

Use of Writing Fellows to Support an Engineering Capstone Course*

NICHOLAS S. BAKER

Department of Mechanical Engineering, University of Nevada, Reno, 1664 N. Virginia St MS 312, Reno, NV 89557, USA.
E-mail: nbaker.unr@gmail.com

WILLIAM J. MACAULEY, JR.

Department of English, University of Nevada, Reno, 1664 N. Virginia St MS 98, Reno, NV 89557, USA. E-mail: wmacauleyjr@unr.edu

EMIL J. GEIGER

Department of Mechanical Engineering, University of Nevada, Reno, 1664 N. Virginia St MS 312, Reno, NV 89557, USA.
E-mail: ejg@unr.edu

A Writing Fellows (WF) program has been implemented at the University of Nevada, Reno. The goal of the WF program is to develop targeted writing feedback and instruction for discipline-related communication that leverages existing university resources. Each WF is trained by the University Writing Center (UWC) and serves as a dedicated peer-reviewer who is able to provide constructive feedback on both the disciplinary content and communication aspects of each assignment. This paper reports the impacts of the initial WF implementation in the Mechanical Engineering capstone design course, which has been assessed using a variety of techniques. The assessment generally indicates positive results. In particular, students favor the continuation of the program and find it more helpful than group consultations within the UWC alone. This is due in part to having a WF from the same discipline engaging with students while developing professional writing skills. Self-assessment by the students indicates higher confidence in their communication skills. Preliminary analysis suggests that the writing fellow improved the scores of graded assignments by approximately one-third of a letter grade overall. Assessment efforts also highlight the need for deeper interaction between the WF and engineering faculty.

Keywords: writing; communication; fellows; capstone; engineering

1. Introduction

The ability to communicate effectively is a critical skill for engineers, and there are many reports documenting the efforts to increase the focus on communication within engineering programs [1–6]. Capstone design courses are a natural opportunity to concentrate on communication, within the context of an open design problem, due to the similarities between the writing and the design processes [7–8]. In both, an iterative approach must be pursued. As new information comes to the fore, previous work must be revisited to ensure harmony throughout the project. Individual voices must be reconciled and made one. Furthermore, there are few instances where design or communication has a single “right” answer.

Different approaches have been pursued to support the students in their writing and communication within capstone courses. At one end of the spectrum, engineering faculty have partnered with writing faculty to divide the instructional duties [9–13]. In these cases, engineering faculty typically focus on instructing the students on technical aspects of the capstone course while the writing faculty, who may come from the English depart-

ment or even be an expert in technical communication, focus on communication aspects. While this approach has been effective, it is resource-intensive and requires “buy-in” from many stakeholders across the university. At the other end of the spectrum, engineering faculty may simply rely on existing resources such as the University Writing Center (UWC) to support the educational objectives related to communication. While this approach leverages resources that are in place, the UWC is challenged to provide specialized instruction for the engineering students [14]. Therefore, this option can be less effective.

This paper will focus on the implementation of a Writing Fellows (WF) program in the Mechanical Engineering (ME) capstone design course at the University of Nevada, Reno (UNR). The WF program, a middle ground approach, uses the existing infrastructure provided by the UWC and attaches a single writing consultant, i.e. a WF, to the capstone course. This approach retains some elements of a dedicated instructor while requiring fewer resources than team-teaching. This paper provides an overview of the WF program, reports initial assessment results, and discusses the program’s successes and continuing challenges.

1.1 *The writing fellow*

The first WF program was founded at Brown University in 1982 [15, 16]. In the 30+ years since, WF programs have diversified in their focuses: wide-ranging departments and disciplines, courses with high failure rates, writing-intensive courses, and specific disciplinary writing [16]. Fellows can work to support student writers individually, support/inform faculty, and most often some combination of the two [17]. WF programs share characteristics with peer review, faculty conferencing, writing centers, supplemental instruction, teaching assistants (TAs), and writing studio courses; all of these characteristics can lead to challenges in WF implementation. While these various roles can make duties of WFs less clearly defined, they more importantly testify to the adaptability of WFs to an array of educational demands and contexts. Still, their central purpose remains stable: providing specialized support for discipline-based writing and communication skill development.

