

Working Backwards: How Departmental Faculty Can Re-think Curriculum to Accelerate Students' Growth as Disciplinary Writers and Thinkers

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Powerful Homework: . . . I find it fascinating that in faculty discussions about curriculum and course structure . . . 90 percent of our discussion focuses on what material and ideas to cover in class. We pay far less attention to the details of homework assignments. So it is good for faculty to learn from students that the design of homework, and how we ask students to do that homework, matters a lot . . . (51).

Writing and Student Engagement: . . . The results are stunning. The relationship between the amount of writing for a course and students’ level of engagement—whether engagement is measured by time spent on the course, or the intellectual challenge it presents, or students’ level of interest in it—is stronger than the relationship between students’ engagement and any other course characteristic. . . . (55)

--from Richard J. Light. (2001). *Making the Most of College: Students Speak Their Minds*. Harvard U. Press

REPLACING THE “TERM PAPER” WITH SOMETHING BETTER

From an interview with an “outsider” student: “I had a professor who didn’t have any writing assignments all semester and then we had a nine-page research paper to do. It was weird because once again you didn’t talk to him about writing in general, so you didn’t know how he wanted it to be written. I didn’t expect him to grade it like an English teacher. I just wanted him to see that I had found a lot of information and I was able to get the word count.”

Author commentary about contrasting “insider” students: We were struck again and again by these students’ [ones who crossed the threshold into insider status] level of engagement in their chosen fields. . . . [T]hese students seemed to have a clear sense of what it means to be an original writer, one who is passionate—even as their passion is disciplined by the academic conventions they’ve learned—and personal. even though their “I” may never appear in the text. . . . The confidence that these students exhibit when they describe their writing indicates that they view themselves as insiders in their disciplines, able to understand and negotiate the demands of individual teachers and courses.

Thais, Chris, and Terry M. Zawacki. *Engaged Writers, Dynamic Disciplines: Research on the Academic Writing Life*. Portsmouth, NH: Boynton Cook: 123, 116, 112-115

What’s Wrong with a Term Paper (Research Paper)?

- Is a pseudo-academic school genre. (No scholar writes a term paper or a research paper.)
- Provides no rhetorical context. Who’s the audience? What’s the problem-at-issue? What’s the purpose? What’s the real-world genre?
- Assumes that students’ understanding is congruent with the instructor’s
- Misrepresents the meaning of “research”
- Leads to curricular assumption that first-year composition courses should “teach the research paper” (as opposed to teaching students to wrestle intellectually and ethically with complex sources)

What’s Better?

“In management, people don’t merely “write papers,” they solve problems,” said [business professor Kimbrough Sherman] [H]e explained that he wanted to construct situations where students would have to “wallow in complexity” and work their way out, as managers must.

[Quoted in Walvoord, Barbara E. and Lucille P. McCarthy. *Thinking and Writing in College: A Naturalistic Study of Students in Four Disciplines*. Urbana: National Council of Teachers of English, 1990. p.51]

- **For seniors:** A disciplinary, capstone-like paper presenting genuine undergraduate research or other forms of disciplinary knowledge-making. (This paper would show that the student has learned “to think like a [historian, economist, nurse, manager, chemist, etc.]”)
- **For sophomores/juniors:** Guided assignments that draw them into disciplinary problems and disciplinary modes of inquiry, problem solving, and argument

PROBLEMS AS THE "STARTING POINT" OF ACADEMIC WRITING

It seems to me, then, that the way to help people become better writers is not to tell them that they must first learn the rules of grammar, that they must develop a four-part outline, that they must consult the experts and collect all the useful information. These things may have their place. But none of them is as crucial as having a good, interesting question.

[Rodney Kilcup, Historian, from a 1980s Puget Sound Writing Project Newsletter]

Thought exercise: Recall a time when you were gripped by a “good, interesting question” that led to a piece of writing. This problem could have been the “starting point” for an article, conference paper, proposal, book, or other piece of professional writing. Or it could be a starting point for a current research project. Please turn to someone sitting next to you and describe briefly the problem that engaged you (or currently engages you).

Examples

Journalism Professor: Several years ago, I knocked on the wooden front door of the home of an elderly woman in Tucson, Arizona. Tears of grief rolled down her cheeks as she opened the door. The tears turned to anger when I explained that I was a reporter and wished to talk with her about her son’s death in jail. Her face hardened, “What right do you have coming here?” I recall her saying. “Why are you bothering me?” Those questions have haunted me throughout my journalism career. Do journalists have the right to intrude on a person’s grief? Can they exercise it any time they want? What values do journalists use to decide when to intrude and violate someone’s privacy?

Biochemistry Professor: During periods of starvation, the human body makes physiological adaptations to preserve essential protein mass. Unfortunately, these adaptations don’t work well during long-term starvation. After the body depletes its carbohydrate storage, it must shift to depleting protein in order to produce glucose. Eventually, this loss of functional protein leads to metabolic dysfunction and death. Interestingly, several animal species are capable of surviving for extensive periods without food and water while conserving protein and maintaining glucose levels. How do the bodies of these animals accomplish this feat? I wanted to investigate the metabolic functioning of these animals, which might lead to insights into the human situation.

