# Community College STEM Faculty Views on the Value of Writing Assignments

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## Introduction

Writing, as a pedagogical strategy, has been advocated, supported, and implemented in higher education for several decades, and its presence is on the rise. Thaiss and Porter (2010), having surveyed 2,034 postsecondary institutions, report 51% of 1,126 United States respondents have a writing program, typically called "writing across the curriculum" or "writing in the disciplines" (WAC/WID) (p. 562). This is a 33% increase over the past twenty years. Moreover, 27% percent of institutions that reported not having a WAC/WID program were planning for one (p. 541). As additional evidence of the vibrancy of WAC/WID, Thaiss and Porter (2010) report that funding for writing programs was "at the school's dime" with at most 21% of funding reported as not internal (p. 536)

This pedagogy has not been challenge-free. Though assertions regarding the effectiveness of writing are numerous, also common are assertions about the lack of evidence, in terms of large data, to support its effectiveness. For example, in Ackerman (1993) a review of thirty-five studies does not find "empirical validation of writing as a mode of learning" (p. 334). More recently, in a meta-analysis of forty-eight writing-to-learn treatments Bangert-Drowns et al. (2004) report that "writing can have a small positive impact" compared to conventional instruction. In their review of learning techniques, Dunlosky et al. (2013) rate summary writing as an overall low-utility technique. Sprigel and Delaney (2014) report they found no evidence that summary writing is more effective than restudying. More narrowly focused on the performance of calculus students, Porter and Masingila (2000) associate a positive impact with writing but could not determine if the difference is attributable to writing itself or to the additional time-on-task.

In addition to the financial cost of running a writing program, implementation can be resource intensive for both instructor and student, and both parties often need a degree of persuasion in order to engage. Faculty has often been reported as skeptical and resistant with regard to writing assignments (McLeod & Miraglia, 1997; Zhu, 2004; Salem and Jones, 2010). The time required to make, write, comment on, revise, and grade a typical writing assignment makes it an inefficient tool. Among science, technology, engineering and mathematics (STEM) departments, writing faces

additional challenges. The fact is, STEM fields use considerably less writing than other fields do. More so, writing is typically associated with staples such as the essay or the term paper that are common in the humanities but not common in STEM. The association is traditional but can be evidenced by the dimensions of writing rubrics, which can serve as operational definitions of writing. This association contributes to the perception that STEM may not be the best place to practice writing.

It is difficult to measure the impact these challenges have on the acceptance of writing pedagogy across fields. At least for mathematics, data from the Conference Board of the Mathematical Sciences, CBMS (2010), suggest low usage of writing. CBMS (2010) reports mathematics enrollment accounting for more than 25% of course enrollment in four-year colleges and close to 30% in two-year colleges. A large majority of these courses are below the calculus level. Yet, only about 16% of sections, for four-year schools, report including writing assignments in the instructional methods. Accordingly, at least one in five undergraduate courses are essentially writing-free. There is evidence that brief writing segments focusing on communicating knowledge about the material can reinforce learning (Bangert-Drowns et al., 2004). Such assignments could also benefit students' communication and writing skills, and if the purpose of writing were narrowed to communicating concepts, we believe writing assignments would have wider acceptance.

## Purpose of the Study

The purpose of this study is to investigate how STEM faculty, at a large urban community college, value writing assignments as a pedagogical tool and to examine their practices regarding such assignments. Literature shows there are several, widely relevant factors that make it important to know the positions of practitioners wherever WAC is implemented. Among these factors are:

- The pedagogy's potential to impact large numbers of students: the impact can be positive, if indeed writing can be used effectively, and negative otherwise. At our school, in Spring 2015, over 2,000 students were enrolled in WI STEM courses. Given the rise of WAC/WID (Thaiss & Porter 2010), such large enrollments are likely not limited to our school.
- The potential for negative impact increases with underprepared students. At our school, 70% of incoming freshmen require at least one remedial course (reading, writing, or mathematics), and the national picture, for community colleges, is similar (Bailey et al., 2010). Attrition rates, for mathematics in particular, are very high with negative consequences towards graduation rates (Bailey et al., 2010). If writing can be effective towards learning mathematics at all levels, we need to articulate measurable implementations lest we risk unnecessarily adding to the load of students who are already at risk.

- Practitioners provide important information on what works and their support is critical to the success of any pedagogical model (McLeod & Miraglia, 1997). Given the conflicting evidence regarding the efficacy of writing assignments, knowing what STEM faculty value can help toward a more effective pedagogy that is easier to adopt.

