

## Integrating Writing with Content in a Science-Themed FSEM

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I have taught FSEM three times at DU and will teach my fourth in Fall 2013. I have incorporated writing assignments into all my previous FSEM classes, but I have not yet found a strategy for these assignments that seems to resonate with students as well as reinforcing the course material. Participating in the FSEM/ASEM Institute has given me some new ideas about how to restructure my writing assignments, and I explore many of those ideas here.

My FSEM course is astronomy-themed and focuses primarily on “backyard astronomy”—that is, objects and phenomena observable to an amateur stargazer with the naked eye, binoculars, or a small telescope. I originally inherited the course from a colleague when the teaching assignments in my department were reshuffled, and I have changed the course title and slightly revised it each year I have taught it. In Fall 2012, it was called “Measuring the Milky Way.” As this course title was meant to suggest, the course incorporates a significant mathematical component; I hope to show students that application of even basic mathematical tools can reveal fascinating insights about the Universe. However, I am also convinced that writing is an essential part of the scientific endeavor and would like this to be one of the lessons of my FSEM as well.

I envision this paper as a means for me to examine some of the difficulties I have had with writing in my past FSEMs, consider what my fundamental course goals are for the students in the class, and explore alternative strategies that I can apply when I teach this course again in the fall. I also plan to initiate discussions with other science, technology, engineering, and mathematics (STEM) faculty about writing in their FSEM courses and the successes and challenges they have encountered.

### 1. What’s the problem?

When I first started making notes for this paper, I generated a list of several ostensibly separate issues that I had with the writing assignments I used in Fall 2012. These included “Students don’t take assignments seriously or spend sufficient time and effort on them” and “The course feels unfocused because I’m trying to teach math skills and physical/astronomical concepts as well as writing skills.” I think, however, that all the issues I listed can be boiled down to one main problem: *my writing assignments are not well integrated with the course content.*

This leads to all kinds of difficulties with the course. I suspect that it seems to students as if the writing is at best an afterthought and at worst something

completely separate from the rest of the class. Student evaluation comments reflected this, for example: “There were many times that our assignments... seemed to have nothing to do with what we were talking about.” In addition, poor integration makes it seem (even to me) that there are far too many assignments in the course. In Fall 2012, I gave weekly homework in addition to biweekly writing prompts, which made the grading very time-consuming, which means I didn’t return work promptly, which sapped motivation even more for everyone involved. One student summed this up by commenting in the evaluations, “There was a lot of outside work, and it would have been easier to follow if so many assignments didn’t overlap [in time].”

I have also noticed that students are very reluctant to write about topics with which they don’t feel comfortable; this effect is likely universal but may be exacerbated in the sciences, which tend to cultivate a reputation for being rigorous, difficult, and accessible only to geniuses. When I ask students to find their own topics to learn and write about (because I don’t have time to cover popular topics like black holes, extraterrestrial life, or the Big Bang), it’s no wonder they have difficulty navigating the arena of exotic physics and phenomena well outside the range of everyday experience. David Bartholomae describes an assignment of this type as “an act of aggression disguised as an act of charity,” pointing out that it asks the student to

assume the right of speaking to someone who knows more about baseball or “To His Coy Mistress” [or black holes] than the student does, a reader for whom the general commonplaces and the readily available utterances about a subject are inadequate. (610)

It’s not as though I haven’t tried to interweave the writing into the course content; I’ve been thinking about these issues since the first time I taught the class, and, I hope, have been steadily improving the situation since then. But I haven’t found the right balance yet, and I’m looking for new ideas.

## 2. What do I want students to learn?

Before I make any changes to my course, I need to define my overall goals, particularly as they relate to writing in a scientific context. Here are the learning outcomes from my Fall 2012 syllabus:

By the end of this course, students will be able to

1. recognize and describe a variety of celestial objects, including planets, stars, constellations, asterisms, clusters, nebulae, and galaxies;
2. understand and explain celestial motions and phenomena using words, diagrams, and/or equations;
3. identify a variety of astronomical tools and measurement techniques;
4. use basic astronomical equations with confidence;
5. read, analyze, and summarize popular-science articles about astronomical topics;
6. identify and discuss significant historical ideas and contributors to our understanding of the Universe.