Implications for Pedagogy

- At what point in their undergraduate careers do students begin posing “good, interesting questions” as the starting point of their writing?
- How could department faculty, working collaboratively in the design of “powerful homework,” help students reach this tipping point more quickly?

TEACHING RESEARCH RHETORICALLY: EXPLAINING YOUR DISCIPLINE'S RESEARCH STRATEGIES

“A surprising number of undergraduates describe learning how to use evidence to resolve controversies in their field, whatever their field, as a breakthrough idea.”
from Richard J. Light. (2001). *Making the Most of College: Students Speak Their Minds*. Harvard U. Press.

Background: New college students often think of research as “going to the library” (or googling the Web) looking for quotes to support their already determined thesis. They need to learn how academic inquiry and argument actually works. Particularly, they need to understand what counts as evidence in a field. Richard Light describes the bafflement of first-year students as they shift from discipline to discipline where they encounter wide differences in the way questions are posed and the way evidence is used. Light describes the classroom strategies of teachers skilled at showing how scholars use evidence to support a claim. What follows is a schema that I’ve found valuable.

Using Bizup’s “BEAM” to teach the function of research sources in your discipline

Kind of Source	Explanation	Example from literature (for undergraduate research on <u>Jane Eyre</u>)
B Background sources	Any source used in a paper to provide context or background	<ul style="list-style-type: none"> • Encyclopedia article on Evangelism • Biography of the Brontes • <u>Victorian Life and Times</u>. (Books or articles on the history/culture of a literary period)
E Evidence or Exhibit sources	Observations, data, documents, or other particulars used to support your argument	Quotations, paraphrases, or other textual citations from <u>Jane Eyre</u>
A Argument sources	The conversation of critical views and relevant scholarship that you are joining <ul style="list-style-type: none"> • Usually argument sources are other scholarly articles or papers • In sciences, often constitutes the “review of the literature” 	Books or scholarly articles that have addressed the writer’s critical problem in <u>Jane Eyre</u> <ul style="list-style-type: none"> • Argument sources create the critical conversation that you are joining • Your goal is to add something new or challenging to this conversation
M Method or Theory sources	References to the theories or methods the writer is employing <ul style="list-style-type: none"> • Often implicit but may be explicit 	<ul style="list-style-type: none"> • References to Foucault, Edward Said, Judith Butler, etc. • Specific references to theory or method—feminism, post-colonialism, new historicism, etc.

Source: Bizup, Joseph. “Recovering an Intentional Stance: From Natural Kinds to Artifacts in Composition Pedagogy.” Conference of College Composition and Communication. Chicago March 2006

Explaining your discipline’s research strategies

What do scholars in your discipline or sub-discipline do when they conduct research? Imagine a prototypical research project in your field and try to explain to a neighbor what the researchers are doing and why:

- What would be a typical question, problem, or unknown that drives the research?
- What would constitute the “evidence/exhibit” box in Bizup’s BEAM chart?

DEVELOPMENT OF STUDENTS' WRITING SKILLS: NOVICE TO EXPERT

MacDonald's Stages of Development: Novice to Expert

Stage 1 [*what students bring from high school*]: Nonacademic or pseudo-academic writing

Stage 2 [*goal of first-year composition*]: Generalized academic writing concerned with stating claims, offering evidence, respecting others' opinions, and learning how to write with authority.

Stage 3 [*early courses in major*]: Novice approximations of particular disciplinary ways of making knowledge.

Stage 4 [*advanced courses in major*]: Expert, insider prose within a discipline [defined appropriately for undergraduates]

Adapted from Susan Peck MacDonald, Professional Writing in the Humanities and Social Sciences. Carbondale, Southern Illinois UP, 1994 (p. 187)

Possible Forms of Expert, Insider Prose for Undergraduates (to be determined by disciplinary faculty)

- Academic or scholarly writing in the discipline (for example, a capstone paper suitable for presentation at an Undergraduate Research Conference)
- Professional workplace writing (proposals, reports, memos, technical papers, or other disciplinary kinds of professional writing)
- Civic or public argument on local or national issues related to the discipline
- Other kinds of writing or communication projects specific to a major or discipline (creative projects, Web sites, multi-media presentations, Power Point presentations, and so forth)

