Emphasizing the "Literacy" in "Scientific Literacy": A Concise Blueprint for Integrating Writing into Biology Classes

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Abstract: Effectively integrating writing into biology classes gives students the opportunity to develop a better understanding of and engagement with course content. Yet many instructors remain reluctant to emphasize writing. Some are concerned about the time commitment writing assessment requires. Others shy away from emphasizing writing in their classes because they have limited experience doing so and no training in responding to student writing. Here, drawing on both research and direct experience, we address those concerns, providing a justification and concise blueprint for integrating writing into biology classes in such a way as to maximize the benefits to students and minimize faculty effort. As a starting point, we suggest that faculty approach student writing as attempts at communication rather than as texts in need of proofreading. Building on that starting point, we introduce the main classroom practices, assignments, and pedagogical considerations that have yielded benefits, including drafting and revision techniques, rubrics, sample questions, a prioritization scheme for responding to student writing, and time-management tips for faculty. Instructors can use these strategies singly or in combination to add a more significant writing component to their classes.

Key Words: Course Development, Writing Assessment, Critical Thinking

INTRODUCTION

In our experience, students frequently misunderstand the nature of disciplinary boundaries—believing, for instance, that writing is only important in English classes. Instructors, however, typically recognize the importance of students' core-area abilities to their performance in biology courses. Students require considerable fluency, e.g., to discern the shades of meaning needed to correctly answer well-crafted multiple choice questions or write effective essays. Consequently, we observe that various student assignments succeed or fail on the basis of both biology competence and linguistic fluency. Routinely, however, some biology students still imagine that only English classes require "good writing," however they might define that phrase. At one public university, 74% of biology faculty surveyed rated scientific writing as an important component of undergraduate education. Although 63% of students surveyed agreed, of the eight factors assessed, students rated only one, a historical viewpoint on biology, lower than they did scientific writing (Marbach-Ad and Arviv-Elyashiv, 2005). These data indicate that a significant minority of students markedly de-emphasize writing's importance.

We biology educators—and educators in general—rather than our students bear most of the blame for that misconception. More than half of the biology students surveyed placed an emphasis on scientific writing (Marbach-Ad and Arviv-Elyashiv, 2005); by not correcting the minority's misconception, biology faculty passively encourage its spread. Research also suggests both that a majority of students at more selective universities want to strengthen their writing and that they consider writing instruction most effective when it is organized around a "substantive discipline" (Light, 2001: 54) such as biology. Yet in our experience due in part to time limitations, faculty who teach large introductory classes find it difficult to rely on writing-intensive assessment. As a consequence, our students' foundational experiences usually center on easily scored short answer questions. Since students need only develop the minimum language skills necessary to pass such introductory classes, their faulty assumptions about the necessity of core-area abilities appear justified. Because short answer questions tend to emphasize rapid response over reflection, they also discourage the more in-depth understanding of course content that writing assignments foster (Paxton, 2000).

Biology faculty routinely note the poor quality of student writing (e.g., Moore, 1992), often while declining to take action to improve the situation. Some assume that English departments bear responsibility for developing underprepared students' writing competence. Others would like to help but feel unqualified (Marbach-Ad and Arviv-Elyashiv,

2005). In our experience, some colleagues see so many problems in their students' writing that they don't know where to begin, despite accepting that they should try to help.

As a first step we suggest that faculty concerns—and complaints—about student writing are also concerns about students' sometimes uncertain grasp of biology. By adopting a more writing-intensive assessment strategy, faculty can address these overlapping concerns (Curto and Bayer, 2005). After exploring the connection between these issues, we address writing assessment: the area about which we have found faculty express the most uncertainty. Subsequently, we address a broader range of classroom practices, assignment design issues, and pedagogical considerations in order to provide a broad perspective on how biology faculty can best integrate writing into their teaching. We conclude with suggested strategies suitable for a variety of classrooms.

Although we review the relevant research in light of our own experiences in seven biology departments, eight language and literature programs, and two writing centers and provide advice for its application, we do not offer an exhaustive list of references. Our purpose is to provide a concise, user-friendly blueprint for colleagues addressing the concerns that have attracted our professional attention. We do not expect practicing biologists to table their research programs while they develop expertise in writing instruction. But we provide readily accessible avenues for further exploration, referencing representative sources that reflect the standard practices of process-oriented writing instruction and, wherever possible, open-access online articles and books commonly available in academic libraries.