UNR's WF program has been operating since the spring semester of 2013, exhibiting generally positive interactions between WFs and students/faculty, strengthening of cross-discipline collaborative efforts related to communication skill development, and measurably improving student writing. The WF program was born out of a successful UWC that takes pride in adapting to demands and interests across the curricula. The WFs have been selected largely by the faculty members whose students the fellow will support. WFs are generally upperclassmen undergraduate students, as funding for the program is not sufficient to support post-graduate TA student salaries (in fact, a single WF's salary per semester is equal to less than half of a graduate TA's monthly salary at UNR). The fellows operate based on the needs and interests of the target faculty, students, courses, and programs. UNR has had success in matching abilities, resources, and fellows through implementation of the WF program. Obviously, the primary benefit of a WF program is better student writing. However, two other regular benefits are also worthy of note: ongoing professional development for all involved and comparatively low costs.

The use of WFs also accomplishes important programmatic goals. While the imposition of writing expectations from outside departments can often provoke resistance, WFs provide resources that disciplinary faculty can deploy in ways that make sense for their courses, students, and assignments [18]. More importantly, for the programs making use of fellows, the support is knowledgeable and resource-efficient. There are some risks inherent in WF programs as well. The seeming ambiguity of

WF responsibilities can leave the fellows vulnerable to interactions with faculty members following professor-student hierarchy rather than between co-instructors [15]. By extension, the students with whom they work can then be at some risk of misguidance, which not only does not serve the intended purposes of a WF program but also complicates them. Direct, open, and honest communication between the faculty, fellows, and directors of programs offering fellows is essential [19]. Regardless of other concerns these communications must always be held in confidence, and UNR has consistently found these conditions with WF program participants.

1.2 *Course overview*

The capstone courses within the ME department at UNR were recently changed to a two-semester sequence (ME451 and ME452) starting in the fall semester of 2011. Students typically work in teams of five on a year-long project that culminates in a spring exposition where the teams demonstrate their prototypes. To support engineering communication as one of the primary educational objectives, the students are required to report on their projects in a variety of modes:

1. **Tasks**—Throughout the fall semester, students submit 2-3 page written reports every 2–3 weeks on their progress. These reports focus on the early and middle stages of the design process.
2. **Design Reports**—At the end of the fall semester, students build on the information previously reported in the Tasks in a "Preliminary Design Report." This report is revised in February and again in May to capture their progress. These revisions are called the "Intermediate Design Report" and "Final Design Report," respectively.
3. **Oral presentations** – In the spring, the students give regular oral, team report presentations on their progress. These presentations are analogous to the written "Tasks" from the fall semester.
4. **Other communication assignments**—Throughout the year, students build a website for their project. In the spring semester, students write a business plan. Finally, students prepare a poster for the spring exposition to accompany the live demonstration of their projects.

The capstone course also fulfills and assesses key ME undergraduate curriculum objectives. The course's objectives are aligned with both departmental and accreditation requirements, and include developing student narrative structure and communication skills as major components. The WF and UWC have helped the ME capstone instructional

team facilitate student skill development in these areas. Pilot implementation of the WF within the ME capstone course occurred during the spring 2013 semester, and efforts have been made to continue its deployment each subsequent semester. The ME capstone course also implemented team mentors during the 2014–15 year who review both normally assigned Tasks and offer technical guidance through the design process. The mentors can be other engineering faculty, qualified graduate students and alumni, or local practicing engineers.

2. Writing fellow capstone integration

At UNR, WFs work much more independently and directly with faculty than traditional UWC staff. As such, their formal training focused on mindful and professional activities between students and faculty, working to understand and represent each accurately to the other. Beyond this formal training, WFs participated in ongoing training after the semester began, focusing on dealing with questions, issues, and relationships that came up as the semester continued. This was especially important since each WF worked with a different faculty member and course. Training generally took 6–8 weeks, utilizing training materials available online, received from the faculty member, and developed by senior UWC staff. As a whole, WFs were trained to support faculty writing goals and develop student abilities toward specific writing tasks, all within the context of UWC policies and best practices.