STEM instructors were invited to participate in an online questionnaire and express their views on the effectiveness of writing assignments as teaching and learning aids. Participants were asked to indicate agreement, using a 1-5 Likert Scale, with claims in the literature, as found for instance in Ackerman (1993), regarding benefits of writing assignments as experienced in their STEM courses, and the extent to which such benefits should serve as a primary goal of writing assignments in STEM courses. Additional questions addressed both views and practices on the amount and frequency of writing and also components of the writing-intensive paradigm, such as revision, peer review, low-stakes writing and high-stakes writing.

Each department has courses with the designation WI ("writing intensive"). These courses follow the college's guidelines on WAC/WID pedagogy and have a required writing component, which is weighted significantly in the calculation of the course grade. The college requires a minimum of two WI courses for graduation. Instructors who teach WI courses have completed a related workshop with general guidelines on the nature of the writing component.

Participants in this study self-identified either as "having WI experience," i.e., had taught a WI course, or not. Instructors with WI experience were also asked about their practices in non-WI courses. The survey was designed by the authors and revised based on comments from the school's assessment office and from supportive faculty.

Through the school's email system, STEM faculty were invited to participate in the online survey. The population of full-time STEM faculty was estimated to be at most 100. Two reminders were sent over a period of four weeks. In total, 65 invitees self-identified as STEM faculty responded to the survey. Of the 65 participants, 39 reported having WI experience at the school and 26 reported not having such experience. A total of 6 participants did not respond to all questions. Consequently, the summary results that follow use the response count for each survey item. All five STEM departments were represented: biology, chemistry, engineering, physics, and mathematics. Mathematics faculty represented roughly 45% of participants with the remaining 55% distributed rather evenly among the other four departments. These ratios are consistent with the relative sizes of the departments. About 8% of all participants reported their status as part-time faculty and the remainder as full-time. Through a survey question, 26 participants volunteered for a follow-up interview. Based on comments participants made in the survey, a stratified sample of 11 was selected for interviews. The goal of the interviews was to have participants elaborate on their responses and to seek additional confirmation that closed responses were interpreted correctly.

## Summary of Results

STEM instructors believe in the potential of writing assignments as indicated by the high ratings of statements in Table 1. Comparisons through Mann-Whitney tests revealed no significant differences in the ratings of these questions between faculty with WI experience and faculty without WI experience.

Table 1. Mean ratings of potential benefits of writing assignments (1 = strongly disagree; 5 = strongly agree).

| Statement | WI Experience (n = 39) | No WI Experience (n = 26) |
|---|---|---|
| WI assignments are an effective means for students to improve their writing skills | 3.74 | 3.96 |
| WI assignments are an effective means for students to learn course content | 3.62 | 3.96 |
| Note: For faculty who did not report having WI experience, the wording of the questions differed slightly from ". . . *are an effective* . . ." to ". . . *can be an effective* . . ." | | |

A majority, 66% (n = 65), of participants agreed or strongly agreed that activities other than WI assignments are as effective in helping students learn content. Alternatives offered as equally effective assignments included projects, presentations, discussions, and lab reports, most of which involve some form of writing. A majority of participants (n = 65) thought the added effort for teaching a WI course was worth the payoff, as indicated by the high ratings of statements in Table 2. No significant differences were found between the two groups on the questions of cost effectiveness through comparisons with Mann-Whitney tests.

Table 2. Mean ratings of cost effectiveness of writing assignments (1 = strongly disagree; 5 = strongly agree).

| Statement | WI Experience (n = 39) | No WI Experience (n = 26) |
|---|---|---|
| If the effort for teaching a WI course were the same as that for a non-WI course, I would prefer to teach a WI course. | 3.54 | 3.42 |
| The effect of WI assignments on students' learning justifies the amount of student effort required to complete the assignments. | 3.49 | 3.81 |
| The effect of WI assignments on students' learning justifies the effort I put to prepare and administer the assignments | 3.23 | 3.69 |

The two groups also agreed with what ought to be primary goals of writing assignments. These are summarized in Table 3. More so, there was strong agreement that these should be primary goals of writing assignments. Such goals are commonly discussed in the literature, Ackerman (1993), as potential areas of benefit from WI assignments.

