# A Tale of Two Rubrics: Realigning Genre Instruction through Improved Response Rubrics in a Writing-intensive Physics Course

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Professor Grosse Perdekamp and his group at UIUC have developed and built instruments for the detection of ionizing radiation for the PHENIX experiment at RHIC and the COMPASS experiment at CERN. Currently the group carries out R&D for an upgrade of the Zero Degree Calorimeter in ATLAS. Grosse Perdekamp studies possible applications of this instrumentation for the detection of fissile materials. He has been teaching a course on Nuclear Weapons and Arms Control since 2012 and is the Associate Director of the UIUC program for Arms Control, Disarmament, and International Security (ACDIS).

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## Abstract

STEM instructors are often not well prepared to assist students in developing as writers or to respond to student writing effectively. Recognizing this challenge, STEM and Writing Studies faculty and graduate students created a long-term collaboration, Writing Across Engineering (WAE), in the College of Engineering at the University of Illinois at Urbana-Champaign. By participation in WAE, the instructional staff of a writing-intensive physics course engaged in a year-long effort to explore and apply evidence-based best practices for writing instruction. In this paper, we focus on how changes in the rubrics for responding to/grading student writing became central to redesigning instruction. A key disconnect was identified between the learning goals for writing, implicit in the course materials and thus not communicated to students, and the details of instructional practice. Changes to the grading rubrics, as well as assignments, addressed this disconnect by shifting response practices away from being heavily focused on strict adherence to specific text conventions. Rather, response became more comprehensive, incorporating best practices from Writing Studies, such as building genre awareness, teaching writing as a process, and using prioritized, selective feedback. The new rubrics also better aligned with the original learning goals and enabled those goals to be both communicated to students and explicitly expressed in the course. We conclude with a discussion of lessons learned and the potential for uptake in other courses and institutions.


## I. Introduction

While the Accreditation Board for Engineering and Technology (ABET) has identified effective communication as a critical competency and writing skills are widely recognized as being important for practicing engineers and scientists [1], strategies for developing those communication skills in engineering students have been rather limited. Engineering faculty typically feel more certain of their ability to convey technical material than to teach (or respond to) student writing. At the level of an individual course, one common model is for technical faculty to collaborate on assignment design and response with co-teachers who specialize in writing or communication, e.g., [2], [3]. This approach addresses two major issues: the lack of preparation most STEM faculty have for teaching communication skills and the knowledge transfer difficulties associated with stand-alone rhetoric or communication classes taught outside of the students' major discipline. However, the co-teaching model is resource-intensive, challenging to integrate fully, and difficult to scale up, generally limiting application of this model to one, or at most two, classes in a curriculum. To pursue deeper integration of writing development throughout the engineering curriculum at a large university, we have leveraged writing studies expertise in support of STEM faculty and graduate teaching assistants.

The work described here was part of a pilot run of a faculty development program called Writing Across Engineering (WAE). The program draws heavily on the Writing Across the Curriculum (WAC) and Writing in the Disciplines (WID) literature [2], [4]–[9], but differs in three key ways.

First, WAE is grounded in a sustained interdisciplinary collaboration designed and led by a team that spans Physics, Engineering, and Writing Studies. Second, rather than the typical one-off intensive workshop model, WAE organized weekly meetings of a small cohort over a semester, similar to a faculty learning community. Meetings introduced technical faculty to best practices from Writing Studies and promoted reflection and discussion about how those practices could be adapted most effectively for each faculty member's course or courses. Third, the structure of the WAE program included individualized mentoring for interested faculty (and, in this case, their course staff) while they were implementing changes in their courses. The pilot run of WAE occurred over an academic year, with the weekly meetings occurring in the fall semester and the individual mentoring in the spring. A detailed description of the WAE program is available in Ware et al. [10].

This paper presents a case study from WAE that highlights how the cooperative, interdisciplinary program fostered change within a writing-intensive Physics course. The course, entitled *Nuclear Weapons and Arms Control* and hereafter referred to as Phys 280, involves the nontechnical study of the physics of nuclear weapons as well as of related social and political issues. The faculty instructor of Phys 280 attended the weekly WAE meetings in the fall semester, and the entire course staff, comprising the faculty instructor and five teaching assistants (TAs), was mentored in the spring semester. In keeping with common practices for assessment of WAC interventions on disciplinary teaching practices in naturalistic environments [7], our methodological strategy in this paper involves documenting expected and novel changes in the course.

Our aim here then is twofold: to share strategies that could be incorporated in other classes and to illustrate how the WAE program enabled the Phys 280 instructional staff to explore and apply evidence-based best practices for writing instruction. After providing some background on Phys 280 and the best practices promoted by the Writing Studies discipline for effective disciplinary writing instruction and response (sec. II), we will describe the learning goals for writing and the grading scheme of Phys 280 before the course staff participated in WAE (sec. III). The next section describes how participation in WAE led the pedagogical goals and practices of the course staff to shift (sec. IV). We conclude with a discussion of lessons learned and the potential for transfer to other courses and institutions (sec. V).