2.1 *Writing fellow responsibilities and deployment*

The “ideal” WF for the ME capstone course would be an upperclassmen/post-graduate ME student with demonstrated writing proficiency who was not enrolled in the course sequence. In many cases, finding a qualified student who exhibited these traits was not possible due to the nature of the WF recruiting process. For the ME capstone class WFs were either recruited by the primary engineering instructor and trained by the UWC or selected from the existing pool of UWC writing consultants. In all cases the WF was an undergraduate engineering student, ranging in class standing from sophomore to junior. Several of the WFs had backgrounds in technical writing as members of various academic research labs at UNR in addition to their undergraduate coursework experience. WFs met directly with the capstone faculty to understand the overarching communication skill development objectives of the course. The WF would also meet with the ME capstone faculty to discuss the specific goals and expectations for each assignment, including reviewing elements of the grading rubric as needed.

The primary responsibility of the WF was to support both the student teams and capstone faculty by providing feedback on drafts of assignments ahead of submission. Particular attention was given by the WF to elicit adaptable student writing styles and techniques, allowing students to present technical content with a clear and concise narrative. In essence, the WF was a specialized writing consultant attached to the capstone class. The student teams were required to provide a draft of their assignment to the WF at least 24 hours before their meeting. True to the nature of the WF program, the fellows would respond to both higher-order and lower-order concerns as a peer reviewer [20–23]. While the WF mostly supported the student teams with their written work, he/she could provide feedback on any of the communication assignments including oral presentations, posters, and the team website. WFs did not revise student work directly but, rather, facilitated student writing practice and skill development. Functionally, the WF was somewhat insulated from the day-to-day aspects of the class, which allowed a unique perspective on the documents under review. After each meeting the WF would write a short report documenting attendance and outcomes. The logistics of scheduling the meetings and reporting were handled through the UWC web interface. The WF was prohibited from grading. After each assignment, the WF would meet with the engineering faculty to debrief and discuss how the students responded to the assignment.

The WF program provided for approximately 50 hours of direct support each semester. Enrollments in the ME capstone sequence were 89, 69, and 103 students in the 2012–13, 2013–14, and 2014–15 academic years, respectively. Teams consisted of 5 members with 13–20 teams per semester, thus the WF could spend a maximum of approximately 3 hours with each team. The exact requirements of when the student teams would meet with the WF, for how long and for which assignments would vary based on the number and type of assignments in a given semester. Generally speaking, students were required to schedule half-hour meetings for 2–3 of the smaller assignments of their choosing and a mandatory one-hour meeting for the larger reports. For the larger reports, rough drafts would be submitted to the WF approximately 2 weeks before the due date, giving the WF sufficient time to meet with all of the groups.

2.2 *Evaluation overview*

The observations and data reported here cover the Fall 2012 (F12), Spring 2013 (S13), Fall 2013 (F13), Spring 2014 (S14), and Fall 2014 (F14) semesters of the ME capstone course. A summary of reporting semesters and mode of supplemental writing gui-

Table 1. Modes of supplemental writing guidance within the ME capstone course series by semester, Fall 2012 through Fall 2014.

Semester	Supplemental writing guidance mode(s)
F12	UWC
S13	UWC + WF
F13	UWC + WF
S14	UWC + WF
F14	UWC + team mentors

dance is given in Table 1. As previously mentioned, the WF program was initiated in S13. As such there was no WF for F12, and instead students were required to meet in groups with regular UWC staff following the frequency and meeting requirements of the WF outlined above. F12 data was collected at the beginning of the S13 semester as part of a retrospective review of course achievements. For the capstone course, a single WF was used during the S13 semester. A second WF started in the F13 semester but resigned in the middle of the semester. Another engineering student, who was already a writing consultant in the UWC, was able to assume the WF role for the remainder of the F13 semester and on through S14. Unfortunately, a WF could not be recruited and trained from either the UWC staff or the greater undergraduate engineering student body for the F14 semester. For F14, writing feedback was accomplished with a combination of peer reviews, mentor reviews, and UWC consultations.

The current assessment of the WF was accom-

plished in four ways involving the three key stakeholders in the ME capstone's WF implementation: students, faculty, and WFs themselves [19]. First, anonymous 'communication surveys' were deployed to the students via online instructional tools (Blackboard). Second, the engineering faculty informally interviewed the student teams. Third, since the student teams were able to choose which assignments they would bring to the WF meeting, the engineering faculty and graduate TA graded the assignments without knowing which submissions had input from the WF (referred to as blind grading). Finally, the WFs were asked to provide short reflective essays on their impressions and observations.