Table 3. Mean ratings of primary academic goal of assignments (1 = strongly disagree; 5 = strongly agree).

| Goal | WI Experience (n = 37) | No WI Experience (n = 26) |
|---|---|---|
| Discipline-Related Writing Skills | 4.15 | 4.08 |
| Critical Thinking | 4.15 | 4.00 |
| Reinforce Class Lessons | 3.96 | 4.08 |
| Make Connections | 3.92 | 4.00 |
| Learn New Content | 3.88 | 3.81 |
| General Writing Skills | 3.46 | 3.69 |
| Research | 3.38 | 3.69 |

The one area where the two groups differed was on their ratings of students' writing skills when asked to show agreement with the following statement: "The writing skills, of students in my course(s), are adequate for the challenge of effective writing assignments." A Mann-Whitney test indicated that faculty with WI experience assessed students' writing skills significantly higher, $U = 94.5$, $p = 0.001$, $r = -0.76$, than faculty without WI experience. However, only a minority (32%) of WI faculty agreed or strongly agreed that students in WI courses had writing skills adequate for effective writing assignments.

Of those who had taught a WI course (n = 39), a majority, 57%, reported often or almost always giving revision opportunities. However, only 30% agreed that a majority of revised work showed significant improvement over the first draft. Only 6% reported using peer-review often or almost always. Revision and peer-review questions were not posed to faculty without WI experience.

### *WI Practices in Non-WI Courses*

In addition to their general views on WI assignments, participants were asked about their practices in non-WI courses. For faculty without WI experience, presumably all of their courses would have been non-WI. In non-WI courses, inclusion of a writing component is at the instructor's discretion.

Among faculty with WI experience, reporting on practices in non-WI courses was significantly different from reporting on best practices for WI courses on the amount

of writing, the number of assignments, and the percentage of each course grade allocated to the assignments. Table 4 summarizes the practices and median amount for each type of course.

Table 4. Median amounts reported by faculty with WI experience (n = 33).

| High Stakes Assignments | |
|---|---|
| Best for maximizing effect to students in WI courses | |
| Number of Assignments | 5 |
| Total Writing (pages) | 6 |
| % Course Grade | 20 |
| Use in non-WI courses | |
| Number of Assignments | 1 |
| Total Writing (pages) | 3 |
| % Course Grade | 10 |

Within WI reporting, total writing had low to moderate correlation with percentage of course grade, Spearman $\rho(31) = 0.476$, $p = 0.005$, whereas within the non-WI data these two variables were moderately correlated, Spearman $\rho(31) = 0.700$, $p = 0.001$. Faculty without WI experience were not asked for practices that would maximize the effect to students in WI courses. For non-WI courses, both groups were asked about practices mentioned in Table 5.

Table 5. Practices used in non-WI Courses on a 5-point scale (1 = "never" and 5 = "always").

| Practice | Faculty With WI experience (n = 33) | Faculty Without WI experience (n = 26) |
|---|---|---|
| Mention in Syllabus | 3.30 | 2.08 |
| Opportunity to Revise | 2.82 | 1.54 |
| Use High-Stakes | 3.09 | 2.08 |
| Use Low-Stakes | 3.12 | 2.04 |
| 40% of respondents reported low return value as a primary reason not to use writing assignments in non-WI courses. | | |

Through responses, such as "too much work," "not appropriate for the course," and "not enough value added," about 40% of participants gave low return value as a primary reason for not using writing assignments in non-WI courses. This was followed by "not enough time" at 38%.

Faculty with WI experience were not asked about these practices for their WI courses. Because of the guidelines discussed in the WI workshop, we presumed the answers regarding these practices in WI courses would be consistently "almost always." Consequently, on these variables, we could not make a direct comparison of what these faculty practices were in WI courses and what they practice in non-WI courses.

In non-WI courses, writing assignments are used at the instructor's discretion. We thought the percentage of faculty who reported low return value (see note to Table 5) as the primary reason to not use writing assignments was very high. This reporting was true for both groups of faculty and was at odds with the results in Table 2, which show high levels of agreement that writing assignments were cost effective. To explore the apparent inconsistency, we made a comparison between the reported return value of writing assignments and use of assignments in non-WI courses. For each participant, we constructed a *return value* score by averaging the participant's levels of agreement to the statements in Table 2 on the cost effectiveness of assigning writing. We also constructed a *usage* score, for each participant, by averaging the participant's reported use of low-stakes and high-stakes assignments. The scores are summarized in Table 6. A comparison of the two scores, using a Wilcoxon signed-ranks test, indicated *return value* was significantly higher than *usage* $Z = 4.23$, $p < .001$, $r = .38$. That is, faculty usage of discretionary writing is significantly lower than their reported return value of writing assignments.

Table 6.Return value and use.

| Composite Score (n=33) | mean | SD |
|---|---|---|
| Perceived "return value" of writing assignments | 3.54 | 1.09 |
| Actual use of high and low stakes writing assignments in non-WI courses | 2.62 | 1.09 |

## Discussion

This study provides further evidence of conflicting positions among faculty regarding the value of writing assignments. We found high appreciation of good writing, belief in the potential of writing to help students learn, but also found significantly lower levels of writing in courses where writing is discretionary and where low return value was the primary reason for the low levels of usage. These conflicting positions are laid over numerous calls for large-data evidence regarding the widespread effectiveness of writing and contrasting conclusions of this effectiveness in studies of smaller scale. Identifying and addressing conflicting positions are important elements for arriving at a model that optimizes the effectiveness of writing assignments.

