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Volunteer Expert Readers: Drawing on the University Community to Provide Professional Feedback for Engineering Student Writers

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ABSTRACT

This paper reports on a 3-year study utilizing a novel approach to providing students in an introductory engineering course with feedback on drafts of course writing projects. In the Volunteer Expert Reader (VER) approach, students are matched with university alumni or employees who have the background to give feedback from the perspective of the target audience for their writing. Data suggest that VER can increase student engagement in engineering course writing assignments and may improve the quality of student writing. Factors most affecting successful implementation include whether student participation is required or optional and whether readers are matched with individual students or with a student team. Other factors may include the type of assignment, whether volunteers' backgrounds are a good fit for the type of writing, and whether readers can respond to student drafts in a timely fashion.

Key words: Writing, communication, feedback, alumni

INTRODUCTION

Much of the writing done by practicing engineers involves specialized, often multimodal communication skills: describing and diagramming complex equipment and processes, presenting various types of data, documenting code, arguing the merits of a new design or approach, and so on. Because such skills are not typically learned in standard composition courses, there is wide agreement that engineering programs must assume more responsibility in helping their students develop technical writing skills (Ambrose and Norman 2006; Rugarcia et al. 2000; Shuman, Besterfield-Sacre, and McGourty 2005; J. D. Ford and Riley 2003). A particularly compelling study was that of Sageev and Romanowski (2001), who surveyed engineers who had graduated and entered the workplace; responses indicate that once students enter the profession, many recognize that they did not receive adequate training in written communication. In response to these recognitions, innovative approaches to providing more occasions to practice writing have been documented in the engineering and technical communications literature, from first-year experiences through capstone projects (see for example Kryder 1999; Mahan et al. 2000; Norback et al. 2002; J. D. Ford et al. 2006). As a result of this increased commitment to writing, today's engineering graduate will likely have written considerably more prose in their engineering courses than the typical graduate thirty years ago.

The *quantity* of writing engineering students do is certainly important. Yet scholars of both writing studies and engineering education acknowledge that students also need feedback that invites serious reflection, rethinking and revision (Harris and Schaible 1997; Jerde and Taper 2004; Gottschalk and Hjortshoj 2004; McLaren and Webber 2009; Flateby and Fehr 2008; Gassman, Maher, and Timmerman 2013; Calvo and Ellis 2010). Unfortunately, the feedback engineering undergraduates receive on their writing often lacks elements widely recognized as necessary for effective writing instruction.

Feedback on student writing, commonly referred to as "response" within writing studies discourse, has been a focus of research within that field since the early 1980s. Two products of this research—Horvath's essay "The components of written response: A practical synthesis of current views" (Horvath 1984) and Anson's collection *Writing and Response (Anson 1989)*—provide a good overview of early research and scholarly perspectives on feedback in the field. Horvath emphasizes that feedback should consider the "full rhetorical situation" of the student text and "respond to it as an integrated work intent on accomplishing a certain aim—the student's intended aim—in the world." Similarly, Hunt (1989) argues in *Writing and Response* that educators need to "create situations in which student writing … is read for its meaning, for what it has to say…" In other words, students need feedback that addresses their writing as attempts to accomplish meaningful communication tasks in specific genres and contexts. The "reader-oriented" feedback these scholars promote parallels the role of feedback in the iterative design process engineers know well; by trying their hands at kinds of writing engineers do, testing out their drafts on members of the target audience, and then revising their writing in response to that feedback, students can learn to successfully *write* like engineers (Wheeler and McDonald 2000). Detailed, personalized, rhetorically oriented response continues to be identified as an essential component of effective writing pedagogy into the twenty-first century (Gibbs and Simpson 2004; Higgins, Hartley, and Skelton 2002; Lipnevich and Smith 2009). Taken as a whole, the literature suggests that receiving thoughtful, constructive responses from engaged readers is essential to students' growth as writers.

Challenges of Providing Feedback in Engineering

The integral role of feedback in the writing studies literature is mirrored in engineering education research, where statements on the importance of feedback on student writing are often accompanied by recognitions of the challenges of providing it. Gassman, Maher and Timmerman (2013) for example, recognize that students need feedback from those with adequate disciplinary expertise, yet also note that engineering faculty (those in the undergraduate setting who possess such expertise) may not “have the time or inclination for close and constant dialogue around the topic of student writing.” Similarly, Flateby and Fehr (2008) emphasize the need for “substantive feedback on students’ writing and critical thinking skills,” yet also comment that many faculty “expressed their lack of preparation to assess student writing and provide meaningful and appropriate feedback.”

In engineering programs, graduate student teaching assistants are often tasked with overseeing student writing in lower-level engineering lab courses. Yet these graduate students often have little professional experience as either producers or consumers of the kinds of writing students are asked to do. Even fewer have any relevant pedagogical training or the motivation to get such training and many are non-native speakers, lacking adequate English language proficiency. Graduate teaching assistants, therefore, cannot generally substitute for the more experienced faculty as providers of high quality “reader-oriented” feedback.

For these reasons, many engineering students do not get the quality and quantity of feedback they need to make substantial gains in their writing skills (Kryder 1999; Gordon 1997). Engineering educators have thus explored alternative sources of feedback for student writing. One obvious source is writing center tutors. Because writing centers are designed for one-on-one interaction, tutors can provide intensive and individualized consultations. However, centralized writing centers are rarely staffed with tutors who have sufficient experience with the relevant kinds of texts and writing conventions. In order to provide feedback more specifically targeted to the needs of engineering students, some schools have experimented with engineering-specific writing centers located within engineering units and staffed with tutors specially trained for working with engineering students (Walker 2000; J. D. Ford and Riley 2003).

Peers have also been studied as providers of feedback in engineering and other STEM classes, through both direct interaction and via computerized “peer review” systems (Kaufman and Schunn 2011; Brodahl, Hadjerrouit, and Hansen 2011; Yoshizawa, Terano, and Yoshikawa 2012; Calvo and Ellis 2010) with mixed success. Peer feedback has become a mainstay of process-oriented writing courses in the U.S., and through the growth of Writing Across the Curriculum and Writing in the Disciplines programs is increasingly common in writing-intensive courses in other fields. In order to accommodate the administrative burden of facilitating peer feedback in large STEM classes, some investigators have developed and studied computerized systems for managing the exchange of texts and responses. A high-profile example of this approach is the Calibrated Peer Review system developed with NSF support (Russell 2004). Others include Peerceptiv (formerly called SWoRD for Scaffolded Writing and Rewriting in the Discipline, Cho and Schunn 2007) and PRAZE (Mulder and Pearce 2007).