2.3 Assessment development

A summary of WF-related communication survey content is given in Table 2. The summative communication survey (SCS) was aimed at gathering both quantitative and qualitative student opinions about the WF, personal communication skill development, WF and UWC interactions, and performance of capstone faculty in implementing capstone communication curriculum at the end of each semester. A second, shorter communication survey ('formative communication survey', FCS) was deployed at the beginning of the S14 semester to establish a baseline of student opinions about their own communication skills and ways in which their interac-

Table 2. Communication survey WF-related content summary detailing questions types, descriptions, and mode of student response.

Question Type	Question Description	Response Mode
Personal Writing/ Communication Skills	<i>Q1: Before taking ME capstone, how would you rate your writing / communication skills?</i>	Likert scale 1–10 rating
	<i>Q2: After taking ME capstone, how would you rate your writing / communication skills?</i>	Likert scale 1–10 rating
	<i>Q3: What were the three top reasons that contributed to your skill improvement? What else would have helped you improve your skills further?</i>	Free response
	<i>Q4: Was your required consultation with the WF / UWC / mentor helpful? Why or why not? Did you meet in addition to your required meetings?</i>	Free response
	<i>Q5: Thinking about your interactions with the UWC and the WF, please rate the following: "Working with the WF was ___ than working with the UWC"</i>	Multiple choice ranging from "much more helpful" to "much less helpful"
	<i>Q6: What did the WF/mentor do that was the most and least helpful to the improvement in your communication skills? If the ME capstone class continues to use a WF/mentor in the future, how might we improve his or her effectiveness?</i>	Free response
WF Opinions	<i>Q7: Should the ME capstone class continue to use a WF/mentor in the future?</i>	Multiple choice ranging from "Strongly Agree" to "Strongly Disagree"
	<i>Q8: With regard to any changes made to documents you brought to the required consultation with the WF, select the statement you most strongly agree with:</i> <i>(A) The WF helped me find issues in my team's writing and offered suggestions to overcome them in the future.</i> <i>(B) The WF helped mostly with low-level writing issues and did not offer suggestions to improve my team's overall writing ability.</i> <i>(C) The WF made the changes to my team's writing without offering suggestions for future improvement.</i>	Multiple choice

tions with the WF might be enhanced over the remainder of the semester. The SCS was comprised of all questions listed in Table 2, while the FCS contained only Q1 and Q6 framed in the appropriate contexts.

Both communication surveys were revised each semester prior to deployment to further refine their scope of inquiry and evaluate any subsequent changes to the WF's role within the capstone course. This is partially because UNR's WF program is still under development. Student feedback has helped to improve both the WF program and associated communication survey questions to address new areas of insights and deficiencies.

Major revisions to the SCS included adding questions to clarify student opinions about the effectiveness of the WF relative to capstone faculty, and evaluate performance of WFs in providing high-level skill development rather than performing basic spell checking and grammatical proofreading of student work alone. Results from these questions assist in characterizing actual student communication skill improvement facilitated by the WF when coupled with blind grading results. Minor SCS revisions generally consisted of streamlining language themes for questions and removing potential response bias induced by question framing. While revisions were necessary to enhance the survey's robustness, common themes are present that allow for analysis and comparison across semesters and as a pooled UNR ME capstone student grouping.

3. Results and discussion

Although a variety of assessment methods were employed, the communication survey data was the most insightful. Overall SCS response rates were 75%, 50%, 41%, 71%, and 55% for the F12, S13,

Table 3. Communication survey individual response frequencies given by question and responding semesters.

Question	Semesters Responding	Number of Individual Responses
SCS-Q1	F12, S13, F13, S14	190
SCS-Q2	F12, S13, F13, S14	189
SCS-Q3	F12, S13, F13, S14, F14	188
SCS-Q4	F12, S13, F13, S14, F14	233
SCS-Q5	S13, S14	91
SCS-Q6	S13, S14	84
SCS-Q7	S13, S14, F14	140
SCS-Q8	S14	49
FCS-Q1	S14, F14	103
FCS-Q6	S14	15

F13, S14, and F14 semesters respectively; FCS response rates were 23% and 83% for the S14 and F14 semesters. An overview of individual communication survey response frequencies are given in Table 3.