## II. Background

### II.1 Course Description

*Nuclear Weapons and Arms Control* (Phys 280) is an entry-level physics course intended to give students an overview of nuclear weapons and arms control. A wide range of majors enroll in Phys 280, as it is cross-listed in Global Studies and fulfills the university's general education requirement for a writing-intensive course beyond first year composition. Student enrollment in 2018 was 54 students, representative of the past five years. Both policy and technical topics are covered; the course emphasizes current events, enabling students to develop their own public discourse on nuclear topics. Students practice writing in several different technical genres (see Table 1 in sec. III). In addition to the faculty instructor, who is an expert in Nuclear Physics, the course staff included five TAs (two from Physics; two from Nuclear, Plasma, and Radiological

Engineering; and one from Global Studies), who were responsible for responding to students' writing and facilitating weekly writing labs. Mentoring was provided by two graduate students from the WAE program—one from Physics who was also served as a returning course TA and one from Writing Studies—and by a technical research writer in the Physics department who is a former English professor and writing program administrator with expertise in professional and technical writing pedagogy.

### II.2 Best Practices Promoted by Writing Studies

As detailed in Yoritomo et al. [11], working with several decades of Writing Studies literature that defines writing as a sociocultural process, we have honed in on three fundamental principles for our needs-based intervention: "i) writing is a complex and social process rather than just a product; ii) writing is a matter of quite specific genres rather than of general skills and broad academic or disciplinary styles; and iii) writing is a way to understand and remember technical material and practice critical thinking (writing-to-learn) rather than just a means of communication." Best practices promoted by Writing Studies for disciplinary writing contexts, then, aim to adapt pedagogical practices to local, situational needs and goals. In Phys 280, we focused on strategies for responding to student writing and for eliciting students' metacognition to build nuanced, realistic conceptions of disciplinary writing.

Writing Studies research has shown consistently that teachers and students alike value response to writing as critical to learning [6], [12]–[14]. In writing courses, response often constitutes the instructor's major time investment. Large courses with teaching assistants have the added difficulty of training and norming response practices, sometimes leading instructors to take on all of the responding work alone. Best practices for response build on instructors' and students' purposes to selectively prioritize feedback on a limited number of high order issues and to stress global, holistic approaches to feedback over detailed line editing, which research has found to be ineffective [15]–[17].

Pedagogy undergirded by writing studies theory aims to foster students' metacognition and help them build nuanced, complex conceptions of writing as a cognitive and social practice. In addition to embedding these goals in response practices, they can be built into assignment design and reinforced in classroom instruction. Assignments and activities that ask students to reflect on their writing, those that foster understanding of and flexibility composing across professional genres, and those that attend to the many and diverse processes that lead to a finished product all work toward these aims [18]–[22]. Some specific practices will be elucidated in the context of this case study (sec. IV). See Yoritomo et al. [11] for more detail on these strategies in practice.

## III. Before Participation in WAE

In this section we will describe the original learning goals for writing and the grading scheme of Phys 280, before participation in WAE. The learning goals were largely implicit, hidden within the course materials and staff's values.

The explicit Phys 280 writing learning objective, found in the course student handbook (link), was vague, especially compared to the content learning objective: "Physics/Global Studies 280 has two main objectives: (1) to enable you, whatever your background, to gain a basic understanding of the nature of nuclear weapons, the threat they pose to humankind, and possible ways to reduce and eventually eliminate this threat; *(2) to enable you to improve your writing skills*." This difference in detail between the two objectives suggests an imbalance in clarity and richness of the objectives. Although the Phys 280 student handbook did not elaborate on the writing learning objective, we identified four writing learning goals implicit within the course.

Students should foster a professional identity in the field of nuclear weapons and arms by

1. developing an attention to detail with regard to both technical content and writing requirements,
2. recognizing the diversity of professional genres and being capable of learning and adapting to new professional genres,
3. learning nuclear concepts by writing, and
4. appreciating that writing is a process.

The first learning goal, to have students develop care for detail, was apparent from examining the assignments (Table 1) and the grading scheme. Phys 280 had detailed format specifications for each written product. The grading scheme, as detailed below, heavily emphasized formatting specifications and adherence to language conventions. The assignments covered a range of genres and emphasized professional genres relevant to the field (second learning goal), but the instruction and grading scheme did not emphasize the skills necessary to learn new genres. The other two goals were more deeply buried within the course materials and emerged as the course staff reflected on their motivation and learning objectives. In particular, assignments RE2 and RE3 (see Table 1) were designed so that students would learn the course content in a precise manner. The importance of writing as a process was suggested by requiring revisions to some assignments, scaffolding the development of the research paper, and assigning some peer review. Yet, no instruction was given on how to effectively revise, resulting in nominal improvement between versions of many papers (based both on assessment and instructor perceptions). Our work suggests that Phys 280 contained, at least in an embryonic stage, writing learning goals more sophisticated than "to enable [a student] to improve [his or her] writing skills," but that these learning goals had not been explicitly communicated to students or fully articulated in instructional practice.