Bloom's Taxonomy and the Gap between Short Answer and Written Response

Bloom's Taxonomy (or the Taxonomy of Educational Objectives) hierarchically classifies educators' objectives in three domains (i.e., affective, psychomotor, cognitive) (Anderson and Krathwohl, 2001; Bloom, 1956), the last of which is relevant here. Cognitive domain objectives range from recollection to three progressively higher order tiers: understanding/comprehension; application; and analysis/evaluation/creativity. Although there is disagreement about the categorization of these domains as higher- or lower-order cognitive activities (e.g., Paul, 1990), many faculty recognize similar hierarchies. Remembering facts, for example—which short answer questions typically emphasize—typically merits less credit than analyzing or applying course content to novel problems in essay responses. Instructional practices can reflect a comparable pedagogical stance, as is demonstrated by an excerpt from an upper-level ecology syllabus (Figure 1).

In our experience, undergraduates frequently have limited preparation for biology classes integrating a significant writing component. Such a situation can become particularly problematic when writing-intensive assessment requires critical thinking (e.g., the application of foundational knowledge to a novel problem). In such cases, the mnemonic training of introductory class multiple choice exams provides virtually no preparation. Thus, some students struggle in transitioning from multiple choice questions (which provide correct answers and, typically, a 25% chance of a correct guess) to situations in which they must formulate responses

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Exam questions will fall into three categories or levels:

Level 1. These direct, straightforward questions will test your **knowledge** of key ecological principles and concepts. Approximately 70% of the exam questions will fall into this category. In order to receive a grade of "C" you will be expected to correctly answer all of these questions.

Example: *How are populations of "wild" animals regulated?*

Level 2. These questions will test your ability to **apply** ecological principles in a variety of different situations, some of which will not have been discussed in class or in your textbook. Approximately 15% of exam questions will fall into this category. Students who receive a grade of "B" or better will be able to answer Level 1 and Level 2 questions.

Example: *How might density influence population regulation mechanisms?*

Level 3. These more complex questions will test your ability to understand the **interrelationships** between different ecological principles and their various applications. Approximately 15% of the exam questions will fall into this category. Students wishing to receive an "A" will be expected to answer Level 1, 2, and 3 questions.

Example: *How might population density and habitat quality be related?*

Fig 1. Excerpt from the syllabus for a 300-level ecology class. At the university in question, the course is required for biology and environmental science majors. The "levels" of questions the syllabus describes generally parallel Bloom's Taxonomy in identifying a hierarchy of learning objectives. In addition, the explanation clarifies to students that higher course grades can only be earned if students demonstrate competence in activities that correspond to the "higher" learning domains. The course in question requires writing on all exams and in lab, including a final lab paper analyzing and interpreting data collected by the students.

independently.

The potential gap students face is summed up by a note one student left on an exam in a required upper-level cellular biology class: "Why can't you at least have some multiple choice? Sometimes I forget the exact words your [***sic***] looking for but would recognize it if I saw it." Yet the exam required responses no more than 2-3 sentences long. The student's note emphasizes the gulf between quick-to-score short answer assessment and questions that require more input, from factual recall to critical thinking. The student's difficulty was with content, a problem that written responses are far more likely to reveal than multiple choice questions. Yet given the level of discomfort and anxiety with which so many approach writing and its assessment, faculty can be tempted to reduce or entirely eliminate writing in their classes. But sound strategies for assigning and assessing writing yield so many benefits that we are far better off resisting that temptation.

A First Priority in Assessing Student Writing: Response Not Proofreading

We begin this section with a worst-case scenario. A writing instructor at a community college where one of us was a writing center tutor graded papers solely on the basis of grammar and punctuation. Each error resulted in a set deduction (e.g., 1 point for a missing comma, 5 points for a sentence fragment). Content was irrelevant. A thoughtful essay that repeated a few types of comma mistakes could earn a lower score than an unfocused, poorly reasoned essay that relied exclusively on simple five-word declarative sentences to avoid errors. The professor mentioned several times (and with evident delight) that his record was a grade of -163 on a 100-point scale.