These systems allow instructors to set up writing tasks for students and then have peers evaluate each other's work using a rubric designed for the assignment. While such systems may have their educational uses, student inexperience and lack of motivation limit the value of such systems for rhetorically-situated writing pedagogy. In addition to the other limitations of peers, the necessarily reductive nature of the feedback tasks can discourage serious engagement and may lead to students gaming the system (Reynolds and Moskovitz 2008). Also, the intentionally (and perhaps necessarily) anonymous nature of these systems precludes dialogic interaction between reader and writer.

At its core, providing rhetorically grounded feedback on student writing is an inherently complex task. This complexity limits the availability of qualified providers, who need expert knowledge of the kind of writing students are attempting in order to comment on student texts as serious attempts at such writing. Writing center tutors and peers can play valuable roles in furthering engineering students' development as writers, and being the provider of feedback is educationally beneficial as well. Generally speaking, however, both groups lack the expertise needed to provide an authentic and accurate "readerly" response. In addition, the social constraints of the classroom context often make it difficult for undergraduates to raise substantive concerns about the writing of their peers.

In a development yet further removed from the expert feedback of instructional staff, software-based feedback systems have been implemented as a means of addressing the labor problem (Dominguez et al. 2012; Calvo and Ellis 2010; Calvo et al. 2011). Yet even the best available systems can do no more than evaluate student writing on discrete, measurable characteristics, not on the actual effectiveness of the writing. Calvo and Ellis (2010) acknowledge the challenges involved in using computerized feedback systems: "There are many difficulties in providing effective feedback in writing, even more so through using computational approaches. Among the most significant is the difficulty in identifying reliable textual features of good writing that can be implemented as a computer model." This means that software-produced feedback is necessarily reductive, tending toward what Narciss (2008) labels "outcome" (ratings of how well the attempt succeeded) rather than "elaborated" feedback. And yet, according to Narciss, "[F]eedback studies that developed elaborated feedback on the basis of thorough analyses of task requirements generally found the developed elaborated feedback types to be superior to simple outcome feedback." This should not be surprising: software cannot determine whether a passage is interesting or useful rather than obvious, whether an explanation is clear, whether a cited source adds value to what is being said, nor whether an argument is compelling or flawed. Software certainly cannot provide useful feedback on the figures, tables, and other visuals that are so essential to engineering communication. Feedback that comments on lower-level matters while ignoring the rhetorical effectiveness of the student text reinforces common misconceptions about what makes for good scientific or technical writing—even if it helps students with some sentence-level issues in standard written English.

Aside from the concerns about feedback quality, these alternatives to faculty-provided feedback share an important deficit: they lack the presence of an invested reader whose response matters to the student. When faculty members respond thoughtfully to student writing, their response not only *educates* the student but also *engages* them in the writing task. Narciss refers to this as the "motivational" function of feedback, which helps students "to maintain the level of effort, persistence, and intensity of task processing" in the face of challenges. In a way, thoughtful, personalized response from a reader is the reward for the student writer's effort. Writing pedagogies that fail to provide student writers with engaged readers have the same limitation as "cookbook" laboratory assignments—they encourage students to go through the motions with the goal of task completion, rather than nudging students toward more sophisticated understandings. Also, receiving feedback on one's writing is inherently an emotional experience—especially so for novices such as engineering students. How students *receive* feedback is therefore at least as important as how it is given. Evidence suggests that a positive relationship between the provider of feedback and the student can be a significant factor in what students learn from the feedback (Dowden, et al 2013). Many of the alternatives described above fail to build a relationship between student and reader. In some cases, the responder is kept intentionally separated and anonymous.

THE VOLUNTEER EXPERT READER APPROACH

The approach described here offers a novel way to provide at least some students with the type of feedback identified as best practice. In the Volunteer Expert Reader (VER) approach, students are matched with volunteers who are either alumni or employees of the institution and who have the professional experience (engineering and/or engineering management for this context) needed to respond to student writing as a member of the target audience. These volunteer "readers" are matched with students and guided in the exchange of drafts and feedback. Depending on the participants' physical locations and preferences, students interact with their assigned reader in person or by phone or webcam (in addition to e-mail). Students get detailed feedback from their reader in the form of written (electronic) comments and/or in person through direct conversation.

Using volunteers in this role has a number of advantages: First, unlike professors, tutors, or peers, readers can be selected on the basis of their experience with the rhetorical context of the specific course or assignment. Second, because volunteers work with only one or perhaps two students during the course of a semester, the time and mental energy they have for these interactions far surpasses what course instructors can do in a sustainable fashion. Third, the novelty of sharing their work-in-progress with professional engineers who work outside of the academic environment can increase students' engagement in course writing tasks and give them a better understanding of the importance of writing in engineering.

VER may have benefits even when engineering faculty do have the required genre knowledge and are able and willing to put in the time. According to Berkenkotter (1984) "One of the major difficulties most [teachers of writing] face is helping student writers write for a responsive audience other than the teacher-evaluator." The additional input from VER readers may help students approach course writing tasks as apprentice activities rather than merely school assignments.

Although the approach proposed here is novel, there are related interventions. In the "Lay Reader Program," developed for secondary school students in the late 1950s and early 1960s, members of a local community (primarily women with English degrees) were partnered with teachers and paid to give feedback and occasionally to grade student papers (Sauer 1961; P. M. Ford 1961). There are also published reports of using engineering professionals to support the development of student writing in engineering; however, these uses are indirect—providing genre knowledge and guidance for engineering or writing program *instructors* rather than sharing their expertise directly with students through feedback on their writing (Kryder 1999; Amare and Brammer 2005).

Note on terminology: I began developing this approach at Duke University in 2006, where it eventually acquired the name "The Duke Reader Project" (DRP or RP). Because this pilot research was conducted with Duke students, faculty, and volunteers, documentation and assessment questions refer to the opportunity and experience using this language. Results presented here preserve the language of assessment questions and participant comments that use "Reader Project" terminology. However, when referring to the approach generally, I use VER (Volunteer Expert Reader).

INTERVENTION

This study of VER was supported by an NSF grant testing various iterations of the VER approach in a number of STEM courses over a three year period. It was conducted as an exploratory series of pilots, where assessment data from one term was used to guide changes for the following term. Here I present results from three successive semesters of an introductory, design-oriented mechanical engineering course. Additional details on the implementation of VER in STEM courses and other results from this investigation can be found in Moskovitz 2014.