The grading scheme used in Phys 280 before participation in WAE was based on point-deductions. Many sections were devoted to formatting specifications (e.g., -4 points for wrong header format, -2 points for wrong font, -3 for no page numbers, -3 for wrong margins), while the quality of content received relatively little attention. For example, in RE2, a student could lose up to 39 points on formatting, putting the student's grade at the specified floor for grading (60/100 points) and deterring TAs from responding to content. The point-deduction mechanism encouraged line-editing and over-responding to papers, making it difficult for students to discern the importance of different comments on their essays. The point-deduction sheets were not shared with students; TAs returned only the students' marked-up essays. The major shortcomings of this approach were its disconnect from the implicit learning objectives, its time-consuming nature, and its ineffectiveness. TAs were particularly frustrated by the limited improvements seen in revised submissions.

| Assignment Code | Professional Genre | Audience | # of stages | Peer Review |
|---|---|---|---|---|
| RE 1 | *Scientific American* News Article | General public in 1954 | 1 | No |
| RE 2 | Congressional Research Service Report | Select group of senators in 1940s | 2 (first draft, final draft) | Yes |
| RE 3 | Congressional Research Service Report | Incoming members of congress in 2016 | 2 (first draft, final draft) | Yes |
| RE 4 | Intelligence brief using “Bottom Line Up Front” (BLUF) style | Members of the National Counterterrorism Center | 1 | No |
| RE 5 | *Scientific American* News Article | General public in 2016 | 1 | No |
| Research Paper | | Students in Phys 280 | 4 (proposal, revised proposal, first draft, final draft) | No |

Table 1. Phys 280 Writing Assignments before Participation in WAE

## IV. During and after Participation in WAE

The goal of spring semester mentoring in WAE was to help the faculty mentees (and their course staff) implement pedagogical changes to better align with and adapt best practices from writing studies to the particularities of their courses. In the first mentoring meeting, the instructor of Phys 280 named three major areas of concern: improving TA response practices, shifting the focus of weekly writing labs from content to writing, and revising assignment prompts to scaffold writing processes. These concerns were linked both to his continued work with the course and to new approaches to which he had been introduced to during the fall WAE sessions, where he continued to hone the course’s writing learning objectives.

An important initial step in addressing these concerns was to design a workshop that introduced TAs to response practices fitted to their course context. In preparation for this workshop, the WAE mentors requested samples of student writing and the current grading criteria (i.e., the point-deduction rubrics described above). They created a mock rubric intended to help TA respondents hone in on, differentiate, and communicate to students the varied learning objectives of the particular assignment with a heuristic that could apply to all course assignments, but still allowed for customized areas of emphasis. In the workshop, the WAE mentors critiqued examples of responses to student writing; challenged both the popular notion that line editing is an effective use of responders' time and that there is an "objective" way to grade writing; and led a round of grading using the new rubric so that this method could be compared with the point-deduction method. After this workshop, the course staff decided to adopt the new grading scheme.

### IV.1 The Grading Scheme

The new rubric, developed by course staff, in collaboration with the WAE mentors, (Fig. 1) broke out, described, and attributed weights to focal features. It focused the TAs' response on the following features: coverage of issues and information, precise and accurate use of concepts, explanation and argument, professional style, conformity to conventions, and copy editing and use of standard language. The "description" column of the rubric was built from the assignment prompts, which often asked that students include specific content, and scoring items from the point-deduction sheets that were now grouped together under features, as a means of defining them. Creating these description boxes facilitated conversation among the course staff and WAE mentors on how to achieve important communicative features of writing across different genres and assignments. These conversations also prompted revision of later course assignments to place more of the burden of inventing content on students by removing direct content instructions (see sec. IV.3 below). The "range" column of the rubric enabled the instructional staff to weight each feature as they found appropriate for a given assignment. For instance, they could more heavily weight the final three features on second drafts of papers after students had revised higher order issues, or on assignments where students were mirroring a tightly controlled technical genre. Importantly, the rubric also includes a space for comments on each feature, with a reminder to note both strengths and weaknesses, and a space for overall comments below, encouraging TAs to synthesize their response in digestible chunks that students can make use of in their revisions.