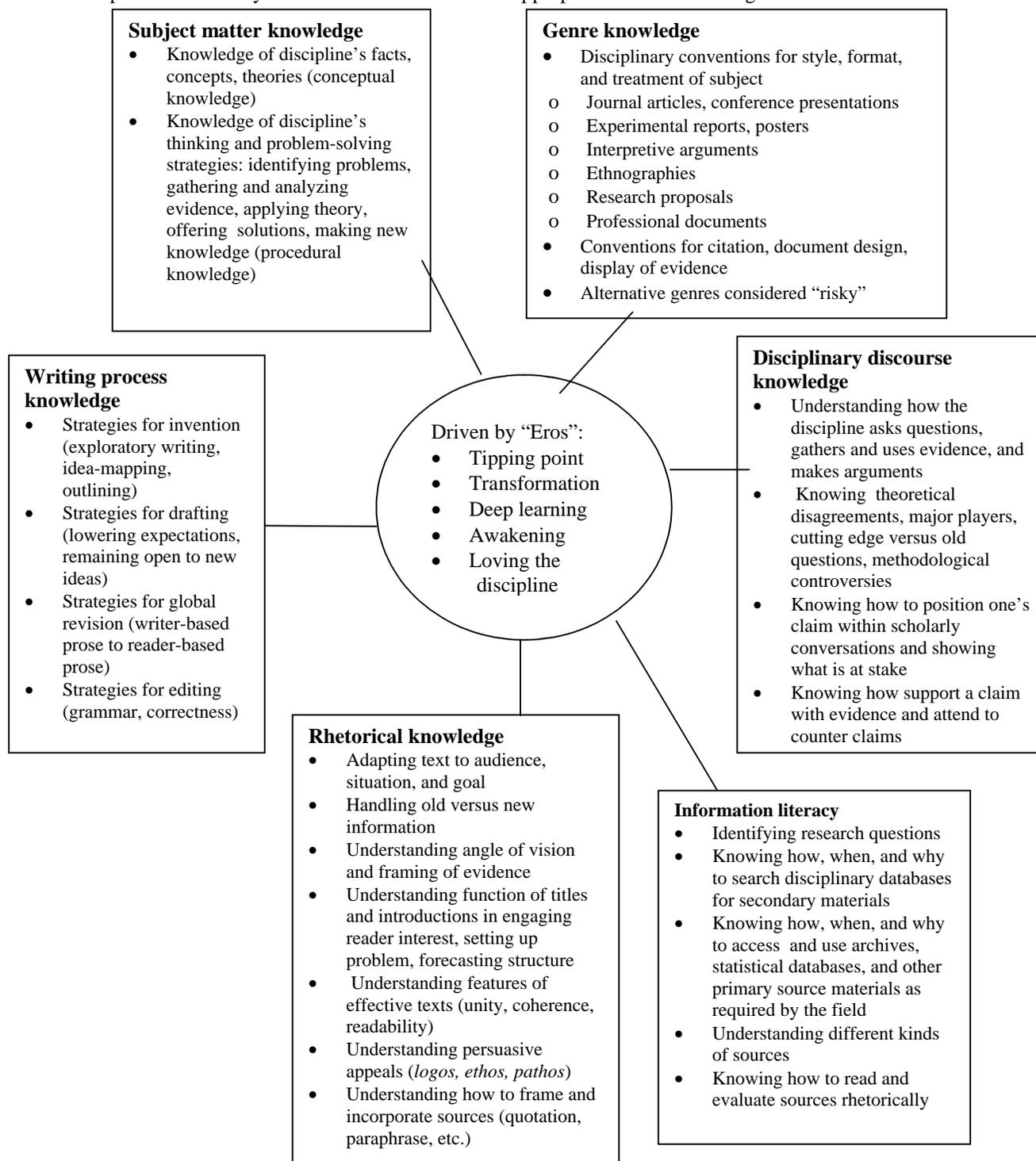
To generate departmental discussion about teaching disciplinary discourse in the major, faculty can pose the following questions:

1. What kinds of academic or professional papers would demonstrate "expert insider prose" for undergraduates in your discipline? What might be a typical undergraduate capstone project or paper in your discipline?
2. What kinds of disciplinary thinking skills and research skills are needed to produce the capstone paper or project identified in 1 above?
3. Using the principle of backward design, how could faculty more effectively teach the skills of disciplinary writing, thinking, and research earlier in the major?

Prototype initial assessment project: Examine papers produced for an embedded assignment in a senior-level course and study characteristic strengths and weaknesses.

SKILLS/KNOWLEDGE NEEDED TO BECOME A DISCIPLINARY INSIDER

Note: Departmental faculty need to define these skills at appropriate levels for undergraduates at their institutions



This diagram is based partly on the work of Anne Beaufort in *College Writing and Beyond: A New Framework for University Writing Instruction* (Utah State Press, 2007)

OUTCOMES FOR EXPOSITORY WRITING PROGRAM COURSES

University of Washington

1. To demonstrate an awareness of the strategies that writers use in different writing contexts.

- The writing employs style, tone, and conventions appropriate to the demands of a particular genre and situation.
- The writer is able to demonstrate the ability to write for different audiences and contexts, both within and outside the university classroom.
- The writing has a clear understanding of its audience, and various aspects of the writing (mode of inquiry, content, structure, appeals, tone, sentences, and word choice) address and are strategically pitched to that audience.
- The writer articulates and assesses the effects of his or her writing choices.

2. To read, analyze, and synthesize complex texts and incorporate multiple kinds of evidence purposefully in order to generate and support writing.

- The writing demonstrates an understanding of the course texts as necessary for the purpose at hand.
- Course texts are used in strategic, focused ways (for example: summarized, cited, applied, challenged, re-contextualized) to support the goals of the writing.
- The writing is intertextual, meaning that a “conversation” between texts and ideas is created in support of the writer’s goals.
- The writer is able to utilize multiple kinds of evidence gathered from various sources (primary and secondary – for example, library research, interviews, questionnaires, observations, cultural artifacts) in order to support writing goals.
- The writing demonstrates responsible use of the MLA (or other appropriate) system of documenting sources.