As I revisited these learning outcomes for this paper, I realized that several were already out of date last fall; for example, I haven’t emphasized “tools and measurement techniques” (#3) or

“historical ideas” (#6) in any systematic way since the first time I taught the course. More importantly for this paper, the only one relating to writing is #5 (although #2 does at least nod in the direction of written communication), and as currently stated, this outcome focuses on reading and responding to “popular-science articles” rather than producing original writing or connecting the process of writing with the process of doing or understanding science.

My current writing goals for FSEM students are twofold: one attitudinal and one practical. First, I would like them to gain an appreciation for the role of writing in science (including some familiarity with the kinds of writing that scientists do); I think this has the potential to broaden the appeal of STEM majors to a population of students who may hold the preconception that one is either a “words person” or a “numbers person” and that those preferences determine one’s future path. In other words, I’d like to expose students to the ideas that being good at writing doesn’t mean you should rule out a STEM major, and conversely, that being a STEM major doesn’t absolve you from learning to write effectively. This forms a nice parallel with my goal for students’ attitudes about math: I want them to understand its central role in science and to be able to use it as a tool, regardless of their intended major. I hesitate to include these attitudinal goals in a formal statement of learning outcomes, primarily because they are very subjective and difficult to assess. However, because they underlie much of my course design, I think it’s important to articulate them; I might call it these two guiding principles my personal “zeroth goal” for my FSEM class.

Second, I would like my students to expand their writing skills, improving their abilities to explain (especially scientific) concepts clearly and learning to employ

deliberate strategies for addressing different audiences in different contexts. I have done a fair amount of work in past FSEMs helping students to identify the audience of a piece of writing and think about how to tailor their own writing for different audiences; I think these have generally worked well and should remain part of my class. This goal dovetails with Linda Flower’s assertion that “the difficulty inexperienced writers have with writing can be understood as a difficulty in negotiating the transition between ‘writer-based’ and ‘reader-based’ prose” (Bartholomae 608). Melissa Rice, an astronomer at Caltech, incorporates this idea into her first-year seminar syllabus explicitly:

By the end of the semester, your written work should demonstrate that you can... begin to think of yourself as a *writer* engaged in trying to have an effect on *readers* – rather than as a *student* trying to satisfy *teachers* (2, emphasis Rice’s).

With this ideas in mind, I propose to revise my FSEM learning goals as follows.

By the end of this course, students will be able to

1. recognize and describe a variety of celestial objects, including planets, stars, constellations, asterisms, clusters, nebulae, and galaxies;
2. understand and explain celestial motions and phenomena using words, diagrams, and mathematical expressions;

3. use basic astronomical equations with confidence;
4. write effectively about scientific topics in a variety of genres and for a range of audiences
5. tailor their own writing to different audiences and rhetorical situations, articulate the authorial choices that this entails,

and identify these strategies in others' writing.

2012 writing assignment	Learning outcome from revised list	Audience
Short-answer homework/exam questions	1, 2	Instructor
Observing reports	1, 2	Instructor
Descriptive paragraph	5	Not specified
Letter to the editor	1, 4, 5	Educated nonspecialists
Scientific proposal + lab report	2, 4	Experts
Topical sequence	1, 2, 4, 5	General public, classmates
Facebook posts/discussions	4	Instructor, classmates

**Table 1.** Mapping of 2012 writing assignments onto revised learning outcomes, with audience specified for each. Note that learning outcome #3 is purely quantitative in nature, so I don't expect it to be addressed by any of these assignments.

I'm not completely happy with #5 yet—I may still try to incorporate some language similar to Rice's—but the last two items in this revised list at least better encapsulate my underlying goals for the writing aspect of the course. In addition, with two items specifically devoted to writing, this list now reflects the central role of writing in the course.

### 3. What needs to be revised?

Now that I have a better idea of my own writing-related goals for the students, I will look at the writing assignments I assigned in Fall 2012 and consider which ones are effective at working toward these goals and which can be revised or replaced. I identified 7 different types of writing I asked the students in that class to

produce. For each, I discuss (and list above in Table 1) the learning outcomes it addresses and the audience for whom the students write.