Typically, TAs continued to provide feedback directly on the students' essays. However, they made fewer direct comments, and these comments more often concerned higher-order issues, like clarity or precision. The amount of line-editing for grammatical mistakes—a time sink for the TAs and a large portion of the written feedback with the point-deduction scheme—was substantially reduced. The rubric's built-in response framework helped to check any remaining inclination TAs may have had to over-respond (or under-respond). Having fewer in-text comments and having them directly linked to a comment on the rubric makes it easier for students to understand the significance and context of the in-text comments [15], [17].

Phys 280 RE2v1 rubric:

| **Features**: | **Description:** | **Range**: | **Comments on student paper for each feature (noting problems and strengths)**: |
|---|---|---|---|
| **Coverage of issues and information** | Sufficiently answers the following:<br>1. What is the definition of a fissionable, fissile, and fertile nuclide? List an example of a fissile, a fissionable but not fissile, and a fertile nuclide.<br>2. What is the definition of a nuclear-explosive nuclide, and a nuclear-explosive material? Are all fissile nuclides nuclear-explosive nuclides? Explain why some nuclides that are not fissile are nuclear-explosive. List an example of an important nuclear-explosive nuclide that is not fissile.<br>3. Explain in one or two paragraphs the basic, general requirements for achieving a nuclear explosion using nuclear explosive material. *Do not go into any of the details of particular weapon designs.* ( ⅓ of paper)<br>4. Explain in one paragraph why the energy released in a nuclear explosion is much greater than the energy released in the explosion of a conventional bomb. In a separate paragraph illustrating the magnitude of energy release of a nuclear explosion, suggest a concrete scenario for the use of a nuclear weapon in the ongoing war effort (World War II). | 25%<br><br>**High**<br><br>**Mid**<br><br>**Low** | |
| **Precise and accurate use of concepts** | Accurate, clear definitions of:<br>- fissile, fissionable and fertile<br>- NEM, NEN<br><br>Accurate explanation of:<br>-nuclear explosion<br>-energy release greater than conventional bomb | 20%<br><br>**High**<br><br>**Mid**<br><br>**Low** | |
| **Explanation & argument** | Suggests a use for nuclear weapons, but does not forward personal opinion.<br>Explains why nuclear explosions are greater than conventional.<br>Suggested military application is realistic. | 10%<br><br>**High**<br><br>**Mid**<br><br>**Low** | |

Figure 1a. An example of the new rubric introduced by WAE. This is the first of two pages. This rubric was used for assignment RE2.

| Features: | Description: | Range: | Comments on student paper for each feature (noting problems and strengths): |
|---|---|---|---|
| **Professional style** | Geared toward college-educated member of congress.<br><br>Congruent with Congressional Research Service report style. Language (word choice, sentence structure, flow of information etc.) is precise and straightforward, attending to:<br>Concision<br>Clarity<br>Brevity<br>Professional tone<br>Organization<br>Comprehensive and thoughtful use of sources (need both NEM and Slides).<br>- Source info clearly cited.<br>- Uses a mixture of quotation, paraphrase, and summary. | 20%<br><br>**High**<br><br>**Mid**<br><br>**Low** | |
| **Conformity to conventions** | 2 pages<br>Title and section headings specified in prompt<br>Header and date in correct format<br>Page numbers<br>12-point Times New Roman font throughout (including page numbers)<br>1.25" side margins and 1" top margins and .5" bottom margins.<br>Citation practices specified in prompt.<br>Key terms bolded in first use<br>(√ = all correct, X = some mistakes (-10), XX = no conformity (-15) )<br>**If you can't find the error, come to office hours! | 15% | |
| **Copy editing and use of standard language** | Grammar and mechanics are edited for correctness and legibility. | 10%<br><br>**High**<br><br>**Mid**<br><br>**Low** | |
| **Overall Comments:** | | | |

Figure 1b. An example of the new rubric introduced by WAE. This is the second page of the rubric used for assignment RE2.

Since TAs made fewer line-edits and consequently were not oversaturating student papers with comments, TAs may have spent less time overall grading. This is suggested by the TA reflections (see section IV.2 and the appendix). However, a rigorous study of the time spent grading by TAs was not conducted before and after, and changes in assignment and time spent on writing instruction could also have led to changes in grading time. The rubrics themselves may have contributed to less grading time, as the TAs did not need to devise their own rubrics. Previously, TAs had created individual rubrics for content issues, since the point deduction sheets had not provided sufficient guidelines (see Reflection One in the appendix). We believe that additional time savings could be created through instructors filling out only the “range” column of the rubric, i.e., no specific feedback provided in the last rubric column or on the essay. Though not ideal, the instructor could still communicate substantive information to the student, since the “description” column of the rubrics we developed is not only detailed but also aligned with in-class writing practice and instruction.