3. To produce complex, analytic, persuasive arguments that matter in academic contexts.

- The argument is appropriately complex, based in a claim that emerges from and explores a line of inquiry.
- The stakes of the argument, why what is being argued matters, are articulated and persuasive.
- The argument involves analysis, which is the close scrutiny and examination of evidence and assumptions in support of a larger set of ideas.
- The argument is persuasive, taking into consideration counterclaims and multiple points of view as it generates its own perspective and position.
- The argument utilizes a clear organizational strategy and effective transitions that develop its line of inquiry.

4. To develop flexible strategies for revising, editing, and proofreading writing.

- The writing demonstrates substantial and successful revision.
- The writing responds to substantive issues raised by the instructor and peers.
- Errors of grammar, punctuation, and mechanics are proofread and edited so as not to interfere with reading and understanding the writing.

INSIGHTS FROM CORNELL UNIVERSITY'S WRITING IN THE MAJORS PROGRAM

Sources for this page:

Monroe, Jonathan, ed. *Local Knowledges, Local Practices: Writing in the Disciplines at Cornell*.

Pittsburgh: University of Pittsburgh Press, 2003

Bean, John C. "Empowering Writing in the Disciplines by Making It Invisible." Rev. of *Local Knowledges, Local Practices: Writing in the Disciplines at Cornell*, ed. by Jonathon Monroe.

Pedagogy: Critical Approaches to Teaching Literature, Language, Composition, and Culture 7.2 (2007): 275-284.

Background on Cornell's Writing in the Majors Program:

- Purely voluntary participation from faculty
- Courses not given any kind of "writing" designation
- No university requirement for a W-course in the major
- Courses not identified for students as "writing intensive"
- Writing embedded in courses because instructors are focused on teaching the thinking processes of the discipline

Significance of this approach: The Case of a Chemistry Professor

[Quoted from my review cited above]

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Hjortshoj [the Director of the Writing in the Majors Program] illustrates the strength of Cornell's voluntary approach with the case of organic chemistry professor Barry Carpenter. According to Hjortshoj, Carpenter "hoped to move students beyond what he called 'the myth of certainty'" (50). He came to the Writing in the Majors program for help on teaching students to confront messy, ambiguous chemistry problems with uncertain solutions. Carpenter's attention was focused on a thinking problem exhibited by organic chemistry students, not on the need to develop their writing skills. Hjortshoj explains:

If I had begun by suggesting that Professor Carpenter should add writing assignments to Organic Chemistry or convert it to a writing-intensive course to improve his students' writing skills, our conversation would have ended abruptly and these questions would not have arisen. Once he had raised them on his own as learning issues, however, Carpenter began to think of possible solutions, and by the beginning of the semester he had devised [writing assignments based on new kinds of problem sets that] simulated many aspects of scientific research and writing: real laboratory research problems, enigmatic results, irregular data tables, and the challenges of working and writing with others. (50-51)

TEACHING CRITICAL THINKING IN FINANCE

Assessment task: Senior finance majors in a capstone course were given a case problem in which they played the role of financial advisor to husband and wife clients faced with an investment dilemma. The retiring couple were considering two choices for investing the wife's lump sum payment (\$155,673.53) from a 401 K plan.

- *Choice A:* Buy an "Immediate Single-Life Annuity" which promises a monthly payment of \$1225.85 for the rest of her life and a lump sum payout to a designated survivor of \$37,000.
- *Choice B:* Invest the lump sum in a growth mutual fund which was yielding 10 percent annual return at the time (the case study was developed in 2000). At 10 percent, the plan would pay the same \$1225.85 but return the original principle at time of the wife's death.

Students were given the following task: *You have crunched the numbers on the two plans, analyzed the results, and begun to formulate some conclusions and advice. Write a 2-3 page memo to David and Marilyn in which you analyze the benefits and risks of each plan and offer advice on how they can make a decision. Explain to David and Marilyn the different methods of analysis you used, why you used them, and what useful information each method revealed. Attach to your memo any visuals or graphics that would be useful to them in comparing the two plans. Note that David and Marilyn are well-educated college graduates but they have no background in finance. (Assignment developed by Professor David Carrithers in consultation with finance faculty.)*

Method: Members of the finance faculty met to develop a rubric for scoring the memos and then to staff-grade them. Following the grading, the department held a detailed discussion of their findings.