While grammar and punctuation are important, the scenario described above represents an extreme end of the response spectrum that biology faculty should avoid. In addition to representing a worst-case scenario pedagogically, this example demonstrates the value of following a Hippocratic-oath inspired maxim: whatever else your feedback does, start by taking care that it does no harm. Fear of error can lead inexperienced writers to performance anxiety so severe that they never manage to answer our questions (Bartholomae, 1985; Shaughnessy, 1977). Overemphasizing error also sends the same message as the instructor in the example above, that "good writing" is "correct writing"—an impression that has long been prevalent among students because it reflects the feedback they typically receive (Shaughnessy, 1977; Sommers 1982). Composition theory recognizes that an excessive emphasis on error is unreasonable for inexperienced writers—both because they are still learning writing's rules and because few readers share a proofreader's concern with error (e.g., Huot, 2002; Williams, 1981).

When integrating writing into your classes we suggest a two-part approach, focusing first on content and subsequently on grammar, punctuation, and format. Begin by recognizing that your primary goal is to respond rather than proofread. Doing so allows students to write without worrying unduly about grammatical error, frees you from developing grammatical expertise, and allows you to focus on writing's main purpose—communicating ideas (Williams, 1981). Responding primarily to content encourages student investment in both writing and course content by taking student writing seriously as an expression of ideas. The prioritization of content is pedagogically sound, benefiting both us and our students (Curto and Bayer, 2005; Huot, 2002; Straub, 2000).

Focus on addressing errors that inhibit communication. Although writers will self-correct errors as they gain experience (e.g. Shaughnessy, 1977), inexperienced writers have not yet attained the best writing of which they will be capable. Instructors can best facilitate the self-correction process by giving feedback that sends the message, "I want to understand your ideas, but the writing here made that hard for me" rather than leaving the impression, "Your writing here breaks the rules of grammar, so what you have to say may not be worth reading." The latter emphasis can easily discourage and exclude students who most need effective invitations to participate.

Emphasizing content does not require that we ignore presentation. It simply encourages us to address presentation within a broader context, understanding that for less experienced writers grammar or punctuation feedback is most useful in moderation. Since so many writers are at least mildly anxious about errors, it can be useful to bypass a focus on error in favor of strategies that allow students to strengthen their writing by making it clearer and more concise (e.g., "Best Practices" below).

In addressing error with inexperienced writers, prioritize fundamental mistakes centering on the sentence as a unit—i.e., sentence fragments (partial sentences punctuated as complete sentences), run-on sentences (two or more conjoined sentences punctuated as a single sentence), and comma splices (two sentences incorrectly linked by a comma) (Moore, 1992). Shifting verb tenses and errors in subject-verb agreement are generally seen as less serious. Failing to maintain parallel structure within individual sentences represents a still less serious problem. Our prioritization of error will vary, reflecting our particular concerns (Moore, 1992). But

one way to assess the seriousness of errors is to read student writing with a more trusting eye; errors that impede our ability to understand the writer's ideas merit more attention than those we would typically overlook in a peer-reviewed article (Williams, 1981).

Whatever one's preferences, focusing on patterns of error typically yields greater benefits than attempting to identify all errors (Bartholomae, 1980; Kroll and Schafer, 1978). Writers tend to repeat errors due to misunderstandings about grammar or punctuation rules. Identifying the most serious and frequently occurring error types allows students to prioritize their efforts, yielding maximal improvement by clarifying the underlying rules being violated while keeping the writer's task from becoming overwhelming (Straub, 2000). It is similarly helpful in making assessment more manageable; by focusing on content and addressing only the most serious one or two recurring punctuation/grammar errors, instructors need not provide detailed proofreading and editing.

Writing: Formal vs. Informal

By distinguishing between different sorts of writing we can encourage our students to better understand biology and help ourselves to provide appropriate feedback. One relevant distinction is between formal and informal writing, analogous to Elbow's (2000) distinction between high stakes and low stakes writing. Classes that rely on a balance of formal and informal writing encourage a reasonable perspective on error. Formal writing requires adherence both to grammar/punctuation and assignment-specific format requirements (e.g., citation methodologies). Formal writing (e.g., research papers, lab reports) emphasizes both content and presentation. Informal writing (e.g., a journal response to assigned readings) de-emphasizes presentation (e.g., grammar, format) while emphasizing content.

The distinction between these writing modes has important pedagogical consequences. Informal writing can give students valuable experience with writing in contexts that de-emphasize mechanical correctness and formatting, perhaps reducing their anxieties about writing. Informal writing also provides opportunities—particularly when students can write without strict time limits—to engage with, synthesize, and analyze course content. Informal writing (e.g., journal responses to readings) can also alert instructors in advance of formal assessment situations about the content with which students are having difficulty.