Overall, the new grading scheme better aligned with best practices from writing studies (sec. II) and with the original, implicit writing learning goals (sec. III). Two of the rubric focal features, precise and accurate use of concepts and professional style, communicated to students that attention to detail (the first writing learning goal) encompassed more than adhering to conventions. The descriptions in these sections were also designed to better convey the disciplinary values that motivated the attention to detail. A more comprehensive notion of genre (second writing learning goal) was incorporated by adding issues like audience, professional tone, and organization, which were described under professional style (see Fig. 1b). Furthermore, the features listed on the first page of the new rubric (Fig. 1a) ensured that the TAs assessed the content of student essays in a more comprehensive manner, providing more global feedback and bringing the third learning goal, writing-to-learn, more to the forefront. Processual components (the fourth learning goal) were also added to the assessment by including, in some assignments’ rubrics, a focal feature devoted to the quality of a student’s peer review.

Importantly, the new rubrics were also favorably received by the instructor and TAs. They provided a structure that encouraged prioritized, selective feedback [13], [15], both on the rubrics and student essays. Based on feedback from instructors, observation of grading sessions, and selective examples of response, we believe the new rubrics made TA grading not only more efficient and but also, importantly, more meaningful. The new rubrics certainly provided more consistency in TA responses in contrast with the point-deduction sheets. In addition to documenting this marked change in the response and assessment practices, we also offer TA reflections on how they experienced the effects of the new rubrics summarized in the next section and presented in full in the appendix.

### IV.2 TA Reflections on the Rubrics

We summarize reflections from three of the TAs (also co-authors) on the new grading scheme in Table 2. The full reflections can be found in the appendix. The TAs discuss how the new rubric helped to align learning goals with practice and helped provide consistency between graders (Reflection One); how the new rubric is more efficient and process-oriented (Reflection Two); and how the new grading scheme enabled more meaningful responses and how WAE encouraged reflection on the grading practices (Reflection Three).

| **Benefit of Rubrics** | **Quotes from TA Reflections** |
|---|---|
| More efficient/ time-saving | "*The introduction of the new rubrics helped guide my grading, eliminating the need for me or the other TAs to create independent goals to grade from. This made grading a much less laborious task for me" (Reflection One)*<br><br>*"As a whole, I believe the new rubrics are more efficient and better reflect the learning objectives of the course… [T]he old rubrics… led to an inefficient tally system… I am no longer required to show students every instance that resulted in a deduction on their paper."(Reflection Two)*<br><br>"*Before [with the point deduction scheme] it felt like I graded the essays multiple times, once for formatting, once for grammar, and then maybe a third time to actually look at content" (Reflection Three)* |
| More meaningful response | *"The implementation of the new rubric gave me more freedom in assigning points… With the old rubrics, I was required to justify each point deducted... The intention [of revision] is that they now critically reread their first draft and make changes on their own in order to receive full credit." (Reflection Two)*<br><br>*"With the new rubrics I feel that my responses to student writing are more meaningful than with the point deduction sheets. Before I was so frustrated by how much time and effort I would put in to finding instances of errors, particularly formatting, but how little the students essays changed with the second version… [T]he rubrics really helped structure my responses so that I focus more of my energy on assessing the content and more important writing issues" (Reflection Three)* |
| Better consistency between graders | "*…I had to come up with my own content objectives [when using the previous point deduction scheme] that each [student] writer should be meeting. Each TA also had to do this on their own, leading to six different grading schemes." (Reflection One)* |
| Better alignment with learning goals | "*The new rubrics help guide my grading by providing a structure to assess if the students are meeting specific goals for each essay. Before, papers were graded using a list of point deductions; these point deductions were primarily focused on paper formatting and grammar, not the content of the essay." (Reflection One)*<br><br>*"As a whole, I believe the new rubrics are more efficient and better reflect the learning objectives of the course." (Reflection Two)* |

Table 2. Summary of the rubric benefits inferred from the TA reflections. We provide excerpts from the reflections that give evidence for each benefit. The full TA reflections can be found in the appendix.

### IV.3 Other Course Elements Affected by WAE

The conversations initiated by creating the new rubrics, in collaboration with the WAE mentorship, prompted other changes to the Phys 280 course as well. Centered around the writing assignments, these changes include i) combining two assignments (RE4 and RE5 in Table 1) to incorporate more process elements, ii) adding a "writer's memo" to every assignment, and iii) improving peer review. In Table 3, we summarize these changes and connect them to the learning goals.

Combining assignments RE4 and RE5 allowed for another revision opportunity. The assignment prompts were also stripped of many details and specifications, making them less product-oriented and placing the onus of determining relevant content on students. One activity ("pre-draft" in Table 3) guided student creation of the content, as students were asked to make the rubrics themselves for the new assignment. Specifically, they were given a rubric, like Figure 1, and asked to fill in the description box for each feature. The student-created rubrics were then used by the TAs when grading and by peer review partners when providing feedback. Having the students decide for themselves what constitutes the focal features of the rubric, like precise and accurate use of concepts or professional style, encouraged them to reflect on the assigned genre and build genre flexibility (the first writing learning goal). Introducing planning processes, i.e. the "pre-draft," strengthened the students' conception of writing as process (the fourth writing learning goal).