The first two communication survey questions asked the students to evaluate their own writing or communication skills on a scale of 1–10 before (SCS-Q1) and after (SCS-Q2) taking the course. The results of SCS-Q1 and Q2 analysis indicate that ~20% more students ranked themselves at 7 or higher after taking the course as compared to their ranking before the course (Fig. 1). Interestingly, the survey responses for each semester were remarkably similar and the impact, if any, of the WF over other modes of writing support could not be discerned. An analysis to determine significance of differences in SCS Q1 and Q2 responses (or, more broadly, quantitative student assessment of general communication skill improvements facilitated by the capstone course) between semesters that utilized a WF and those without found that no statistically significant difference was observed with a minimum P-value of 0.068 (selected significance level = 0.05).

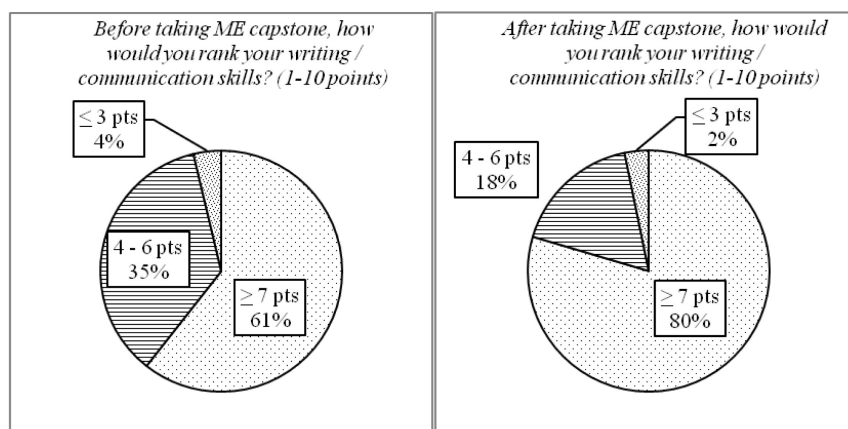


Fig. 1. Pie graphs of cumulative SCS-Q1/Q2 student response distributions showing improved self-assessed student opinions of communication skills before and after taking the ME capstone course.

This may indicate that further revisions to both the communication surveys may be needed to provide a more robust student assessment of WF effectiveness. This assertion is validated by general trends in qualitative student responses. Special attention will be given during future assessment development to evaluate the face validity of communication survey assessment instruments to ensure their questions are capable of capturing desired information without restricting the breadth of student responses or causing bias in results (similar to [24]).

When looking at the questions that were specifically about the WF, the responses were much more favorable. When asked if the ME capstone class should continue to use a WF (SCS-Q7), 69% of responders either agreed or strongly agreed while 18% disagreed or strongly disagreed. Furthermore, 77% of respondents stated that the WF was either much more helpful or somewhat more helpful than the UWC, as opposed to 7% who felt that the WF was somewhat less helpful or much less helpful (SCS-Q5). These results are encouraging and demonstrate that the students appreciated the role of the WF within the course. When asked about the nature of their interactions with the WF (SCS-Q8), 73% of responders felt the WF gave high-level insight into common writing mistakes and offered suggestions for future improvement while 27% felt the WF only offered help to correct low-level writing issues without offering suggestions to improve the student team's writing abilities; no respondents felt that the WF simply performed necessary document revisions without offering suggestions for writing skill development. Most student responses showed improvement in their writing quality. Even when they did not, their responses demonstrated increased awareness of the quality of their writing.

Several free response SCS survey questions (SCS-Q3 and Q4) asked how capstone curriculum and WF meetings helped students with their writing (if at all), as well as inviting suggestions for improvement in the WF's effectiveness (SCS-Q6). When comparing results between semesters utilizing UWC resources only and those with a dedicated WF, 88% of respondents view their interactions with the WF as helpful while 73% of respondents view UWC interactions as helpful for communication skill development (SCS-Q4). Two major positive themes emerged in student responses about the WF meetings: "[t] was good to have an outside perspective review papers," and "[the WF] understood the technical elements of the papers." The most common negative comment was some version of, "No, . . . [the WF] would more just check for grammatical errors." On the other hand, some students did value the focus on grammar. Whether positive or negative, the focus on grammar was

surprising as the WFs were instructed to focus on higher-order concerns (focus, organization, development, etc.) first, followed by lower-order concerns (sentence and word-level).