In order to obtain maximal advantage, we should provide appropriate responses to these different sorts of writing. On an exam, for example, requiring students to define terms using complete sentences rather than independent clauses would unproductively emphasize grammar/punctuation over content comprehension. It is neither realistic nor productive to expect students writing under the stress and time constraints of exams to demonstrate the performance typical of less time constrained conditions. In some respects, then, while exams are among the most formal writing contexts, they can be productively assessed as informal writing. Thus, if a student's exam essay demonstrates an exceptionally high degree of biology competence, it would merit an "A" despite errors in spelling and grammar. Conversely, however polished the writing, a response failing to demonstrate minimal biology competence cannot merit a "C."

Drafts and Drafting

A gulf exists between the theory of writing instruction, which emphasizes drafting and revision, and grading, which emphasizes assessment of final products. This divide can be apparent even in English departments, where professors may teach graduate student composition instructors the necessity of acclimating undergraduates to revision. Yet literature professors in the same departments might never mention revision or respond to student drafts. Biology faculty can profitably avoid this oversight.

Some might object that since they already lack the time necessary to assess writing, they certainly cannot assess it more than once during its production. But a method for avoiding this largely theoretical hurdle is an established feature of process-oriented writing instruction: dedicate the majority of time allocated to providing feedback on formal writing assignments to drafts. The time allotted to assessment remains unchanged but is reallocated. While feedback on graded writing arrives too late for many students to see it as anything other than an unfortunate post mortem, they can use feedback on drafts to produce stronger finished work. This general strategy can be tailored to fit a variety of situations. For instance, Chuck and Young (2004) conclude that formal assessment and text-specific feedback on draft reports led to improved student writing when students were given time to reflect on their work. Chuck and Young (2004) also report that while the average assignment took longer to complete, since they achieved target goals for writing improvement using fewer assignments, responding to drafts resulted in a net time savings.

Teaching writing as a process- rather than product-oriented activity involves a variety of potential strategies, most beyond the scope of the current discussion. (For brief introductions to teaching revision see Heard (2002) and Willis (1993).) One additional point is central, however: we have a better chance of successfully integrating

writing into our classes if we recall a general truth about undergraduates. Whether students consider themselves "good" or "bad" writers, they typically do so without recognizing that their first drafts rarely represent their best work (Emig, 1971; Willis, 1993). Our students' most common misconception about writing is that "good" writers produce flawless texts quickly and effortlessly. Emphasizing the drafting process demonstrates that effective writing is achieved via regular effort extended over days or weeks rather than a single stressful evening.

Best Practices: Starting Points

Numerous strategies increase the likelihood that our students will benefit from writing activities as they develop subject-area competence. Above and beyond particular options for use in biology classes that have been reported in detail (e.g., Chuck and Young, 2004), we conclude with several suggestions. These options—organized by the type(s) of assignment for which they are most appropriate—can be integrated into existing classes singly or in combination.

For Papers or Lab Reports:

Grading Rubric: To make grading less mysterious and the writing process more productive for students, provide a rubric that includes the specific point breakdown you will use during grading. On a 100-point assignment, for instance, grammar/punctuation might count for 5-10 points, while clear articulations of the null and alternate hypotheses might count for 10-20 points. By quantifying our emphasis on various aspects of assignments, students can more effectively work to the standards we will apply (Mansilla et al., 2009).

Grading rubrics also simplify and speed the responding process while facilitating consistency, as was demonstrated for one of us who used a rubric in an upper-level Darwinian medicine class. One of the 90 students submitted identical copies of the 3-5 page research paper. Although the double submission went unnoticed until grades were being recorded, the two copies—graded a week apart—scored within 1.5 points of one another.

Benefits: reduced student anxiety; clarification of grading standards; faster, more consistent evaluation

For Papers:

Short Research Paper Revision Exercise Using Strunk and White: Strunk and White's *Elements of Style* (1918) is a public domain resource (http://www.bartleby.com/141/). This strategy uses chapters 9-13, an introduction to improving short writing assignments that covers organization, conciseness, and active voice. These short chapters consist mainly of brief examples that can be included in handouts or online posts. Although this strategy is described in terms of short papers, it is suitable for other writing assignments. Guiding writers through the process of shortening a document by 30%-50% while making the writing more effective provides an exceptional learning opportunity.