In the initial workshop on response, the presenters also discussed using writer's memos as a way to encourage dialogue. In the course of the discussion, the Physics faculty member suggested using these memos for peer review, which led further to the idea of pairing students in different specializations. The WAE mentors then facilitated the inclusion of writer's memos for every writing assignment. The instructions for these memos varied by assignment. Some were meant to guide peer review by having students provide specific questions to which their peer review partner would respond. The questions could be related to either content or writing issues. Memos for the second versions of assignments asked students to state how they took up feedback from their TA grader and peer review partner and justify why they did not incorporate any feedback that they chose to ignore. These memos were meant to encourage students to reflect on their writing process and to facilitate the peer review discussion.

Peer review was added to more assignments, and improvements to peer review were twofold. First, the peer review activity became more structured. The instructions were more detailed, requiring reviewers, at a minimum, to respond to the questions posed in the writer's memo of their partner. Students were given time in class to discuss their reviews with each other. Second, a new assignment, called "collegial response," was introduced to the research paper sequence. It took advantage of the interdisciplinary composition of the class: the research paper now had students assume the role of either someone with a strong technical background or someone with policy expertise. For the collegial response, students were asked to contribute original material pertaining to their role for the research paper of their partner, who had the other role. This was meant to simulate the professional world where writers often need to seek out the different expertise of their coworkers to draft a successful document.

| Assignment Code | Professional Genre | Audience | # of stages | Peer Review | Writer's memo | Explanation of changes made | Additional learning goals of revisions |
|---|---|---|---|---|---|---|---|
| RE 1 | Scientific American News Article | General public in 1954 | 1 | No | **Now required** | Added genre analysis activity in writing lab.<br><br>Added reflective writer's memo to all assignments asking students to be reflective about their process and intentional about eliciting useful feedback from TAs and peers. | Become aware of genre conventions through analyzing models.<br><br>Build metacognitive awareness of own writing processes and awareness of writing-as-process.<br><br>Practice writerly agency; take responsibility for eliciting helpful feedback for revision. |
| RE 2 | Congressional Research Service Report | Select group of senators in 1940s | 2 (first draft, final draft) | *Enhanced* | **Now required** | Changed structure of peer response hereafter so students responded to drafts as homework and discussed together in writing lab. | Build culture of collegiality.<br><br>Begin comparing genre conventions to learn by contrast. |
| RE 3 | Congressional Research Service Report | Incoming members of congress in 2016 | 2 (first draft, final draft) | *Enhanced* | **Now required** | Same as RE 2 | Repeated practice in this particular genre. |
| *RE 4* | *Intelligence Brief using "Bottom Line Up Front" (BLUF) style -or- Scientific American News Article* | *Members of the National Counterterrorism Center -or- General public in 2016* | **3 (pre-draft, first draft, final draft)** | **Enhanced** | **Now required** | Gave students a choice between the prompts that were originally RE4&RE5. Revised both prompts to put more impetus for content creation on students.<br><br>Added a prewriting task and had students cowrite the rubric content for their chosen paper in teams. Had students respond to a peer who wrote on the prompt they did not, using the student-created rubrics. | Introduce aspects of choice in content and venue exercised by professional writers have and introduce planning processes professional writers might utilize.<br><br>Compare and contrast genres to build genre flexibility.<br><br>Sustain focus and valuing of peer response as collegial learning tool. |
| **Research Paper** | **Bulletin of Atomic Scientists Article** | **Readers of the Bulletin of Atomic Scientists** | 4 (proposal, **"collegial response"**, first draft, final draft) | **Collegial response** | **Now required** | Specified a professional venue and tied genre expectations to it. Introduced assignment earlier in the semester. Created new instructional materials that framed assignment in terms of purpose, process, etc. Split students into policy and technical experts to focus their writing and response. | Mimic professional processes of collegial response between area experts across fields. |

Table 3. Phys 280 Writing Assignments after participation in WAE. In the first six columns, bolded red indicates significant changes (e.g., nothing existed before), italicized blue indicates moderate changes. The last two columns identify changes and additional learning goals.

## V. Potential for Uptake Across Contexts

In this paper, we have described changes in instruction, assignment design, and response practices in a writing-intensive physics course and how they were supported by the WAE program. Here, we reflect on aspects of this work that might be effectively taken up in other contexts from two perspectives: the pedagogy of individual courses and the WAE support.

