S %: 23.1 F %: 14.3	4 Total %: 40 S %: 46.2 F %: 28.6	5 Total %: 20 S %: 15.4 F %: 28.6

S = Spring semester, 2005; F = Fall semester, 2005

Describe the purpose of your senior biology paper.

How is writing important to you?

What did the senior biology paper teach you about academic writing in your field?

Tally Results of Student Survey

Responses tallied are in the format of: Total (Spring 2005, Fall 2005)

Writing is an important skill only in English/literature courses.

16 (11, 5)—strongly disagree

3 (2, 1)—somewhat disagree

0—neither agree nor disagree

1 (0, 1)—somewhat agree

0—strongly agree

Writing is a necessary skill for my discipline/major course of study.

0—strongly disagree

1 (0, 1)—somewhat disagree

0—neither agree nor disagree

7 (3, 4)—somewhat agree

12 (10, 2)—strongly agree

I write often for my biology classes.

3 (1, 2)—strongly disagree

1 (1, 0)—somewhat disagree

5 (3, 2)—neither agree nor disagree

6 (5, 1)—somewhat agree

5 (3, 2)—strongly agree

The senior biology paper was a helpful experience.

0—strongly disagree

3 (2, 1)—somewhat disagree

4 (1, 3)—neither agree nor disagree

8 (6, 2)—somewhat agree

5 (4, 1)—strongly agree

All I need to know about writing I learned from my freshman English class.

12 (8, 4)—strongly disagree

5 (4, 1)—somewhat disagree

0—neither agree nor disagree

2 (1, 1)—somewhat agree

1 (0, 1)—strongly agree

In my freshman composition course, I learned skills that helped me write in other courses.

1 (1, 0)—strongly disagree

3 (2, 1)—somewhat disagree

5 (4, 1)—neither agree nor disagree

7 (4, 3)—somewhat agree

4 (2, 2)—strongly agree

I find it difficult to write in classes other than my major.

9 (5, 4)—strongly disagree

5 (3, 2)—somewhat disagree

3 (2, 1)—neither agree nor disagree

1 (1, 0)—somewhat agree

2 (2, 0)—strongly agree

The senior biology paper was the first time I wrote an academic paper in my major.

4 (3, 1)—strongly disagree

4 (3, 1)—somewhat disagree

1 (0, 1)—neither agree nor disagree

5 (3, 2)—somewhat agree

6 (4, 2)—strongly agree

The senior biology paper taught me a lot about writing in my discipline.

1 (0, 1)—strongly disagree

3 (2, 1)—somewhat disagree

4 (3, 1)—neither agree nor disagree

8 (6, 2)—somewhat agree

4 (2, 2)—strongly agree

Appendix B— Mentor Interview/Questionnaire

1. Is writing an important skill for biologists?
2. What types of writing are typical in the biological fields?
3. Is the biology WAC requirement reflective of any of these types of writing?
4. What are the goals of the biology WAC requirement?
5. As a mentor for the program, do you feel these goals are reached, for the most part?
Why or why not?
6. What are your expectations concerning the writing skills of biology students?
7. Do students meet your expectations in writing these papers?
8. Do you think this particular requirement is useful to students for their future careers?
9. Is there anything about the WAC requirement in biology that you do not like, or find ineffective?
10. Do you have any suggestions for improving the WAC requirement for biology majors?