- a) *Short-answer homework and exam questions*, mainly factual (“Describe how the Solar System formed,” but occasionally opinion-based (“Why do you think people made up constellations?”). Students seem comfortable with these types of questions, though they often answer them very tersely—Doug Brent calls this a “highly efficient but low-investment [strategy] based on retelling information” (279). This primarily addresses learning outcomes #1 and #2, since writing for the audience of the instructor is something with

- which the students presumably need no practice.
- b) *Short “observing reports”* after stargazing sessions. These have been a bit of a throwaway (students normally don’t spend much time on them), but I think they can be developed into more useful exercises (see section 4). In the past these have addressed learning outcomes #1 and #2 only, but as I discuss in the next section, I can envision modifying them, by adjusting the assigned audience, to meet goal #4 and possibly #5.
- c) *Descriptive paragraph* about an object that represents the student, assigned during the first week. In class, students rewrite their paragraphs as a technical or aesthetic description (as opposed to a personal one). This is a good first-week activity that demonstrates how choices about writing depend on the rhetorical situation (and thus begins to address learning outcome #5); however, it has little to do (on the surface) with the course material. I also realized that I do not assign an audience for this writing, though I indirectly suggest some as examples to help students understand the assignment.
- d) *Letter to the editor* of a newspaper about whether or not Pluto should be considered a planet. This is a great example of a scientific debate, but it’s getting somewhat dated and most of my recent students don’t seem to think it’s much of an issue. Also, I wonder whether letters to the editor are losing their relevance for today’s students—if they don’t themselves read newspapers, they may have difficulty understanding the audience and striking the appropriate tone. The assignment is designed to address learning outcomes #1, #4, and #5 (in addition to the letter, I ask students to write a paragraph describing their rhetorical strategy, citing specific examples from their own text).
- e) *Scientific proposal and report*, in groups, accompanying a lab exercise. I didn’t give the proposal enough emphasis last year; this is a great example of persuasive scientific writing for an expert audience, but we did not spend much time on it. The lab report is very boring for most; I think the students don’t see it as “real writing,” but rather as a cookbook exercise. Because I put so little time into discussing these as rhetorical exercises, I would classify them as supporting learning goals #2 and #4 only.
- f) *4-assignment sequence* on an astronomy topic of the student’s choice. Students first envision and describe a non-specialist audience member; find a press release on their chosen topic and summarize it for that particular audience; read a scientific article on the topic and compare/contrast it with the press release; and finally present the topic to the class at the end of the quarter. For each of the written assignments, I ask them for an extra paragraph of meta-analysis in which they discuss specific choices they made in their writing. Students struggle somewhat with the scientific article, but I think it’s important for them to be exposed to this genre of writing, at least in an introductory way. In 2012, the capstone presentations were pretty bland; there was much too much

- PowerPoint involved. Taken as a whole, this sequence addresses all my writing-related learning goals. I think the sequence is effective overall, but I would like to revise the presentation aspect of it to make it more of a creative opportunity for the students (and more interesting for the audience).
- g) *Class discussions on Facebook.* I envisioned this as a way for students to talk about the class and share astronomy-related pictures and news stories they came across, but it wasn't very successful. Maybe the students felt it was too creepy to have the instructor be part of the group, but there was little activity except when I mandated it, and almost no follow-up commentary to anyone's posts. I've tried this also in listserv and discussion board formats, with no luck; I'm about ready to give up on the idea. Perhaps the problem is that I've never fully defined the purposes of this discussion space; I have a hard time assigning it a place in my list of learning outcomes, since it doesn't entail much actual writing. However, since my intent was for them to discuss course topics with their peers, I will classify this under learning outcome #4.

My main reaction to this list is that it's far too long, especially given the weekly homework assignments (which incorporate a and b but not the others). As I discussed in section 1, an advantage to reworking the writing in this class will be to streamline things, allowing for more immediate student feedback, something Brent argues is important for helping students "focus on high-level goals" (279). However, I think that my learning

outcomes are well represented in my list of assignments, and I want to make sure I retain that distribution as I revise the assignments.

The easiest place to start seems to be to eliminate the assignments that only fulfill one of my four relevant learning outcomes—perhaps not coincidentally, these are the two (descriptive paragraph and Facebook posts) that I feel most ambivalent about. Given the ideas I have found in my reading this past week, I think I can also remove the letter-to-the-editor assignment and incorporate its most salient aspects into another type of assignment, which I'll discuss further in section 4 below.