### *Suggestions for individual courses*

At the level of individual courses, several of the strategies applied here could be helpful in a wide range of STEM classes. One fundamental strategy is ensuring that the learning goals associated with a course or assignment have been articulated and explicitly communicated with students. No single course can fully develop a skill as complex and situated as writing, but any course can contribute in some way to students' development as writers. In the case presented here, uncovering the implicit learning goals led to identification and correction of disjunctions between those goals and what was being conveyed to students and assessed. Another fundamental strategy is an attention to the ***process*** of writing that spans classroom language and tasks, assignment design, and response and assessment practices. Recognizing the real time constraints faced by instructors, we pragmatically suggest reducing the number and/or length of writing assignments in favor of having students engage in thoughtful revisions and reflective writing, including student responses to feedback. Third, we believe it is critical that the assessment scheme reflects the learning goals and provide here an example of a rubric that encouraged selective, prioritized response in those areas most relevant to this course's learning goals.

As time spent responding to writing is often a major challenge, particularly with STEM instructors [11], we outline some additional suggestions that the Phys 280 staff identified as particularly productive. First, instructors should avoid point-deduction or error-finding grading schemes (which we expect were not unique to Phys 280) and adopt a rubric approach that helps structure response in relation to important overarching areas of focus. Second, instructors should adopt strategies that help students produce better final drafts by enabling teaching and learning at crucial points throughout the writing process. In Phys 280, we increased the number of "check-in" instances with students and TAs by having writing activities in the weekly writing labs, incorporated more structured peer review, and added another revision opportunity. Third, instructors should ask students to be intentional and reflective about the choices they make in their writing, for example, commenting on what they have revised for second versions of papers and providing a rationale for both the changes they did and did not make. This helps create a collegial instructional relationship between students and TAs, enabling students' agency in taking responsibility for their learning and helping focus TAs on students' concerns when responding to these papers. In Phys 280, we asked students to do this in the "writer's memo" (see sec. IV.3) for second versions of assignments.

### *Suggestions for institutional change*

Throughout this work, our experiences repeatedly emphasized the importance of transdisciplinary collaboration around the integration of writing in STEM courses. This was accomplished here through the Writing Across Engineering program for the faculty instructor and through targeted workshops and conversations about response practices and grading rubrics at weekly meetings for the course staff, and was supported through the on-going, intense engagement of the mentoring team. Our sense is that the success of this effort is due to three factors that could inform other faculty development work. First, meeting with technical faculty over an entire first semester provided faculty with extended opportunities to learn about evidence-based practices from Writing Studies, to discuss them, and to richly imagine how to apply them. WAE particularly emphasized faculty workshopping key writing assignments from their courses to provide support for developing new approaches to the assignments' design and implementation, from delivery through assessment. Second, embedded mentoring supported faculty and their course staff as they refined and implemented their new assignment approaches, now live in their classrooms with students. This approach gave instructional staff the opportunity to revisit concepts and experimental applications from the previous semester's WAE meetings, strategize their implementation in real-time, and respond to instructional questions and student needs as they arose. Third, helping technical faculty to unpack their assumptions about writing in their fields was central to developing a meta-awareness that enabled technical faculty and TAs to change their instructional practices. The new practices not only contributed to more effective and efficient teaching of writing, but also to developing students with an improved awareness of their disciplinary culture [23], [24]. In the case of Phys 280, the technical faculty selected writing practices that were suited to engineering culture. For example, peer review is an important real-world activity (e.g., in writing Congressional Research Service Reports on nuclear weapons) and attention to detail is a crucial habit of mind to succeeding in projects where such details can cost money and lives. Articulating these instructional rationales further translated into how writing assignments and their learning goals were communicated to students. Overall, we advocate for extended, transdisciplinary collaboration to improve adoption and adaption of best practices from writing studies by STEM faculty and promote STEM students' development as writers.

## VI. Conclusion

We have described how the WAE program fostered and supported improvements to the writing instruction of a writing-intensive physics course. Through examining existing assessment practices and TA reflections on them, a key disconnect was identified between the Phys 280 writing learning goals and the details of instructional practice before WAE. A new grading scheme, in particular new rubrics (Fig. 1), was introduced by the WAE mentorship to replace the previously used point-deduction system. This new scheme better aligned with the original course goals and enabled those goals to be both communicated to students and explicitly expressed in the course. Moreover, our experience was that the new grading scheme brought three main benefits: more efficient grading, more meaningful feedback for both TAs and students, and better consistency between TAs. The identification of these benefits was supported by the TA reflections (see Table 2 and the appendix) and our informal observations. The creation of the new rubrics—a collaboration of WAE mentors and course staff—precipitated changes to other course elements as well. It is quite clear that the WAE program had a very substantial impact on how writing in the course was assigned, responded to, assessed, and communicated to students.