While many students found their meetings with the WF to be beneficial, suggestions for how the WF's role might be improved overwhelmingly sought deeper interaction between the Capstone instruction team and the WF to create clear-cut writing expectations for each assignment. This demonstrates a potential limitation of the WFs role as a teaching assistant who carries no grading power, as incongruities in expectations of student performance between capstone faculty and WFs may not be easily identified until multiple teams receive unexpectedly low task scores on a frequent basis after having a favorable assessment by the WF. Another suggestion involved having the WF give 1–2 lectures on common issues that occur with technical writing. Some students thought that the WF should have been a senior student or even graduate student due to the level of writing experience associated with the capstone class. Student opinions about WF qualifications are in line with those of the capstone faculty, and demonstrate a limitation of the program's funding and resultant man-hour support capacities. Despite being generally well received, an overwhelming majority of students (~90%) did not meet with the WF beyond those required by the course (Q4). Many students indicated that they would have preferred meeting with the WF more but were precluded by scheduling issues, both with the WF and within their respective teams. These results indicate that future WF implementation may require additional WFs to meet the needs of the growing capstone student body.

While no WF was utilized in the ME capstone course for the F14 semester, SCS results were obtained focusing on the roles of student team mentors to serve as a means for comparison with SCS results for semesters using WFs. F14 SCS questions about which aspect of the course contributed the most to personal student communication skill improvement and what may have helped students improve further generally indicated similar responses to those of semesters with WFs. Common positive themes contributing to student development include the use of mentors to facilitate development of professional technical writing skills, peer review of assignments prior to submission, practicing group work on engineering projects, and the available UWC resources. Common negative themes that did not aide communication skill development include perceived incongruities in communication skill expectations between UNR's dedicated engineering communications course and

the ME capstone course and a lack of feedback on communication skills within graded task rubrics; these themes offer opportunities for course improvement by the capstone faculty and are not within the purview of WF duties within the capstone course.

Similar to the UWC program, many respondents (74%) found meeting with their mentor to be beneficial. Unlike WF survey results, respondents focused on the helpfulness of the mentors' professional engineering experience to help evaluate and guide project design choices, with fewer respondents noting communication skill development aided by the mentor. Additionally, 40% of respondents indicated they met with their team's mentor beyond requirements of the course, and 74% of respondents strongly agreed or agreed that the mentor program should be continued, but investigation into the statistical significance of response differences between semesters utilizing team mentors and those with WFs could not be made due to the question's phrasing. Many suggested areas for improvement in the mentor program were also similar to those made for the WF program, including adding to the pool of mentors and increasing their availability to meet with teams, and for the capstone instruction team to clarify expectations of the mentors to improve interactions. The similarities between the mentor and WF communication survey results indicate that a happy medium may be to leverage both resources simultaneously, with mentors working to develop feasible technical aspects of student team projects and tasks, and WFs focusing on broadening higher-level student communication skills and writing style adaptability within the context of the ME capstone course.

Informal discussions between engineering faculty and student teams covered writing and communication within the context of the capstone class, including the implementation of the WF. The informal discussions supported the same conclusions gathered from the surveys regarding the WF. Additionally, students stated that the group-written reports helped ensure that the team "was on the same page" and exposed individual assumptions about the design project. In this regard, the written reports were more than just a reporting mechanism and actually contributed to the design process.

Tracking assignments that received input from the WF for the blind grading assessment only occurred during the F13 semester. A summary of average Task scores for assignments with ('WF Task score average') and without ('Group Task score average') WF input are given in Table 4. Due to a clerical error the meeting and Task summary for one team has not been accounted for in the table. There were a total of 70 Tasks sub-

mitted (5 Tasks for 14 teams), of which 15 received input from the WF. The impact of the WF was evaluated in 3 ways: a) all tasks collectively, b) each task individually for all teams, and c) each team individually for all tasks. The results of each of these calculations showed that the input of the WF helped the students by slightly better than 1/3 of a letter grade (e.g. C to C+ or B- to B, etc). Interestingly, six of the teams received their best task scores with input from the WF. Furthermore, no teams did worse after meeting with the WF.