However, simply removing a few of the smallest assignments won't make much difference in the writing workload for students in my class (particularly if I replace them with new assignments); nor will it guarantee a tighter connection between the writing and the course content. In section 4, I consider how to revise the remaining assignments and incorporate new types of writing in ways that will keep the writing closely tied to the content of the course. As I plan my new course over the rest of the summer, I will also consider making some assignments (such as the lab report) into shorter, in-class writing exercises; this will also allow me to incorporate more collaboration and peer review, as well as discussion of good and bad examples of the forms I assign. Happily, the astronomy content of the course is quite flexible, so I don't feel as much "coverage pressure" in this course as I might in one designed for majors; thus, I have quite a bit of flexibility in deciding what will happen during my class meetings.

#### 4. What new options can I introduce?

During the FSEM/ASEM Institute, I read and heard about many other types of writing that professors at DU and elsewhere incorporate into their courses. Four in particular seemed to me promising possibilities for my own course: journals, blogging, microthemes, and multimodal presentations.

I spent some time researching astronomy-themed first-year seminars at other institutions and found a useful article by Tom English at Gardner-Webb University, in which he discusses his experiences incorporating writing into a course very similar to mine. I found his idea of a “student observing journal” particularly interesting; English describes how keeping a regular observing log can help students develop precision in both observing and record-keeping. In his course, students conduct and record their own observations of the sky twice a week; the logs are evaluated with feedback three times during the semester, but scored for credit only at the end. Throughout the term, his students generally progress from sketchy weather reports to detailed descriptions, predictions, and accounts of explaining celestial phenomena to friends and family. English concludes, “These writings show a general enthusiasm for the sky that would not necessarily be developed in the traditional classroom treatment... Though this is a simple exercise, it is truly writing to learn” (21).

Although the “observing journal” as English implemented it was focused primarily on one task, I think it could easily be modified to serve some of the same functions as journaling in non-science courses, e.g., reading responses, early free-writing or drafting for longer writing assignments, or communication with the instructor about course content or difficulties. In past versions of this class, I have frequently given in-class

quizzes to help students practice for exams, but these have proven more stressful than useful for first-year students, so I have decided to eliminate them. Some of the functions of the quiz could, however, be incorporated into the journal. Especially if these aspects were included, the observing journal could address all my writing-related learning outcomes and cover a wide range of audiences, while its recurring format would allow me to assign entries that closely follow course topics. As English suggests, I would grade these only once or twice per quarter, but find a way to provide ungraded feedback to students as the course progresses; this will make the journaling assignments low-risk for the students and simple for me to grade.

Many instructors at DU and elsewhere are making use of course blogs as a way to give students practice writing for the public—because so much of these students’ lives is now conducted online, this seems to me the natural successor to the letter-to-the-editor” exercise. It also has the potential to incorporate the social and community spirit I envisioned would arise from the Facebook experiment. Several instructors with whom I’ve discussed these ideas assign students to maintain personal blogs; some then hand-pick particularly interesting or well-written posts to be featured on a central course blog. A good example in astronomy, though designed for a more advanced course for majors, is John Johnson’s course blog for Ay20 at Caltech: <http://ay20class.blogspot.com>. Johnson grades his students’ posts on a 5-point scale, providing helpful links in an early post to examples of 1-point, 3-point, and 5-point entries on his own personal blog.

I have mixed feelings about this idea (though will almost certainly imitate Johnson’s structure in an upper-level astronomy class I’ll be teaching next winter). I think the idea of writing for a

larger web audience could be very motivating for FSEM students and make them think carefully about what they post. On the other hand, if I incorporate the journal/observing log idea above, I think adding regular blog posts would be too much to ask of the students. One way to get around this would be to find a way to make the students' journals electronic, so that I could easily copy/paste exemplary writing into a main course blog. Another way would be to use Lydia Gil Keff's model in which students are paired up to revise one or more of their journal entries into posts for the course blog. This would only need to happen once per quarter for each student, so would not add to the overall writing load too much (although timing might be tricky in some weeks). Such an assignment would be written for

a general or educated non-specialist audience and could fulfill learning goals #1, #2, and #4 (possibly also #5 with a follow-up analysis).