Findings:

- Approximately half of the students scored in a range which the faculty consider cause for concern while even top-half students showed considerable critical thinking weaknesses
- Almost all students used tools and methodologies covered in the finance curriculum (NPV analysis, calculating an IRR, etc.) but many students used them randomly, often applying them to extraneous data, and revealing no purpose or goal in the calculation
- Many students failed to address the client's problem and provide the requested financial counsel
- Many student were unable to translate finance concepts/methods into lay language
- Generally students failed to construct rhetorically useful graphics

Departmental Efforts to Improve Curriculum and Instruction:

- Finance faculty realized that in finance courses students were typically assigned algorithmic homework sets teaching use of mathematical tools (formula-based problems or quantitative story problems—"well-structured" problems with "right answers")
- Faculty are developing methods to place more ill-structured problems into these earlier courses through writing assignments or small group activities requiring group speakers to present extended arguments in support of solutions
- Faculty are developing assignments requiring students to create rhetorically effective graphics for a specified audience and purpose.
- Faculty are developing written and oral assignments that require students to address lay audiences.
- Overall goal is more balanced attention to mastery of both algorithmic tools and the "big-picture" ability to construct finance arguments

Details of this project can be found in the following publications:

- Carithers, D., J.C. Bean, and T. Ling. (June, 2008). Messy problems and lay audiences: Teaching critical thinking within the finance curriculum." *Business Communication Quarterly*: 152-170.
- Carrithers, D. and J. C. Bean. (March 2008) Using a client memo to assess critical thinking of finance majors. *Business Communication Quarterly*. 71.1 (March 2008): 10-26.

TEACHING A “MAJOR SCHOLARLY PAPER” IN ENGLISH

English Department’s Decision about “Expert, Insider Prose”: After much discussion, English faculty agreed with the following statement: *Our curriculum should create opportunities for students to complete a sustained scholarly project that would lead to an effective “statement of purpose” for graduate school.* The discussions were influenced by Gerald Graff’s argument that the generic thinking and arguing skills required for such a project translate well to all sorts of career interests other than graduate school.

Graff and Hoberek’s Examples of Opening Frames for Statements of Purpose

Bad (the “I love literature” approach): Ever since age three I’ve been passionately in love with the sensuous sound of words. So when Mother Goose was read to me in my crib, I somehow knew I was destined for a lifelong love affair with literature.

Better: In a college seminar paper, I discussed the prevalence of gendered battle imagery in Hamlet . . .

Best: In a college seminar paper on battle imagery in Hamlet, I discussed the debates inside and outside feminist circles on the question of how specifically gender colors language and how far imagery can be defined as “male,” “female,” . . . etc.

[From Graff, Gerald and Andrew Hoberek. “The Application Guessing Game.” In Gerald Graff. Clueless in Academe: How Schooling Obscures the Life of the Mind. New Haven: Yale UP, 2004]

Results of Departmental Negotiations—The Following Revised Curriculum

[From University Bulletin. I have boldfaced for emphasis]

LITERATURE (300-LEVEL)

300-level courses build on the skills of close reading developed in 200-level courses, extend students’ repertoire of interpretive strategies, and teach the habits of scholarship needed for success in 400-level courses. . . . **English Majors are required to complete at least one 300-Level course identified as CT (Context & Theory) in the quarterly class schedule before taking a 400-level course. 300CT courses specifically prepare students to do the advanced scholarly work required in 400-level courses.** In order to prepare for the research writing and theory components of 400-level courses, students in CT courses will learn (1) to analyze literary texts within their cultural and historical contexts; (2) to understand how different interpretations of a literary text are shaped by the critic’s theoretical assumptions and reading practices; and (3) to write an insightful 8-12 page researched critical argument about a literary work using the conventions of the Modern Language Association. Typically, CT courses differ from other 300-level courses by treating fewer literary works in greater depth in order to teach students how to produce a scholarly research paper in literary criticism.

LITERATURE (400-LEVEL)

Courses with a 400 number are advanced studies in literature and writing and build on the research writing skills introduced at the 300 level. They have three goals: first, to help students gain a depth of understanding of a series of texts focused by theme, by author, or by a particular genre; second, to help students gain an understanding of various literary theories and methods of literary criticism, as well as learn to apply them to the central texts of the course; third, to assist students in the writing of a **major scholarly paper** or creative portfolio. **The literary paper will demonstrate close reading, the raising of a literary question in relation to debates among the critics, and the pursuit of an extended literary argument with insight and style.**

ABOLISHING THE LAB REPORT IN ORGANIC CHEMISTRY

Source for this page:

Alaimo, P.J., and J. M. Langenham (2008). "Teaching Professional Writing in an Organic Chemistry Laboratory by Abolishing the Lab Report: Rethinking Writing and Learning in the Discipline of Chemistry." Paper presented at the 8th International Writing across the Curriculum Conference, University of Texas, Austin.

What were the problems with senior theses?

- Non-professional style and/or format
- Inadequate background, theory, context
- Unclear statement of aim
- Unclear target audience
- Illogical presentation of data
- No persuasive, logical argument
- Not thinking like a chemist

What is wrong with lab reports?

What "lab reports" do:

- Teach non-professional writing habits that students must later *unlearn* (the "lab report" is a pseudo-academic genre)
- "Lab report" implies a professor-student relationship
- Therefore students think and write like students

What we want our assignments to do

- To teach professional writing habits
- To imply a collegial relationship between writer and reader
- To reward students for thinking and writing like professionals

Conclusion

- We want to integrate "scientific papers" into the courses in the middle of our curriculum
- In order to do this, we need to reverse engineer our curriculum to teach students early how to write a scientific paper

What we did:

- Redesigned labs by designing investigative experiments involving inquiry
- Developed strategies for teaching the scientific paper using a rhetorical, writing-intensive pedagogy
- Discovered that it is relatively easy to teach the experimental methods and results sections
- Discovered that writing the introduction and discussion sections requires active knowledge of disciplinary discourse

Conclusions so far:

- Moving from pseudo-academic to professional writing has resulted in professional attitudes and behavior in the laboratory
- We have used investigative experiments to replace those that confirm a known result; this too has elicited a positive change
- We are currently in the process of formally assessing
 - improvement in student writing
 - transfer to upper-level courses
 - transformation in attitudes and behaviors

Writing a Discussion Section

What is a Discussion Section?