Participants reported low use of writing in discretionary cases coupled with low return value as the most frequent reason reported for such low use. This is contrary to the highly rated potential and cost-effectiveness of assignments in WI courses. It is reasonable for writing to have a stronger presence in WI courses. However, given that questions were phrased in terms of maximizing benefit to students, it would also be reasonable to expect comparable levels of writing in non-WI courses. Although we do not have strong evidence to support or refute an explanation for the discrepancy, below we offer several possibilities.

*Workshop Influence*

It is possible that guidelines and training of the WAC workshop offered at the school had influence on responses pertaining to questions about WI courses. There is evidence in favor and against this explanation. For example, responses aligned with workshop recommendations on use of revision and the percentage of grade assigned to writing but differed significantly from the workshop-recommended ten pages of writing.

*Speculative and Self-assessment Questions*

Questions pertaining to WI courses had a speculative and self-assessment aspect. For example, asking whether assignments in WI courses help students learn course content is asking for an assessment of one's own effort, and asking for the number of pages of writing to optimize effectiveness is asking for a speculation. It would be surprising to see faculty give low ratings to work in which they engage, particularly when no conclusive evidence exists on the lack of positive impact by WI assignments. In contrast, questions pertaining to non-WI courses were more factual—e.g., "do you use low stakes in non-WI?"—and for these questions it is easier to have more accurate ratings.

*Program Assessment*

Ratings for questions on the effectiveness of assignments in WI courses can be seen as indirect assessment of the school's WAC program. This is a university-wide initiative spanning over twenty years. Similarly to the previous possibility, high ratings may be expected on these questions partly because they can be seen as ratings of a group effort. Each respondent is a member of the group, both as a faculty member and as WI-certified, and it may be more difficult to give low ratings to one's own effort.

The very fact that there are WI and non-WI courses shows writing assignments are not placed uniformly across the curriculum. The rationale used to determine which courses receive WI designation may help explain the discrepancy that we found.

*Writing Where It Is Most Effective*

Another possibility, that could help explain the discrepancy, is that writing is indeed better-suited for courses that are designated as WI. This possibility would explain and justify higher usage and higher return value of writing in WI courses. However, this interpretation begs the question, "What criteria would make a course better suited for WI?" Accepting this interpretation would require reviewing the claim that every course stands to benefit more or less equally from writing.

*Writing Where It is Least Disruptive*

Similar to the previous interpretation, the low use of writing in non-WI courses may be due to the reasoning on which courses were initially designated as WI. A cursory search of several schools, as well as our school, suggests higher-level and for-majors courses are designated as WI at a much lower rate than introductory courses or courses for non-majors. This suggests writing is not thought of as equally suitable and used in courses where some reduction in content coverage may be acceptable.

*Validation of Past Reasoning*

Another possibility, which may help explain the discrepancy, is validation of a prior reasoning process. Among the participants were faculty who, over the years, helped their departments identify which courses to designate as WI. The designation was based on some criteria. The discrepancy found in the present study may be seen, at least in part, as an indirect validation of those criteria.

In additional findings, respondents to this survey offered alternative activities as equally effective equivalents to writing. This is consistent with other findings and theoretical reports on active learning, which position writing as one tool among many equal alternatives, e.g., verbal communication and collaboration. (Bullock Report, 1975; Penrose, 1992; Spirgel and Delaney, 2014; Bangert-Drowns et al., 2004; & Dunlosky et al., 2012.) However, the alternative activities offered in this study involved some form of writing. There is some inconsistency in suggesting poster presentation as an alternative to writing. We think this in part due to writing, as an academic task, being associated more with the essay or the term paper. These are not as common in STEM and particularly in mathematics. Such an association would reduce the perceived relevance of writing in STEM and could deter faculty from using it frequently.

Consistent with the schools' remediation needs, participants did not think students' writing skills were adequate for assignments to be effective. However, in relation to writing practices, a low skill level can be cause for concern because writing assignments have been reported as potentially counterproductive for low-skilled

writers (Penrose, 1992; Bangert-Drowns et al., 2004.) The majority of our writers need improvement at the paragraph level before addressing the level of an article or report.