A t-test was carried out to determine significance of the observed differences between Group Task score average and WF Task score average grades, which found the difference to be almost statistically significant (P value = 0.051, selected significance level = 0.05). While the general trends of blind grading results are encouraging, the small sample size and utilization of two different WFs in the F13 semester must be remembered. Additionally, variations in grading between the TA and faculty and changes in rubrics from task to task have not been considered. It should also be noted that the teams were allowed to resubmit one task for a re-grade. Many student teams met with the WF to review the task, and subsequently re-graded submissions were improved by approximately one and a half (1.5) letter grades. This lends support to the student's comments that the WF should work more closely with capstone faculty, as a markedly greater improvement in task grades was observed when the teams interacted with both the professor and WF as compared to the WF alone. In particular, the expectations of the faculty must be made clearer to the WF to support their roles [25].

The reflective essays provided by the three WFs provided valuable insight into strengths and weak-

Table 4. Blind grading results for Fall 2013 semester. Note a 15-point grading scale is used to assign task letter grades (i.e.—'A' range = 85–100%, 'B' range = 70–84%, etc.)

Team #	Group Task score average	WF Task score average	Group-WF Task score average delta
1	70%	80%	+10%
2	72%	78%	+6%
3	53%	56%	+2%
4	72%	81%	+9%
5	46%	47%	+1%
6	69%	74%	+5%
7	65%	71%	+6%
8	74%	83%	+8%
9	61%	70%	+9%
10	61%	83%	+22%
11	65%	73%	+8%
12	55%	63%	+8%
13	64%	69%	+5%
Column Average	64%	71%	+8%
Column Std. Dev.	8%	11%	5%

nesses of their role with the ME capstone course. All three WFs expressed that students seemed to appreciate the extra set of eyes reviewing their work; this was helpful in improving the cohesion of tasks and design reports authored by student teams. The WFs also agreed that the group discussions in their meetings facilitated the student team's abilities to reach their own conclusions while addressing the structure and purpose of each assignment. The statement of one WF, in particular, characterized these sentiments: "Engineers tend to write papers by checking boxes, rather than examining the overall reason for creating what they are writing, and I was doing my best to get that to change." The WFs also agreed that the majority of the writing issues they encountered stemmed from this linear thought process, along with a "black-and-white" approach many students applied to their reports. The WFs identified several potential areas for improvement in the future implementation of their roles, including working further on helping students develop an adaptable writing style and setting clear assignment expectations with the course instructor. Overall, the WFs were pleased with their interactions with students and believed that the skills they tried to elicit during their sessions would be useful to students in their professional lives beyond the capstone course.

4. Conclusions and future work

The instructional team's observations on the WF program are provided as a final point of discussion. In particular, it is important to note that identifying and recruiting qualified and interested candidates for the WF position has proven to be challenging. The ideal candidate should be an upper classman in ME, but should not already be in the capstone course. Of course, students from other engineering disciplines or STEM majors could also be (and were) considered. Broadening the search did not lead to a suitable candidate for the F14 semester despite the efforts of the UWC and ME faculty and staff, which leads to concerns about the sustainability of the WF program in the capstone course. This was particularly unfortunate since the F14 semester had a record high enrollment of students in the ME capstone course. Moreover, funding levels for the WFs also precluded the use of graduate teaching assistants. An additional requirement, which is perhaps more challenging to fulfill, is finding a STEM candidate that is interested and passionate about improving writing and communication. In fact, of the three WFs, the student who was already a UWC writing consultant was able to provide the best feedback to the capstone teams. This is likely due to the student's experience, but

also because the student had already expressed an interest in this type of work. On the other hand, the WF who resigned cited a misunderstanding of expectations. These two anecdotes suggest that the best candidate may actually be an existing UWC writing consultant. Unfortunately, there are typically very few, if any, writing consultants from STEM fields.

Despite the challenges of identifying WFs, the instructional team did find the services of the WFs to be helpful at a qualitative level. At the same time, the instructional team had to manage the expectations of the capstone students. For example, some teams felt entitled to better grades due to their meetings with the WFs, forcing the instructional team to reiterate that the WFs should be considered similar to tutors. In other words, the student team's work had to stand on its own regardless of the input, if any, from the WFs. This resulted in some frustration for several teams. Further investigation revealed that in some of these cases, the writing of the capstone teams was too poor for the WFs to have a significant impact given the time constraints of their meetings. This reiterates a bigger need for writing/communication skill development throughout the undergraduate engineering student's educational career.