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**Appendix: TA Reflections on the Rubrics**

In this appendix we provide reflections from three of the TAs (also co-authors) on the new grading scheme. They discuss how the new rubric helped to align learning goals with practice and helped provide consistency between graders (Reflection One); how the new rubric is more efficient and process-oriented (Reflection Two); and how the new grading scheme enabled more meaningful responses and how WAE encouraged reflection on the grading practices (Reflection Three).

Reflection One:

*The new rubrics help guide my grading by providing a structure to assess if the students are meeting specific goals for each essay. Before, papers were graded using a list of point deductions; these point deductions were primarily focused on paper formatting and grammar, not the content of the essay. The incorporation of the new rubrics has shifted the focus of my grading away from minor grammar errors and towards the content of the essay. Rubric categories such as "coverage of issues and information" and "explanation and argument" help me assess the student's ability to accurately convey the necessary information and give me a space to address any concerns. The "conformity to convention" and "professional style" categories still allow for the addressing of any formatting or syntax errors, but in a way that is more constructive than the point deductions I used previously. The new rubrics have aligned the grading of these papers with the goal of the class: to improve the students' technical writing ability.*

*Apart from formatting, the previous point deduction scheme did not explicitly outline the goals for each essay. This meant that I had to come up with my own content objectives that each writer should be meeting. Each TA also had to do this on their own, leading to six different grading schemes. For instance, some TAs would take off for use of the passive voice, where other TAs would not. This led to confusion and aggravation between the students, which caused arguments about grades between students and TAs. The introduction of the new rubrics helped guide my grading, eliminating the need for me or the other TAs to create independent goals to grade from. This made grading a much less laborious task for me and I feel more confident in my grading using the new rubrics.*

Reflection Two:

*As a whole, I believe the new rubrics are more efficient and better reflect the learning objectives of the course. The implementation of the new rubric gave me more freedom in assigning points per "Feature". With the old rubrics, I was required to justify each point deducted from a student's paper. This led to an inefficient tally system that was less focused on the student's ability to write a cohesive technical paper and instead was weighted toward whether or not correct punctuation, font, and spelling where used. When using the new topics, "Coverage of issues and information", "Precise and accurate use of concepts", and "Explanation and argument", I felt that I was better able to evaluate the student's technical writing capacity as a whole, rather than if they were able to stick to particular conventions. The remaining topics of "Professional style", "Conformity to convention", and "Copy editing" are more in line with the* *focus of previous rubrics. I feel that the grading of these three topics is also more efficient now. I am no longer required to show students every instance that resulted in a deduction on their paper. An added benefit of this is that students cannot simply correct each marked error and expect a full grade on the revision of their paper. The intention is that they now critically reread their first draft and make changes on their own in order to receive full credit. I believe the new rubrics also provided some other benefits. I now am able to give the students a more structured feedback mechanism, rather than less focused comments dispersed throughout their paper. The new rubrics are also able to evolve with the TA's teaching experiences. New issues can be adequately addressed by including them in the appropriate "Feature", rather than making a new deduction bullet point. I believe the "Feature" system also helps the students to better gauge what areas of technical writing they are least proficient at.*

Reflection Three:

*With the new rubrics I feel that my responses to student writing are more meaningful than with the point deduction sheets. Before I was so frustrated by how much time and effort I would put in to finding instances of errors, particularly formatting, but how little the students essays changed with the second version. Before it felt like I graded the essays multiple times, once for formatting, once for grammar, and then maybe a third time to actually look at content. Now the rubrics really helped structure my responses so that I focus more of my energy on assessing the content and more important writing issues, like clarity and organization. I do think I spend somewhat less time grading, but the biggest benefit to me is that now the rubrics encourage me to address true writing and content issues, not just superficial concerns like margins, etc. I think my students appreciate my feedback more as well. I noticed more substantial revisions this year, especially in RE 4, than the previous time I taught the course. I think it was particularly noticeable in RE 4 because now the students had to come up with the content themselves, unlike the previous assignments where it was pretty obvious what to write about, down to the paragraph.*

*Learning about Writing Studies practices, like selective and prioritized feedback, was also a great benefit. I am a fairly detail-oriented person so I would give lots of comments on student papers expecting them to address every single one. WAE challenged me to reflect on whether there is a limit to the amount of feedback a student can actually take up. What I realized is that there certainly is! Students may be overwhelmed by how marked up their papers are and not know how to begin to address my comments. I was basing my previous expectations on my own experience receiving feedback, but that experience is primarily receiving comments from my advisor on a draft to be published in a journal. My scenario is quite different from my students. The relationship between my advisor and me is not the same as the relationship between me and my students. Also I'm a physics grad student; they are undergrads, some with little vested interest in this class than an advanced comp fulfillment. WAE helped me step back and try to understand where my students are coming from.*