The low use of discretionary writing is consistent with reported skepticism regarding the effectiveness of the pedagogy and the appropriateness of having "non-writing" faculty give writing instruction. Ground for such skepticism is provided by the lack of large-data support, particularly after decades of implementing the pedagogy; evidence that other treatments can be as effective as, or more effective than, writing; reports on writing's weak effects and in cases potentially negative effects; associations of writing with the essay or term paper; and the overhead required in implementing writing assignments. However, the perfect need not be the enemy of the good, and a case can be made for writing in early STEM courses.

A form of writing, focusing on effective communication of content, seems well suited to help students succeed. Yet, writing has not found wide acceptance as a pedagogical tool in STEM (CBMS, 2010). Algebra, for example, the mathematics course with the highest registration and notorious for high attrition rates, rarely gets a WI designation. We think one reason for the low levels of WI designation is that WAC pedagogy is presented mostly through the humanities lens, leading to faculty perceiving writing as a task of low relevance in STEM instruction. STEM is consistently part of the WAC/WID discussion, yet, we find the discussion pertaining considerably more to the humanities, with STEM, and mathematics in particular, looking for creative implementations. To quote from Fulwiler (1984), "As a group, mathematics teachers seem to have the hardest time figuring out how [WAC] workshop ideas apply to their teaching" (p. 116). Two innovative (but of uncertain scalability) approaches are discussed in Young (2011) and Bahls (2009). Young discusses a technique whereby students summarize a concept or lesson including associated difficulties they may have faced and then each exchange notes with another student, responding to each other. Bahls discusses using poetry in calculus.

To increase meaningful engagement with writing assignments among faculty, and just as importantly among students, we believe a branching and possibly rebranding of WAC/WID pedagogy is in order. This branch would target STEM-type writing and could focus on (1) writing for effective communication and (2) quantitative writing. Communicating about quantities is at the core of STEM. Therefore, writing having these foci is readily identifiable as aligning with the purpose of STEM instruction and can become an attractive pedagogy even among faculty who would be otherwise skeptical.

Clear communication regarding a concept can be stronger evidence of understanding than solving exercises is. It also makes it easier to pinpoint problem areas. Assignments having communication as the primary goal can be designed for various levels of learning. Young (2011), for example, discusses a form of *writing to*

*communicate*, in which assignments are "designed to expand and refine students' knowledge and mastery of the subject matter" (p. 47). However, as STEM content can be very dense with meaning, assignments through which students simply demonstrate their knowledge are an appropriate entry point.

Quantitative writing involves the use of quantities to explain or support a conclusion. It encompasses quantitative reasoning, another critical skill, and typically involves real or realistic data. The explanation may rely on quantities ranging from simple percentages or averages to more complex relationships between variables. Quantitative writing is discussed in the literature, for example in Wolfe (2010), Grawe and Rutz (2009), Lutsky (2008), and Miller (2007). Notably, Wolfe (2010) makes a strong argument for bringing quantitative writing to the composition classroom. Laboratory reports asking students to communicate conclusions are examples of such writing, and any course that uses statistics would abound with quantitative writing opportunities.

In traditional mathematics courses, where abstractions are more frequent than measurements, there may be proportionally fewer opportunities for quantitative writing based on data. However, we think there are still plenty of opportunities and the writing can be based on abstract quantities as well as on real data. Beginning with entry-level mathematics, there are numerous concepts with applications that are accessible to students. For example, given a mathematical model, an assignment may ask students to interpret the components of the model and support conclusions based on these components. Conversely, given a scenario with competing explanatory models, students may be asked to compare the models for feasibility.

Assignments can also be structured on concepts that may not at first seem to have clear applications. Students may be asked to explain the rationale behind the steps of a procedure, rather than just stating the steps, to compare two alternative procedures, or even to paraphrase a textbook explanation. As writing assignments, these can be complex tasks, albeit of just a few sentences. As mathematics assignments, they can reinforce students' procedural fluency and conceptual understanding. For example, evaluating log 0.0001 without a calculator may seem a tedious task. However, stating and justifying the steps requires considerable effort on the part of the writer along with knowledge of powers of ten, negative exponents, understanding the meaning of the expression log x and synthesis for a cohesive piece of communication.

A WAC branch focusing on communication and quantitative writing would differ from WID, which does address field-specific writing but is more relevant for the majors. For community college students in introductory STEM, students who will not become majors, it would probably be more beneficial to spend time on content and communication than on learning the writing nuances of a field. STEM faculty is already participating in WAC and the participation is considerable. However,

reluctance to use writing remains, as does skepticism about its effectiveness. Writing that is more easily associable with the needs of STEM instruction, particularly for underprepared non-majors as may be found at a community college, is more likely to be tried and perhaps adopted as a pedagogical tool.

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