Course and Assignments

Data were collected for three semesters in Engineering Innovation, a preexisting introductory course for mechanical engineering majors with substantial writing assignments prior to involvement with VER. The course synopsis describes the course this way:

> Engineering Innovation introduces freshmen to the process of team-based creative conceptualization, visualization prototyping, and product realization. Students use computer-aided design tools to create custom circuit boards and computer numerically controlled (CNC) machined components to produce prototype systems. Design concepts are introduced and supported through hands-on assignments.

Engineering Innovation is designed to give students the opportunity to engage in engineering design challenges at the start of their engineering education. The applications-oriented, inquiry-based nature of the course also makes it a productive context for beginning students' training in engineering communication. During the semesters of this study, students were given four distinct design challenges during the course, each involving a communications component. Students who participated in VER worked with their readers on two of the four major course projects. In the first semester of this study, these were the "Campus Problem" assignment and the "Happy Meals" assignment. For the "Campus Problem" assignment, students were asked to identify some type of engineering-related problem on campus, locate the person responsible for oversight of that issue, conduct an interview to better understand the problem, and then propose a feasible solution in writing. For the "Happy Meals" assignment, students were to design a toy that would fit the requirements for McDonald's Happy Meals: "a new and creative toy that is fun, low-cost, and most importantly, safe for children to use." For both assignments, students were provided with detailed instructions on written deliverables. The Happy Meal assignment, for example, asked students to produce a written design report. The major sections of the document were as follows: executive summary; description of design approach and selection; toy description including technical drawings, part specifications, cost estimates, production tolerances and one-page marketing sheet; market analysis. (For details see Appendix A.) For all assignments, students worked in teams and produced a single report for their team.

As is standard practice for the Duke Reader Project, I collaborated with the instructor in the preparations needed to implement VER. This included making decisions about student-reader matching and the kind and timing of student-reader interactions, as well as articulating the rhetorical context of the VER writing tasks for participants. At Duke, we have developed two forms to support this process: "Course Information" and "Context for Student Writing." The completed forms for this course can be seen in Appendix B.

Student-Reader Matching

As part of this study, the instructor participated in a discussion of the possible advantages and disadvantages of implementation decisions, some of which would bear on the matching process. One of these decisions was whether to make student participation optional or mandatory. The presumed benefits of mandatory participation were operational simplicity and ensuring that all students received any benefits. The presumed benefits of optional participation were as follows: (1) based on prior experience with VER in other courses, students who were required to participate had lower rates of follow-through and meaningful engagement with readers; and (2) fewer volunteers would likely be needed. There were trade offs for data collections as well: requiring participation would ensure a larger set of participant data for analysis, while having non-participants would provide comparison-group data. The instructor initially teaching the course preferred to begin be trying required participation. Following analysis of assessment data after the first semester, participation was changed to optional for the following two terms.

The second major implementation decision resulted from this being a team-based project. There were two obvious matching arrangements: assigning one reader to each team or assigning individual readers for each students. The one-reader-per-team model had the advantages of needing to recruit significantly fewer volunteers and having fewer people to coordinate. The likely downside (again, based on prior experience) was decreased student-reader interaction. It was decided to experiment first with the one-reader-per-team approach: if successful, this would be more sustainable and easier to expand. Based on less-than-satisfactory assessment data, this was changed after the first term to a one-reader-per-student model.

In the Duke Reader Project, the default mechanism for locating readers each semester is by email solicitations from a standing pool of volunteers. For this course, we recruited volunteers with professional experience in engineering or engineering management. The sign-up survey included questions about prior relevant experience and whether readers would be willing to work with more than one student or group, should the need arise. (A number offered to do so.) Some readers participated for more than one term while others volunteered for a single term only.

Guiding Reader-Student Interactions

Approximately two weeks prior to the first scheduled student-reader interaction, the project coordinator for the Duke Reader Project notified students and their assigned readers of their match by email, providing each with the other's contact information and the short biographical statement participants had provided when they signed up. This email also instructed participants to schedule an introductory meeting (in person or via webcam or phone). Participants were provided with a guide for the introductory meeting, which was intended to provide an occasion for (1) participants to develop an initial relationship prior to the exchange of documents, (2) readers to clarify the timeline and expectations for their involvement, and (3) for students to get a sense of their reader's background to facilitate writing the initial draft with a better sense of audience.

For the second step, the project manager reminded students when it was time to email a copy of the draft to their readers, who were asked to provide feedback within one week. Students then revised the draft taking into account the VE reader's feedback along with any other feedback they may have received. Students were instructed to meet with their reader once again to discuss the revised draft in advance of preparing the final version of the paper.

Reader Training

The aims of providing feedback on writing for VER are not the same as those in the professional engineering workplace. VER is intended to support students' engagement in school writing tasks and help them develop their writing skills and sensibilities. In contrast, feedback on workplace writing is primarily aimed at improving the written product; if improving communication skill of the writer is a goal, it is secondary. The heavy-handed editorial corrections common in workplace settings do not tend to increase students' interest and engagement in school writing tasks, nor does it help students develop a more sophisticated understanding of effective written communication that can be applied to various future writing tasks (Berkenkotter 1984; Sommers 1982). Workplace feedback practices, then, may not be optimal for VER. Regardless of their level of professional experience (or sometimes because of it) volunteers need explicit guidance on how to give feedback in the VER context.

To provide readers with such guidance, volunteers were given a link to guidelines shown in Appendix B. These describe and encourage reader-based feedback: sharing with student authors one's reactions to the drafts considering the intention of the writing and the context for which it was written. Rather than having readers "correct" student work, these guidelines encourage readers to describe and explain the aspects of the draft they find effective and those they find to be ineffective, inappropriate to the context, or otherwise problematic—through the lens of the experienced engineer. We encourage individualized reflective comments ("I'm confused about this," "This makes sense," or "I don't see how this figure supports your claim") rather than directive comments ("change X to Y") or line editing. For making comments within documents, we explicitly discourage the use of Track Changes in favor of inserted comments. We also encourage real-time conversations for readers to discuss their reaction to student drafts in a dialogic format, rather than having students and readers merely exchange documents by email. When readers feel that specific changes are warranted, we ask that they clearly explain the reasoning behind those suggestions; such explanations increase the ability of students to learn principles they can transfer to future writing tasks.

At the start of this investigation, readers were provided with written guidelines only. To enhance their training, these were later supplemented with examples of volunteer feedback that clearly modeled reader-oriented comments.