A scientific paper is a specialized form of persuasive writing. In the discussion section, the author interprets the information contained in the data/results section to construct a persuasive argument that addresses the aims provided in the introduction section.

Imagine yourself as a lawyer trying to convince a jury of scientists about what your findings *mean*. To do this, you must **first** take time to interpret critically your data/results. Your data section will contain all data that support *or contradict* the arguments you will make in your discussion. As an ethical scientist, you must consider whether contradictory data undermine your ideas, or whether the contradictory data can be reasonably explained. If data undermine your argument, you must qualify your argument in a manner consistent with the contradictory data, or not make the argument at all. If you have a reasonable explanation for contradictory data you should provide it, but avoid resorting to unsubstantiated claims for why certain data are invalid. For example, students often discount certain results because of "human error," without providing evidence of specific circumstances when error was a factor. If you wish to argue that error was the cause of certain data, you must provide evidence and describe the error specifically.

Once you have interpreted your data and developed your ideas, you are ready to communicate to the jury, the scientific community, by writing your discussion section. Your discussion must be well organized and logical, progressively making specific points using specific data, until you have built a convincing case.

Who is Reading your Discussion Section?

The audience for a discussion section is other scientists who have no prior knowledge of your experiment and who have the same or greater chemistry education level as you. You must explain your interpretation of your data/results to this audience; *the burden of proof is on you to convince them your arguments are justified*.

Examples of Discussion Sections

Below is an example of a discussion section corresponding to the first example on the "Writing a Data/Results Section" handout. For a synthetic experiment your aim is to synthesize a specific compound. Thus, in the corresponding discussion you must persuade readers of the compound's *identity* and its *purity*.

Discussion (Example 1):

The elimination of tosylate **1** (Fig. 1) provided a good yield of a clear oil. An assignment of the chemical shifts and multiplicities of the ^1H NMR spectrum provided strong evidence that the product of the reaction was unsaturated ester **2**. Proton resonances at 1.36 ppm and 7.20-7.04 ppm correspond to the *tert*-butyl group and the phenyl group of **2**, respectively.¹ The resonance at 6.90 ppm, corresponding to the vinyl proton,² is split into a quartet by the adjacent methyl group; the resonance for the methyl group (1.74 ppm) is split into a doublet. The remaining resonance is consistent with the methylene group on **2**, since it integrates to 2H and is a singlet. Since no additional peaks were observed by ^1H NMR spectroscopy and since a single spot was observed by TLC, it can be concluded that ester **2** is highly pure.

[the references cited would be included in the references section]

Discussion (Example 2):

[another example]

Assignment: Writing Experimental Procedures and References for the Extraction Experiment

Learning Objectives:

- Learn to describe accurately a scientific procedure using proper word choice, adherence to scientific writing conventions, correct grammar, and few mechanical errors.
- Learn to produce writing that conveys a clear and correct understanding of science.
- Learn to adapt your writing style for a professional scientific audience to produce papers with the detail and conciseness that is appropriate for this audience.
- Learn how to properly cite and document sources using standard American Chemical Society (ACS) format to avoid issues of plagiarism.

Task: Write the experimental procedure and references sections of a scientific paper on the extraction experiment that you performed in the lab. Use the following handouts provided in class as your guide: “Scientific Writing in Chemistry 345-347,” “Writing an Experimental Procedure,” and “Referencing Sources in Science.”

Audience: Remember that the audience for your writing (the readers) are other scientists who

- have no prior knowledge of your experiment, and
- have the same or greater chemistry education level as you.

Therefore you must carefully consider what knowledge you can assume they have and what level of detail is necessary and sufficient for clear and concise communication.

Evaluation: Your writing assignment will be evaluated using the rubric found on the following page. Note that you can use this rubric to self-assess the quality of your own writing.

Is the description complete?

10	8	6	4	2	0
Procedure contains enough information that it is reproducible (through the text or by appropriate referencing).		Procedure is missing some critical information required for fully evaluating or reproducing the experiment.		Procedure is so vague that reader cannot begin to evaluate or reproduce the experiment.	

Is the description concise and well-targeted to the audience?

10	8	6	4	2	0
Procedure conveys only necessary & relevant information.		Procedure is wordy in some sections. Contains some unnecessary or irrelevant information.		Procedure is verbose, and contains large quantities of unnecessary or irrelevant information.	

Is appropriate information referenced?

10	8	6	4	2	0
Writer has referenced, rather than restated, all possible information.		Writer has restated, rather than referenced, some information.		Writer has restated large quantities of information that should have been referenced.	

Is the style appropriate?