In short, the implementation of WFs in the ME capstone course as UNR has shown qualitative signs of success, yet more work is needed to improve both the program itself and the instruments used to assess its effectiveness. From an institutional perspective, the WF program leverages existing resources from the UWC and allows for focused writing support at low costs. Student reactions to the WF have been generally positive with most students agreeing that the WF program should be continued. Early assessment on the effectiveness of the program suggests that the WFs do contribute to student learning. However, these assessment efforts have highlighted a critical aspect for improvement. Namely, the engineering faculty needs to work more closely with the WFs in communicating expectations to the students.

Recommendations for WF program implementation in engineering capstone courses at other institutions include establishing frequent interactions between the WF and instructional team to ensure expectations of student writing proficiency are fully detailed for both the overall capstone course and individual writing tasks, involving the WF in writing task rubric development to solidify performance expectations quantitatively, and identification of other pre-capstone engineering courses in the undergraduate engineering curriculum where WFs may be effectively implemented earlier in the student's educational career. Additionally, special

attention should be given to evaluate any assessment instruments used to evaluate the performance of WFs relative to capstone course writing / communication skill development objectives to ensure their validity and robustness. These areas offer opportunities for improving WF deployment, and future work will focus on using the observations of students, the capstone instruction team, and WFs to enhance the implementation of the WF program within the ME capstone course at UNR. Other areas for future work consist of determining the scope of potential future WF and team mentor deployment, refining current assessment methods, and developing writing task rubrics that capture incremental writing skill development goals capable of fulfilling overall course objectives.

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Nicholas Baker earned his B.S. in Mechanical Engineering with a minor in Statistics from the University of Nevada, Reno (UNR) in 2013. He is currently employed in the medical device industry while completing his M.Sc. in Mechanical Engineering under Dr. Geiger at UNR. Mr. Baker's research interests include engineering education and assessment, biotechnology, and renewable energy technologies. Mr. Baker is an NSF EPSCoR recipient (Summer 2012) and support member of a 2014 Curricula Development Proposal under the Nevada NASA Space Grant Consortium. Mr. Baker spends his free time enjoying the company of his wife and young daughter in the outdoors of Northern Nevada and California.

Bill Macauley received his BS from Grand Valley State University (1986), his MA from Pittsburg State University (1988), and his PhD from Indiana University of Pennsylvania (1999). Bill was hired at UNR in July of 2011 to serve as the Director of the University Writing Center and Associate Professor of English. He has taught courses in academic writing, writing for business, literature, nonfiction writing, and writing via technology, as well as writing program administration, WAC/WID, writing center theory/pedagogy, composition theory/pedagogy, community writing/publishing, and writing systems. Bill has been an editor with a number of professional journals and, along with his co-editor, Nicholas Mauriello, won the 2007

International Writing Centers Association Outstanding Scholarship Best Book Award for *Marginal Words, Marginal Work? Tutoring the Academy in the Work of Writing Centers* (The Hampton Press). His research interests include student agency in writing, writing program/center administration, and first-generation/working-class students' acquisition of academic discourse. He has been involved in a number of community projects directed toward breaking down barriers to higher education. Bill is committed to inclusive scholarship and collaboration across contexts.

Emil J. Geiger received his B.S. with Honors in Mechanical Engineering from Louisiana State University (LSU) in 2003. While at LSU, he worked as an undergraduate researcher building polymeric devices with both hot-embossing and injection molding. In 2006, he received his M.S. in Mechanical Engineering from the University of California, Berkeley. His master's work involved using plastic injection molding to encapsulate and package discrete silicon-based microfluidic components. He graduated from UC Berkeley with his Ph.D. in Mechanical Engineering in 2008. His Ph.D. research involved developing a highly-functional, polymer-based microfluidic device. From 2008–2010, he was a post-doctoral researcher at Lawrence Livermore National Laboratory. There he worked on developing polymer-based microelectrode arrays for neural applications including a retinal prosthesis. He has been with the University of Nevada, Reno since 2010, where he has been the primary capstone instructor in the ME department since 2012. His current research interests lie in developing polymer-based microsystems for biological applications.