METHODS

Data for this research were collected during the fall terms in 2011, 2012, and 2013. Data consisted primarily of responses to confidential surveys administered to students in the course and to volunteer reader participants during this period using Qualtrics online survey software. For student surveys, the instructors were asked to administer the survey in class if possible and to ask any students who were not in class that day to complete the survey out of class. Readers received the survey link by email. Data collection methods including informed consent processes were approved by the Duke University Office of Human Subjects Research.

During the first term, student participation in VER was required per preference of the instructor; for the following two terms, student participation was optional. Given the possibility that VER could be a significant benefit to students (both for the class itself and for the possible networking value beyond the course), random assignment of students to VER was deemed inappropriate and potentially detrimental to the ethos of the class. However, having some students *not* participate after the first term—even on a voluntary basis—provided the opportunity to collect comparison data. Because treatment assignment was self-selection, comparison data may be biased by the non-random allocation of more motivated students into the treatment group. Nevertheless, if interpreted with caution, such data are not without value—especially since they could reveal a lack of effect in spite of the potentially favorable bias. So for the 2012 and 2013 terms, the student survey had two major sections: The first section was for all students, whether or not they participated in VER. There was no mention of VER prior to or within this section, which asked students about their overall experience with writing during the course. The survey then bifurcated, with separate sections for VER participants and non-participants.

VER participants were asked about their VER experience, including perceived benefits and problems. For non-participants, students were queried on reasons for opting out, what they heard about VER from those who participated, and whether they would have chosen differently given what they knew about VER at the end of the term.

Given the small number of study participants and the qualitative nature of many of the survey questions, responses are evaluated only by computing means and proportions. When describing changes across the study, data are presented by study year; for presenting overall trends, data are presented in aggregate.

To supplement the surveys, the course instructor and a self-selected group of students participated in group interviews after the completion of the 2012 and 2013 terms (6 students and 8 students, respectively). During these interviews the interviewer asked a series of general questions about students experience with VER and then asked follow up questions. Questions asked about what students saw as the benefits and drawbacks of participating, as well as suggestions for future application of VER in this course. Data were collected through interviewer notes and analyzed by looking for trends related to themes emerging from survey data

RESULTS AND DISCUSSION

Participation data for students and readers are shown in Table 1. The right-hand column shows the number of volunteer readers participating each term, including the number who worked with two students rather than only one.

Numbers of student survey responses by year are shown in Table 2, including the total number of responses for the course and the number of student respondents who participated in VER.

Figure 1 presents professional biographies (supplied by the volunteers) for a sample of readers, showing both the broad range of engineering backgrounds and experiences among volunteers and the extent of professional experience they brought to their interactions with students.

Because this was an exploratory study, changes were implemented each term in response to assessment data as they were collected. Pooled data from all three semesters are presented first, followed by comparison of results from the first (2011) and last (2013) semesters to show the net effect of all changes. The major changes implemented between these terms are described below.

Pooled Data for 2011-2013

The means by which students and readers interacted is shown in Table 3. As expected, nearly all participants interacted by email, with nearly two thirds also interacting by phone and one third by

Table 1. Participation data.

YEAR	Student participation required?	Total class enrollment	Students participating in VER	Readers participating
2011	Yes	28	28 (1 reader/team)	9
2012	No	18	12	9 (3 readers doubled)
2013	No	27	20	14 (6 readers doubled)

Table 2. Student survey sample size year.

YEAR	# total responses (response rate)	# VER responses (response rate)
2011	N/A (VER required)	15 (53.6%)
2012	18 (100%)	12 (100%)
2013	24 (88.9%)	18 (90.0%)

I was a mechanical engineer and economics major at Duke and went on to work for Merrill Lynch in their Energy & Power group in investment banking for two years. I now work for a private equity firm that works with lots of entrepreneurs. I remember taking a similar class at Duke and would love to help current students.
I have been in engineering for 25 years. I have been in private consulting and have been here at Duke for the last 7-1/2 years. I am an architectural engineer by education but do most of my work with mechanical engineering.
I'm the Director of Ventures at Johns Hopkins and I work with faculty and student inventors focused on entrepreneurial projects. I have my BSE in BME and EE from Duke and a Masters in BME from UCSD.
I retired from a full-time career as an electronics designer in industrial controls, optical character recognition, aerospace computer design and medical device design, and hold 10 US patents. I have also served as consulting design engineer in my own sole proprietorship for 33 years.
I am a mechanical engineer. My background is in both design and investigation of building mechanical systems. After 13 years with an international architecture and engineering firm, I now work as a consultant providing forensic engineering services and expert witness testimony. As part of my work, I prepare a lot of presentations and reports geared to both technical and non-technical audiences.
I am a Duke engineering graduate, and, although I went in to marketing and general management quite quickly, I have always retained a love for engineering, particularly, innovation.
Background as an engineer. Currently facilitate with R&D pharmaceutical development teams to evaluate the business proposition of their program (ROI analysis) and prepare them for presentations to senior governance for money to execute their program.
Over 30 years in technical work as a systems engineer, developing new systems; additional experience as a Lean Six Sigma expert developing new and improved processes. With the Navy Reserves, I also supported a section in the Pentagon looking at technology trends and issues, looking 10-30 years into the future.
Assistant Director, Duke University Medical Center Engineering and Operations. I have done peer review for Department of Energy and also have mentored several students at the Nicholas School.

Figure 1. Example bios for volunteer readers.

Table 3. Modes of student-reader interaction showing number and proportion of students reporting each mode.

Mode of interaction	#	%
Email	25	86%
Phone	18	62%
Webcam	10	34%
Face to face	3	10%
Social Media	2	7%
Texting	0	0%

webcam. The low number of face-to-face interactions was expected since most readers resided out of town.

For student assessment surveys, both participating and nonparticipating students were asked to indicate their agreement with a series of statements relating to their experience with writing during the course (Figure 2). In response to the statement "The writing tasks were educationally beneficial" (top), participating students *strongly agreed* more often than non-participants (8 of 30 vs. 1 of 12). Results were similar for the responses regarding improvement in the paper (7 of 30 vs. 1 of 12, bottom). In response to the statement "I was engaged in the writing process" (middle), participating students strongly agreed much more often than non-participants (15 of 30 vs. 2 of 12).