10	8	6	4	2	0
Sounds like a professional chemist.		Sounds like a good chemistry student.		Sounds like a chemistry student new to scientific writing.	

References

Are references appropriate?

5	4	3	2	1	0
Reference sources are appropriate for a scientific paper. Number and variety of references indicate that author has a high level of understanding of the subject.		Some reference sources are not appropriate for a scientific paper. Number and variety of references indicate that author has a moderate understanding of the subject.		Reference sources are inappropriate for a scientific paper. Small number of references indicate that author has little understanding of the subject.	

Are references formatted properly?

5	4	3	2	1	0
References properly cited in text and formatted correctly.		References not properly cited in text or formatted correctly.		References are improperly cited in text and formatted incorrectly.	

FOUR EFFECTIVE WAYS TO CREATE SHORT PROBLEM-BASED ASSIGNMENTS FOR STAGE 2 OR 3 WRITERS

1. Give students a problematic thesis to defend or attack

- In recent years, advertising has (has not) made enormous gains in portraying women as strong, independent, and intelligent.
- The paper by Baron-Cohen et al. supports (undermines) the fetal testosterone theory of autism
- The overriding religious view expressed in Hamlet is (is not) an existential atheism similar to Sartre's.
- Prescribing Ritalin and other psychotropic medications is (is not) an appropriate treatment for behavioral problems of children.

2. Give students a problem-laden question

- What should Project Manager Hisako Hirai propose to her supervisor in response to the problems that have cropped up in Week Three? Role-playing Ms. Hirai, write a memo to your supervisor [part of a business management case]
- Do you believe that the proposed air bearings provide the optimal solution for the circumference-mounted radiator fan?
- How does Person A's approach to this problem differ from Person B's? What is at stake?

3. Give students raw data (such as lists, graphs, tables, etc.) and ask them to write an argument or analysis based on the data

- To what extent do the attached economic data support the hypothesis "Social service spending is inversely related to economic growth"? First create a scattergram as a visual test of the hypothesis. Then create a verbal argument analyzing whether the data support the hypothesis
- Your friend and you are looking over Table 1 [next page of this handout] and note that in 1998 the median income for all families was \$33,400 but the mean income was \$53,000. Your friend was confused about the difference but had to leave for work. Send your friend a coherent, well-structured email message about one screen in length that explains the difference between "mean income" and "median income" and that speculates about the economic factors in the United States that lead to such differences between mean and median incomes. To put it another way: What can we say about the distribution of income in the United States if we know that mean income is considerably higher than median income?

4. Let students develop their own questions

- Now that we have practiced asking interpretive questions about poems, consider Yeats' "Among School Children." Propose your own interpretive question about this poem, and then write an explication of the poem that tries to answer your question.
- What questions about _____ are left unanswered in Hamilton's article?

GENERIC METHOD FOR CONVERTING A "RESEARCH PAPER" INTO A PROBLEM-BASED DISCIPLINARY PAPER

Task: Write a 7-10 page analytical or argumentative paper on a significant question related to any aspect of [course subject matter]. The introduction to your paper should pose the question or problem that your paper will address and engage your reader's interest in it. Your proposed answer to this question (summarized in a single sentence) will serve as the thesis statement for your paper. Imagine this paper will be delivered at an undergraduate research conference. Assume that your audience has NOT read this assignment and will attend your conference session because your title hooked their interest.

Prospectus: Midway through the course, you will submit to the instructor a prospectus that describes the problem or question that you plan to address and shows why the question is (1) problematic and (2) significant

Table 1. Before-tax family income for previous year, by selected characteristics, of families, 1989, 1992, 1995, and 1998

(Thousands of 1998 dollars, except as noted)