Once students receive preliminary approval for their research topics, they consult Strunk and White (1918) chapters 9-10 in preparation for submitting 1-2 page synopses and references. After final instructor approval, students develop 4-5-page drafts. Students consult Strunk and White (1918) chapters 11-13 before and during the drafting process, making independent progress on conciseness. Instructors can quickly highlight areas requiring student attention (e.g., by writing the number of the relevant Strunk and White chapter(s) in the margins), allowing students to take responsibility for revisions and effectively produce 2-3-page final drafts.

Many instructors find Strunk and White's prose especially clear, as do many students who use it to address the significant hurdles of identifying an appropriate voice and tone for their writing (Bartholomae, 1985). Nonetheless, some students might have difficulties—e.g., reconciling their expectations of what constitutes specific, concrete language with Strunk and White's preferences (Ohmann, 1979). It is advisable to address the material in advance of and/or during the drafting process. Key points and examples can be covered in one 30-40-minute PowerPoint presentation/discussion or several shorter sessions. If time permits, use sample revisions from current students to demonstrate the strategy's viability.

Benefits: students develop revision strategies without the need for grammatical expertise; instructors can quickly provide text-specific response to student writing

For Exams, Papers, Journal Entries, or Homeworks:

Sample Responses: Identify an essay question you like but are willing to retire from use on exams. (It will be used to good educational effect, so you won't be losing it.) After covering the relevant material, allow students to formulate practice essay responses individually and/or in small groups. Once students finish, provide sample answers (e.g., as handouts or PowerPoint slides) that range from A-level to F-level work. Allow students to read and discuss all sample responses before identifying/explaining the grade each response received.

Benefits: reduced test anxiety; reflective thinking/communication about course content; grade norming/clarification of grading standards

For Exams:

Sample Question Assignment: As part of exam preparation, students write several multiple choice

and essay questions appropriate for an upcoming exam. In class discussion, explore the questions' strengths and weaknesses, possible revisions, and reasons why proposed questions are particularly appropriate/inappropriate given the emphases of the class and your assessment approach. Submitted questions can be graded as homework assignments, often with minimal written feedback because many questions will have been discussed in class.

Benefits: students receive clarification about requirements and develop more familiarity with course content; faculty obtain ideas for exam questions

CONCLUSION

Integrating more writing into a class does not require that we abandon existing plans and assignments. Rather than moving suddenly into unfamiliar instructional territory, transition gradually. As you do, integrate assignments/activities using instructional strategies that will increase your students' likelihood of succeeding. Remember: students will require assistance and guidance engaging with course content outside of a short-answer-only paradigm. To assist with this process, we include a list of reminders (Table 1).

Understand in advance that regardless of your committed effort and pedagogically sound approach, some writing will merit failing grades. In one crucial respect, grading writing is similar to grading short answer questions: failing grades need not prove damaging for students. Quite the contrary: students need to know when their work does not meet minimum expectations. If we refrain from assigning the low grades that students' work merits because we are unduly concerned with potential negative impacts, our good intentions risk doing students harm rather than good.

Inflated grades may rise to whatever level students consider acceptable. Such a situation is better avoided. It will give some students no compelling reason to improve, since their current performance has already proven sufficient. Grades that accurately assess students' work make clear that additional effort is not optional but necessary. Elbow (1983) addresses the sometimes conflicting demands of teaching—on one hand to the students whose intellectual growth we seek to foster and on the other hand to the disciplines whose standards our grading is meant to reflect.

Elbow's (1983) conclusion—that only by having high expectations of our students can we truly serve them—remains a useful touchstone as faculty integrate writing into their classes. Our emphasis, however, is not that we can help students improve their writing—that laudable goal remains an ancillary benefit. The best reason for integrating writing into our classes is that doing so gives students the opportunity to better understand biology. Creating a learning environment within which students write about, read about, and discuss course content will make them more literate, but it will also help them learn biology (Curto and Bayer, 2005; Krajcik and Sutherland, 2010; Saunders and Sievert, 2002).

Table 1. Final Reminders

1. Clarify your expectations for what constitutes exceptional, acceptable, and failing work and articulate the criteria you will use in assessing student writing. Present examples of sample graded writing to students and discuss that writing with them. Develop grading rubrics and share them with students.

2. Spend at least 50-75% of the total amount of time you will allocate to providing feedback on writing assignments to response you provide before final grading. Require and respond to drafts of complete assignments or draft sections of longer assignments.

3. In responding to student writing, focus first on content—and remind yourself regularly that content is your main interest. When you respond to drafts, take particular care in this regard: while writers are still in the early stages of exploring, organizing, and clarifying their thinking about a subject, their work is subject to major revision. There is little to be gained by providing in-depth revisions of passages that will end up being deleted.