Amount of Interaction

Both students and readers were asked their opinion on the amount of interaction they had with their partners (Table 4). Of 34 student responses and 21 reader responses, no participants indicated they would have preferred *less* interaction. It appears that both students and readers would like more interaction; however, because over half of student participants were happy with the amount of interaction they had, additional interaction opportunities should be optional rather than expected, so as not to overburden participants. In addition, the consistency of responses across semesters suggests that the amount of interaction is not likely a factor in improved assessment data from 2011 to 2013. It is important to note that these data do not distinguish between cases in which participants completed all intended interactions and desired even more versus those who preferred more *because* they did not or were not able to complete the intended interactions.

Conflicting Feedback

Because students received feedback on their written work from their TA and/or instructor in addition to their reader, they were asked whether they ever received conflicting feedback and, if so,

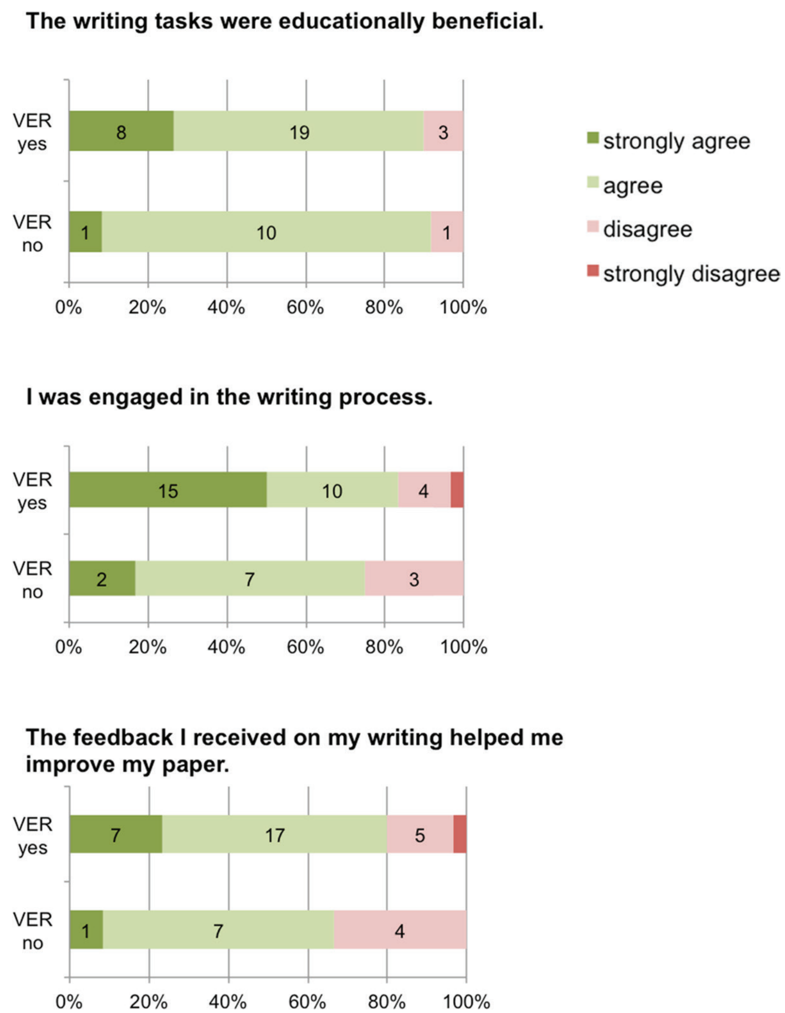

Figure 2. Student responses to the prompt: "Think about the kinds of writing you did during this course, along with the various kinds of help you received with your writing. Please rate the following statements according to your experience. Results for students who participated in VER (VER yes) and those who did not (VER no).

Table 4. Student and reader responses to the question "What are your thoughts about the amount of interaction you had with your reader/student?"

Response	Students	Readers
Would have preferred more	15 (44.1%)	7 (33.3%)
Just right	19 (55.9%)	14 (66.6%)
Would have preferred less	0	0

Privileged instructor/TA comments:

"In this instance, it was an issue of how to organize the paper. I decided to follow the advice of the instructor, because he was grading it, but kept notes on how the reader suggested to do it."

"I listened to the TA or teacher because they are the ones grading it."

"For the most part, I went with the TA feedback. While I learnt from both, ultimately I was being graded by the TA and went with his/her advice."

Privileged reader comments:

"As my reader was an expert in her field, I trusted her feedback over that of the TAs, who are essentially my peers."

"Trusted my reader over my TA"

Exercised own judgment:

"Made my own decisions."

"The graders and the reader were looking for different things in the paper: the graders looked for explanation of the approach in designing, whereas the reader focused more on the business side. I incorporated both."

"Merged them."

Figure 3. Student responses to the prompt, "Please explain how you dealt with conflicting feedback you received on your writing."

how they dealt with it. Over the three years of data collection, 14 of 45 (31.1%) indicated that they had received conflicting feedback at some point. Of those who indicated how they dealt with this conflict, data showed three types of responses, with no consistent trend:

- privileged instructor or TA comment because they determined grades,
- deferred to reader comments since they had more professional expertise, or
- considered both responses and made their own decisions based on what seemed best for each situation.

Examples of each are shown in Figure 3.

Comparative Data: 2011 vs. 2013

Between the 2011 and 2013 terms, a number of changes were made in response to assessment survey data, discussions with the instructors, and conversations with students about their experiences. Because of the need not to interfere with the course design and other learning objectives, changes were implemented when they worked with the instructors' plans—rather than systematically for optimal data collection. While it is difficult to infer causal outcomes from any of the changes individually, data do suggest that the changes were successful overall in moving the course from mixed success with VER to markedly so. Those changes are outlined here:

Structural Changes:

- Student participation: was changed from required to voluntary, with participating students getting an extended deadline on assignments as a carrot for participation.
- Reader matching: changed from matching one reader per team to one reader per student
- Changed which of the assignments involved VER

Minor Changes:

- Improved instructions for readers on how to give feedback
- Increased direct involvement on the part of the instructor in alerting students to each step of their interactions with their readers

When the matching process was changed to assign each participating student his or her own reader, students still coauthored their documents in teams. Students doing VER were instructed that they could request feedback on any or all parts of their team's document. This was important because even though teams may assign different students to draft different parts of the reports, all students were expected to assume responsibility for the entire document.