Family Characteristic	1989			1992			1995			1998		
	Median	Mean	Percent of families									
All families	33.2	52.2	100	30.4	45.6	100	32.7	47.4	100	33.4	53	100
<i>Income ('98\$):</i>												
Less than 10,000	6.6	6.2	14.7	6.4	6	14.8	6.2	4.7	15.1	6.2	5.2	12.7
10,000 - 24,999	15.9	16.7	23.8	17.5	17.3	27.1	17.4	17.4	25.1	17.2	17.1	24.7
25,000 - 49,999	35.9	36.1	30	36.3	36.7	29.5	37.1	36.5	31.1	35.5	35.9	29
50,000 - 99,999	66.4	68.9	22.7	65.5	68.7	20.9	66.5	69.1	21.3	65.9	68.7	25
100,000 or more	144.8	239.3	8.7	140.4	195.3	7.6	148.3	219.5	7.4	141.9	237	8.7
<i>Age of head (years)</i>												
Less than 35	26.6	35.5	28.1	28.1	34.6	25.8	27.3	33.3	24.8	27.4	36.1	23.3
35-44	46.5	63.3	21.5	40.9	53.2	22.8	40.3	51.7	23	42.6	59.8	23.3
45-54	49.2	76.9	15.1	48	64.6	16.2	42.5	70.4	17.9	50.7	69.5	19.2
55-64	33.2	60.7	13.9	33.9	56.4	13.2	36	57.1	12.5	38.5	71.4	12.8
65-74	21.3	45.5	12.6	19.9	33	12.6	20.7	39.8	12	24.3	46.4	11.2
75 and more	17.3	32.5	8.9	15.2	26.6	9.4	17.4	28.2	9.8	16.2	28.9	10.2
<i>Education of head</i>												
No high school diploma	17.3	24.9	24.3	14	19.9	20.3	15.3	22.1	18.5	15.2	21.7	16.5
High school diploma	29.2	38.1	32.1	26.9	34.3	30	27.3	37.3	31.7	29.4	37	31.9
Some college	37.2	51.8	15.6	31.6	42.2	17.8	32.7	43.1	19	35.5	50.7	18.5
College degree	53.1	92.3	28	51.5	74.6	31.9	49.1	75.8	30.7	54.7	85.2	33.2
<i>Race or ethnicity of head</i>												
White non-Hispanic	38.5	59.9	74.8	35.1	50.4	75.3	34.9	52.1	77.6	37.5	58.6	77.7
Nonwhite or Hispanic	18.6	29.3	25.2	21.1	31.1	24.7	21.8	31	22.4	23.3	33.5	22.3
<i>Work status of head</i>												
Working for someone else	41.2	52.3	57	39.8	50	54.8	39.3	51.6	58.3	40.5	53.4	59.2
Self-employed	47.8	120.9	11.1	51.5	86.5	10.9	40.3	84.1	10.3	52.7	108.3	11.3
Retired	18.6	30.7	25.2	17.5	26.1	26	17.4	29.7	25	19.3	32.6	24.4
Other not working	9.3	18	6.7	12.9	23.9	8.3	12	19.8	6.5	11.1	23.2	5.2
<i>Housing status</i>												
Own	42.5	65.8	63.9	39.8	55.9	63.9	40.3	58.7	64.7	43.6	66.3	66.3
Rent	17.3	28.2	36.1	19.9	27.5	36.1	19.6	26.7	35.3	20.3	26.7	33.7

FEATURES OF AN EFFECTIVE ASSIGNMENT HANDOUT

Describe the task: Explain what you want students to do in the paper. Often the task is best presented as an ill-structured disciplinary problem requiring a claim/argument rather than mere information. Sometimes the task might be given as thesis to support, or the instructor might provide other specific instructions such as summarize and critique an article or write a technical report on an experiment.

Specify a rhetorical context for the task by describing the writer's role, the audience, and the format or genre:

- **Role and audience** Generally ask students to write to audiences who know less about the subject than the writer (so the writer can teach them something new or clarify something) or whose views on the topic differ from the writer's. Example cases: "Address your paper to professionals-in-training at an undergraduate research conference" (or to readers of a certain newspaper or magazine or to a student who missed last week's classes.) Consider telling students that the intended audience doesn't know the assignment. Discuss what is old and new information for this audience. Explain how the title and introduction have to provide a context for the writer's problem, hooking the audience's interest and providing needed background.. Students typically think of their teacher as audience, placing them in the awkward position of addressing a person who knows more about the topic than they do.
- **Genre and format:** Try to raise students' awareness of the features of typical genres in your discipline—experimental reports, posters, academic journal articles or conference presentations, workplace genres such as memos, proposals, or white papers, and so forth. Specify expected length, manuscript form, margins, spacing, and similar details

Specify expectations about process to be followed: Specify a time schedule for completion of first draft, peer review workshop, revisions, and so forth. Consider asking students to save all drafts and submit these in a folder along with the final draft. Also consider asking students to include an "acknowledgements page," in which they thank persons who discussed the topic with them or responded to drafts. (These requirements can discourage plagiarism and encourage students to treat writing as a process.)

Explain criteria for evaluation: Explain how the final product will be graded. How much weight will be given to ideas? To organization and development? To sentence style and readability? To grammatical correctness? To manuscript form and appearance? Ideally, provide a rubric or scoring guide for the assignment.

Consider explaining the purpose of the assignment: Often students appreciate why you have designed the assignment in a certain way. What concepts or skills is the assignment trying to teach? How does the assignment connect to overall learning goals for the course?

Questions for Peer-Reviewing an Assignment Handout

- Is the assignment clear? How might a student misread the assignment and do something not anticipated?
- Does the assignment specify an audience and a role for the writer (that is, a purpose for writing to this audience)?
- Are my grading criteria clear? Have I adequately explained them to students?
- If you were a student, would you find the assignment interesting and challenging?
- If you were a student, how difficult would this assignment be? How long do you think it would take?
- If the assignment is quite difficult, could it be preceded by a simpler "skill-building assignment" that would serve as scaffolding?
- To what extent does this assignment stimulate critical thinking? Does it cause students to wrestle with key concepts or key thinking skills in the course?
- Is the purpose of the assignment clear? Does it seem to tie into my course goals? Would it seem like busy work to some students?
- Are the mechanics of the assignment clear (due dates, expected length, single versus double spacing, typed versus handwritten, manuscript form, etc.?)
- Is the process students should go through as explicit as possible?
- Should I build any checkpoints built into the assignment to verify that students are on track? (e.g., submission of a thesis, title, and introduction? Mandatory conference? Annotated bibliography?)