4. Consider incorporating a question development component to your classes in which students propose possible questions for exams and papers. Discuss the strengths and weaknesses of the questions students propose so that they can develop a sense of what topics are most important in your classes and what types of questions they can expect.

5. Recognize that some assignments merit failing grades, and don't be hesitant to assign them when appropriate.

REFERENCES

ANDERSON, L. W. AND D.R. KRATHWOHL. 2001. A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives. Longman, New York. 336p.

BARTHOLOMAE, D. 1980. The study of error. College Composition and Communication 31(3): 253-69.

BARTHOLOMAE, D. 1985. Inventing the university. In Rose, M. When a Writer Can't Write: Studies in Writer's Block and Other Composing Process Problems. Guilford, New York. 12p.

BLOOM, B.S. 1956. Taxonomy of Educational Objectives, Handbook 1: The Cognitive Domain. David McKay Company, New York. 199p

CHUCK, J., AND L. YOUNG. 2004. A cohort-driven assessment task for scientific report writing. Journal of Science Education and Technology 13(3): 367-76.

CURTO, K. AND T. BAYER. 2005. Writing and speaking to learn biology: An intersection of critical thinking and communication skills. Bioscene 31(4): 11-19.

ELBOW, P. 1983. Embracing contraries in the teaching process. College English 45(4): 327-39.

ELBOW, P. 2000. High stakes and low stakes in assigning and responding to writing. In Elbow, P. Everyone Can Write: Essays Toward a Hopeful Theory of Writing and Teaching Writing. Oxford, New York. 9p.

EMIG, J. 1971. The Composing Processes of Twelfth Graders. Research Report No. 13. National Council of Teachers of English, Urbana, Illinois. 160p.

HEARD, G. 2002. The Revision Toolbox: Teaching Techniques that Work. Heinemann, New Hampshire. 144p.

HUOT, B. 2002. (Re)Articulating Writing Assessment for Teaching and Learning. Utah State Press, Logan, Utah. 216p.

KRAJCIK, J.S., AND L.M. SUTHERLAND. 2010. Supporting students in developing literacy in science. Science 328(5978): 456-459.

KROLL, B.M., AND J.C. SCHAFER. 1978. Error-analysis and the teaching of composition. College Composition and Communication 29(3): 242-48.

LIGHT, R. 2001. Making the Most of College: Students Speak Their Minds. Harvard University Press, Cambridge. 242p.

MANSILLA, V.B., DURAISINGH, E.D., WOLFE C.R., AND C. HAYNES. 2009. Targeted assessment rubric: An empirically grounded rubric for interdisciplinary writing. Journal of Higher Education 80(3): 334-53.

MARBACH-AD, G. R. AND R. ARVIV-ELYASHIVl. 2005. What should life-science students acquire in their BSc studies? Faculty and student perspectives. Bioscene 31(2): 11-15.

MOORE, R. 1992. Writing about biology: How should we mark students' essays? Bioscene 18(3), 3-7.

OHMANN, R. 1979. Use definite, specific, concrete language. College English 41(4): 390-97.

PAUL, R. 1990. Critical Thinking: What Every Person Needs to Survive in a Rapidly Changing World, 3rd edition. Sonoma State University Press, Rohnert Park, California. 575p.

PAXTON, M. 2000. A linguistic perspective on multiple choice questioning. Assessment and Evaluation in Higher Education 25(2): 109-19.

SAUNDERS, D.K. AND L.M. SIEVERT. 2002. Providing students the opportunity to think critically and creatively through student designed laboratory exercises. Bioscene 28(3): 11-15.

SHAUGHNESSY, M. 1977. Errors and Expectations. Oxford, New York. 324p.

SOMMERS, N. 1982. Responding to student writing. College Composition and Communication 33(2): 148-56.

STRAUB, R. 2000. The student, the test and the classroom context: A case study of teacher response. Assessing Writing 7(1): 23-55.

STRUNK, W. AND E.B. WHITE. 1918. The Elements of Style. W.P. Humphrey, New York. 105p.

WILLIAMS, J. 1981. The phenomenology of error. College Composition and Communication 32(2): 152-68.

WILLIS, M.S. 1993. Deep Revision: A Guide for Teachers, Students, and Other Writers. Teachers & Writer's Collaborative, New York. 192p.