Assessment results for student participants in the 2011 and 2013 terms are compared below. Figure 4 presents student responses to a series of statements relating to perceived benefits of participation. Responses to the statement that participation "made the writing process more engaging" (top), were markedly more favorable for 2013 than 2011—with a higher proportion of "agree" and "strongly agree" responses and no "strongly disagree" responses. Nearly 80% of participating students in 2013 indicated that participation increased their engagement in the writing task. When asked whether the experience helped them write a better paper, there was again a marked shift from disagree and agree response categories (middle); in 2013, 18 of 19 participating students indicated that their work had improved as a result of the experience. Although improving understanding of course content was not a stated goal of this approach, pilot data suggested that this might be an added benefit. Results for this prompt for 2011 and 2013 (bottom) are roughly equivalent, with about half of participations reporting this benefit.

Students' overall assessment of the VER experience should take into account both the perceived benefits and any perceived costs such as extra time involved. To encourage students to reflect on the total experience, they were asked, "If you had the opportunity to participate in the Reader Project again, would you?" In the 2011 survey, 8 of 15 students responded "yes" compared with 17 of 19 students in 2013.

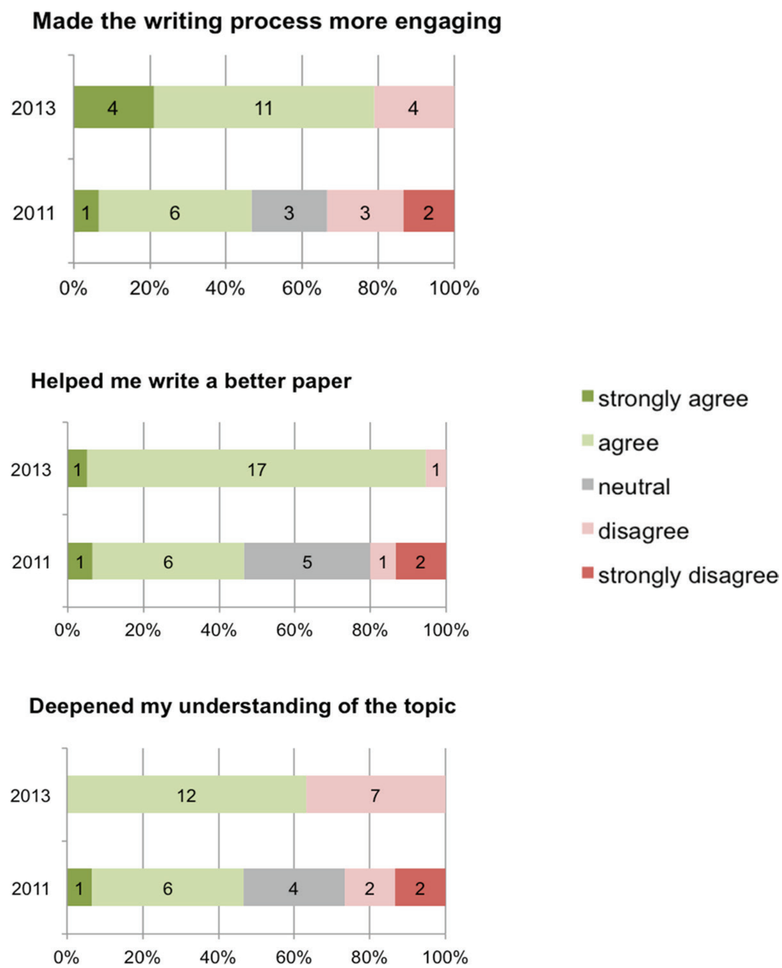

Figure 4. Students' self-reported benefits from participation.

Problems

Students were asked to reflect on undesirable aspects of the VER experience through the question "Were there any aspects of the Reader Project that you found unproductive or problematic in any way?" For 2011, 40% of participating students responded "yes" compared with 21.1% in 2013. When asked to describe these problems, most responses across all three terms reflected difficulty in getting timely feedback from readers such as these:

"Volunteer aspect made it hard to get a lot of feedback and/or interest"

"My reader was most often busy and the response time to [sic] slow to be valuable in doing drafts of a report for a college class."

Table 5. Student responses to the question "Was your instructor enthusiastic about the Reader Project?"

Answer	2011	2012	2013
Very	5 (35.7%)	4 (36.4%)	13 (68.4%)
Somewhat	9 (64.3%)	6 (54.5%)	5 (26.3%)
No	0	1 (9.1%)	1 (5.3%)

"Reader was often too busy to give feedback within a reasonable window."

These results suggest that while changes to date have been effective in improving students' overall experience, it is important to emphasize to prospective volunteers that they will need to be able to respond to drafts within a few days at most given the pacing of undergraduate assignments.

Student Assessment of Readers and Instructors

The student assessment survey also asked about students' perceptions of their reader and instructor with regard to VER. Regarding instructor enthusiasm (Table 5), results for the first two years were comparable, with about one third of students claiming their instructor was "very" enthusiastic. For 2013, the proportion of "very" responses was nearly twice that of the prior years. Because the instructor for 2013 was different than for the prior two years, these data may reflect differences in instructor personality and/or emphasis on VER in the course.

Student responses to the question "Was your reader engaged and responsive?" show modest improvement over time (Table 6). This improvement may reflect better volunteer recruiting and/or better communication with readers about their roles; however, a major factor is likely the change from one reader per group to individual matching.

Beginning in 2012, students were asked to evaluate how well their reader's background fit the needs of the writing projects for the course. As shown in Table 7, responses for 2012 were evenly split between "satisfactory" and "good" fit. In 2013, most students felt their reader was a good fit. These results correlate with students overall assessment of VER, suggesting that reader fit may be a factor in overall satisfaction with the experience.

Table 6. Student responses to the question "Was your reader engaged and responsive?"

Answer	2011	2012	2013
Very	7 (50%)	7 (63.6%)	13 (68.4%)
Somewhat	5 (35.7%)	4 (36.4%)	5 (26.3%)
No	2 (14.3%)	0	1 (5.4%)

Table 7. Student responses to the question "Considering your reader's background and experience, how good a fit was this reader for giving feedback as a member of the target audience for the assignment(s)?"

Answer	2011	2012	2013
not a good fit	-	0	0
satisfactory fit	-	5 (55.6%)	4 (44.4%)
good fit	-	6 (28.6%)	15 (71.4%)

Student Non-Participants

When student participation became optional in 2012, students who opted out were asked why they made that choice (Table 8). The most common response was that it would be too time consuming. Non-participating students were then asked, "Given what you've heard, would you participate in the Reader Project if you had another chance?" In 2012, there were 6 responses and all were negative; in 2013, there were again 6, and all responded positively. These data suggests that student participation might be increased through developing ways of better informing prospective participants about the experience of recent past participants who have had positive experiences.