In his book *Engaging Ideas: The Professor's Guide to Integrating Writing, Critical Thinking, and Active Learning in the Classroom*, John C. Bean discusses a type of writing assignment with which I was previously unfamiliar: what he calls "microthemes," "very short piece[s] of formal, closed-form writing usually less than 250 words" (111). It's not the brevity of these assignments that makes them stand out to me, but rather the flexibility in tone, audience, and structure they allow in student responses. Bean's two examples take the form of a question about physics

2013 writing assignment	Learning outcome from revised list	Audience
Short-answer homework/exam questions	1, 2	Instructor
Weekly journal/observing log	1, 2, 5	Various
Microthemes	1, 2, 4, 5	Various
Scientific proposal + lab report	2, 4, 5	Experts
Topical sequence	1, 2, 4, 5	General public, classmates

**Table 2.** As in Table 1, but for tentative 2013 writing assignments.

to an advice columnist/Q&A answer person and a hypothetical discussion among psychology students analyzing a case study. Such assignments seem particularly well suited to combining scientific content with different types of writing; they could address all my learning outcomes as well as being quite flexible in terms of how I incorporated them into the class (as homework or part of a journal assignment or an in-class exercise; individually or as part of a group). I can imagine assigning microthemes that ask students, for example, to respond to an online call for comments about the federal budget allocation for NASA, to predict the location and phase of the Moon on a given date, to address the myth of an egg

balancing on the equinox, or to speculate about what kind of alien life might survive on the new exoplanets being discovered every day. I would grade these, as Bean suggests, using a simple rubric emphasizing correct understanding of scientific topics combined with clarity of expression and appropriateness for the intended audience.

## 5. Preliminary plan for 2013

With the above discussion as a guide, I present a preliminary plan for the writing assignments in my FSEM for Fall 2013, noting what decisions I still need to make before September. The updated table connecting assignments with audiences and learning mechanisms is shown in



Table 2. My tentative new scheme includes fewer separate assignments, but each type of assignment addresses more of my learning outcomes. The increase in smaller writing exercises will also result in greater flexibility in weekly scheduling.

- a) *Short-answer homework/exam questions*: I plan to keep these mostly intact from 2012, though in some cases I may replace them with microthemes or journal entries.
- b) *Weekly journal/observing log*: I will incorporate this new type of assignment, as a way for students to engage with course material in “real time” through informal writing. I tentatively plan to require 2 short entries per week, one an “observing log” and one an assigned exercise (reading response, pre-writing, microtheme, etc.) and collect them for assessment or grading 3 times during the quarter. As I continue to plan the course, I will brainstorm writing prompts that respond to course content and ask students to consider writing strategies for various audiences.
- c) *Microthemes*: I plan to use these in homework or journal assignments as well as in group work in class. I will spend some time this summer writing prompts for microthemes, exploring a range of topics, formats, and audiences.
- d) *Scientific proposal and report*: I will keep these assignments similar to last year’s but reschedule the course so that I can spend more time discussing the proposal and having students read examples. I will also try to schedule the topical sequence (see item e below) so that the students look at scientific papers before they write their lab

reports. Finally, I will consider making the lab report an in-class project so that teams of students can get feedback from me and this assignment will not add to their workload outside class.

- e) *4-assignment sequence*: I will keep this mostly intact, but revise the final presentation to give students a range of genre options, such as a blog post or salon.com article, a Nova-style educational video, a hands-on demonstration, etc. I will add an analysis paragraph to this part of the assignment (similar to those I already assign for the other parts) asking students to describe the choices they made when designing their presentations for an audience of their classmates. If students see this as more of a creative activity, it may feel less onerous to them at the end of the quarter.

I am still considering whether to incorporate the “class blog” idea into my plans for the fall. In addition to the advantages I discussed in section 4, this might help me prepare to use this tool in future courses. However, I’m reluctant to make too many changes to my FSEM at once, so may decide to keep this in mind for a future incarnation of the course.

I appreciate the opportunity the FSEM/ASEM Institute has given me to reflect on writing in my course, learn about the pedagogical theory underlying the FSEM project, and discuss related issues with other instructors. I hope to organize a few informal discussions among STEM faculty teaching FSEM and ASEM later this summer. I am also happy for the encouragement to produce a more-or-less complete piece of writing on this topic; it will be a valuable resource for me as I continue to refine this course in the future.