INTERVIEW DATA

Interviews with students, conducted jointly with the course instructors, generally confirmed survey data, although the open-ended nature of the conversation contributed additional course-specific reflections.

Table 8. Student responses to the prompt "Why did you not participate in the Reader Project? Please check all that apply."

Response	2012	2013
I thought it would take up too much time.	5 (100%)	4 (66.6%)
I didn't understand it.	0	0
I didn't feel like I needed the additional help with my writing.	2 (40%)	0
I didn't think I would feel comfortable sharing my writing in this way.	1 (20%)	0
I wanted to, but there were not enough readers.	0	0
I didn't sign up in time.	1 (20%)	2 (33.3%)

Why Participate?

When asked about their motivation for participating, many students noted the potential benefits for their writing (no prior experience with engineering writing, wanting to learn how to write actual technical papers) and that readers could provide technical "real world" insight. What we did not expect was the number of students who were motivated by the opportunity to learn about the world of professional engineering. These students said they were hoping to get insight into the engineering life, to see what kinds of things engineers were working on, and hear how these professionals got to their current positions. Some students also admitted they were motivated by "carrots" for participating—namely extended deadlines on assignments.

Mode of Interaction

Student comments about how they interacted with readers showed differing experiences with respect to webcams in particular. Because most readers did not live near campus, meetings tended to be by phone or webcam. Those who met with readers by webcam were enthusiastic about the value of seeing their readers and suggested encouraging its use. Others, however, noted that their readers did not want to use webcams (which might be a generational difference). Students generally encouraged on-campus, face-to-face meetings whenever possible.

Feedback

There was a consensus that the turnaround time for reader feedback could be better. Students agreed that volunteers should be expected to give feedback within four days of receiving a draft, whereas our standard expectation for the Reader Project is one week. Comments related to audience awareness were generally perceived as useful, but were seen sometimes as beyond the scope of the project. Not surprisingly, students had different opinions on what they wanted from the feedback. One student, for example, would have preferred more comments on "big picture" issues rather than a focus on the prose; another would have preferred more direct comments on the text itself. There was general agreement with two suggestions for how readers should give feedback: (1) more feedback in the earlier stages of writing; and (2) have a set of questions/objectives for readers to guide giving feedback, especially to encourage readers to respond in ways that would help students apply comments to other course assignments. Finally, students encouraged the use of "think aloud responses" in which the volunteer reads the student paper aloud, pausing frequently to explain their reactions to the text. This type of response encourages attention to how well the text succeeds as a communication document and discourages random editorial comments.

Selection and Timing of Assignments for VER

Students in the 2012 interview generally agreed that VER worked better for one of the two assignments than the other. All students interviewed felt that the "Happy Meal" project was a good fit for VER. In contrast, there was a consensus that the fit was not good for the Duke Campus Problem assignment, largely because this assignment already involved interacting with people outside of the class setting and thus VER added too much complication. Also, for the 2012 term we had decided to overlap student work on projects to allow more time for students to receive feedback and revise their papers in response to VER feedback. However, students found it difficult to work on two major projects simultaneously and expressed a preference for non-overlapping projects.

Other Advice

In addition to the comments discussed above, students made a number of suggestions for future implementation of VER:

- Place more emphasis on getting to learn about the work of an engineer.
- Make assignment information available to readers.
- Readers should be within the US (time zone issues).
- Give readers and students more explicit instructions for interacting.

CHALLENGES

Clearly, a central challenge of the VER approach is soliciting volunteers who are qualified and willing to give their time in this way. While few students fully appreciate the importance of writing in engineering, experienced practitioners understand it well. This discrepancy may account for the eagerness of some volunteers, as demonstrated by these unsolicited comments from new volunteers:

> "As an engineering manager, I have had the opportunity to recruit and develop many bright young engineers over the past couple decades. It seems that only a very small fraction have the writing skills to communicate their ideas in an organized, coherent fashion."

> "Oftentimes, engineers seem to think that the calculations are all they need to be good at. My response has always been that it doesn't matter how good your idea is if you can't communicate it, and that much of the time, the people deciding whether to approve a project expenditure only understand the text, not the technical data."

The scale of this pilot was small, and volunteer solicitation was limited to the current standing volunteer pool. When reader needs were increased with the change from one-reader-per-group to one-to-one matching after the first term, we had too few volunteers and thus had to double up some readers with two students (which these readers had agreed to do if needed in their sign-up survey). We have not yet attempted to scale up to serve a significant number of our engineering students. However, it is worth noting here that when a similar shortage arose for volunteers with environmental science expertise, a single targeted invitation sent directly from the school of environmental science returned nearly one hundred volunteers. We could expect that a similar solicitation targeting engineering graduates may yield a proportional number of volunteers.

It is also important to acknowledge that aspects of the undergraduate engineering context complicate the application of VER. Some of these are true of STEM more broadly: first, many engineering students believe that they don't "like" writing, having had little exposure to serious scientific or technical discourse, and it is safe to say that few appreciate the importance of written communication within the profession. Those at the beginning of their engineering education may be uninterested or even antagonistic to anything related to writing instruction. Second, writing-intensive assignments in STEM are often team-based which makes the VER process more complicated. Third, laboratory courses are frequently the primary site for writing assignments in STEM. These are often taught by graduate students. While VER may be valuable in these settings, graduate teaching assistants are likely less adept at doing the needed coordination. Finally, for engineering in particular, it has become more common in design courses for students to interact with real-world clients on major design projects; adding VER to the mix for such courses may make things overly complicated for both students and instructors.

Limitations

Given the preliminary nature of this study, a number of limitations should be acknowledged. First, a main limitation of this research is the prevalence of confounding factors: a pedagogical intervention this intertwined with course writing and research projects cannot be studied in a controlled manner varying one parameter at a time; there are simply too many variables at play to sort out their effects with any certainty. Second, the self-reported data may be affected by recall and other biases. Third, data were collected from a single course at a single institution. Given the variability in outcomes associated with different course and assignment types I have described elsewhere (Moskovitz 2014), we could expect that outcomes would be different (possibly better or worse) for different types of engineering courses and at different institutions. Finally, students in this sample were in their first or second year of college, and all were just beginning their engineering training. Students at more advanced levels will likely have different motivations—both for the decision to participate and how they choose to engage with volunteers. For example, more advanced students may place more value in learning the craft of engineering communication as pre-professional preparation or be interested in VER for possible networking opportunities.

CONCLUSION

Writing studies scholars have long identified personalized, expert-based, reader-centered feedback as among the most effective practices for writing instruction. Yet much of the feedback received by undergraduate engineering students comes either from those without the expertise to respond authentically to the assignment or fails to take student writing seriously as attempts at meaningful communication. Such feedback does not take full advantage of the writing assignments which engineering programs have so dutifully built into their curricula. While there are structural challenges to providing extensive reader-based feedback, we should seek ways to overcome these problems when possible given the widely recognized importance of developing students' communication skills. VER is such an attempt.

This exploratory investigation suggests that VER can be a useful tool for engaging students in engineering course writing tasks. While preliminary, results suggests that feedback from members of the institution's broader community who possess engineering expertise can effectively supplement feedback students receive from others as part of their engineering training. In addition to the benefits for students, VER is good for the university community, offering alumni a way to contribute their acquired knowledge directly in service of the institution's educational mission. But data also reveal that the success of VER in any specific teaching context is highly dependent on how it is implemented. Factors particularly important for success are whether student participation is required or optional and whether students are assigned their own readers.

Not surprisingly, there are many potential avenues for future research on VER in engineering. Here are just some of the questions that might be profitably pursued:

- Does participation in VER help students develop pre-professionally in areas other than writing?
- Are upper-level students more or less likely to have productive VER experiences than are students beginning their engineering education?
- Is VER suitable for students pursuing independent research projects in engineering?
- Are students more likely to develop a productive relationship with readers who are in the subfield students plan to pursue? If so, should this be accommodated in the match process?
- Do students get proportionally greater or lesser (or different) benefits from VER experiences in more than one course?
- Do instructors' experience (or lack thereof) in non-academic engineering settings effect their willingness to employ VER or their enthusiasm for it?
- How do the benefits of VER vary between schools with different levels of selectivity into their engineering programs?
- Are the benefits of VER different for woman or minority students? Could VER have value in encouraging retention of students in these populations?

While VER shows promise in the undergraduate engineering context, it is clear that some experimentation will be required to get the maximum benefit in each course setting. While I hope that this research helps those who wish to implement VER at other institutions do so more successfully, I caution against the assumption that it can be done "right" on the first attempt. Realistically, this research should guide those implementing VER in asking the right questions and figuring out how to adjust the various parameters in order to maximize the value of VER for students in their specific course and institutional contexts.

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APPENDIX A

EXAMPLE ASSIGNMENT: Happy Meals

EGR Corp has been contacted by Fluke Toy Corp ("If it's fun – It must be a Fluke!TM"), to engage EGR121 teams on an exciting opportunity: providing a new toy design to be placed in McDonald's Happy Meals in late 2014. In particular, they wish to have a new and creative toy that is fun, low-cost, and most importantly, safe for children to use. Fluke is therefore seeking design team proposals and a verbal marketing presentation to be submitted at the prestigious upcoming "Toy Fair" event.

Toy Concept Development

Working in teams, your design challenge is to create and document a McDonald's Happy Meal toy that is fun, economical, and safe. Development requirements include:

- Toys must include at least three plastic pieces
- Parts must be designed to accommodate standard injection-molding principles
- Team must show evidence that toy is designed for efficient mass-production through
- 3D CAD modeling and basic tolerance analyses methods
- To prevent a choking hazard, each easily-separable part must be large enough to not fully fit within a 1.25" internal diameter cylinder which has a slanted bottom varying in depth between 1.00 and 2.25 inches. (A "test cylinder" meeting these specifications will be available in lab for your inspection; also see attached drawing)
- All unassembled parts together must be able to fit within a ~5" x 5" x 5" cube
- Each team-member is expected to fully design and document at least one part each
- Other parts may be added so long as any separate pieces meet choking hazard rqmt

Deliverables

Written Documentation (Memo Format):

Executive Summary

Approach Description

- Idea on techniques used and why
- Idea refinement and selection techniques used and why

Toy Description and Documentation

- Overview discussion of toy features
- Identify Critical-to-Fit/Function (CTF) dimensions
- Three-view layout drawing of each part showing basic and CTF dimensions

- Cross-section view of each part
- 3D Exploded view of toy assembly
- Part material specification(s) Estimated production costs and volume (parts/year)
- Complete Tolerance analysis of part fit for all CTF dimension
- Discussion of basic design-for-manufacturability features
- One-page "Marketing Sheet" handout showing toy sketch and illustrating key features

Marketing Analysis

- target customer/demographics: age/gender/ethnicity (US only? World-wide)
- production volume and duration - any parent-friendly features?

Conclusion

Appendix

Toy Fair Presentation

- Toy Fair Marketing Display Materials (to be determined by team)
- Toy Fair Verbal Presentation - 5-minute duration (max.)
- Marketing Sheet handout

Toy Model

- Teams will have the opportunity to download CAD files to "3D printer" to render rapid plastic prototypes of their toy concepts
- 3D Printer dimensional accuracy = 30.004 inches
- TAs will coordinate CAD file submission and 3D printer process

Note: plastic proto parts are produced on a best-effort basis and are not guaranteed. Please prepare a backup plan just in case there are production difficulties.

APPENDIX B

COURSE INFORMATION

Please answer everything you can. If you're not sure, put a question mark. We'll figure those things out together.

ABOUT THE COURSE

Course name	**Engineering Innovation**
Course number	EGR 121L
When will this course usually be offered?	Fall

ENROLLMENT

Expected class enrollment	30
Predicted enrollment breakdown (as percentages):	Freshmen: 50% Sophomore: 50% Junior: Senior:
Is student participation in the RP required or voluntary?	Required

THE WRITING ASSIGNMENT(S)

Length of paper (range):	7-15 pp
Will the first draft be completed all at once, or submitted in parts?	As a whole
Will papers be *individually written* or *coauthored*?	Coauthored
Approximately when will students be starting the paper (or first of the papers) that will be part of this project? (Approx date or number of weeks into term)	2 weeks into term

THE MATCHING PROCESS

What type(s) of background or experience would be appropriate for readers to have?	Engineering background w/ experience in management. Ideal: Also have experience in entrepreneurship (venture capital, CEO, etc.)
Do you want to be involved in the matching process? (Yes, No, unsure)	**no**
Would you be interested in helping us recruit any readers? (Yes, No, unsure) Some instructors have ideas for people they know who would be a good fit with their course. We're happy to invite them!	**no**

CONTEXT FOR STUDENT WRITING

This information is intended to help students and their Reader Project volunteers understand the rhetorical context for student writing: what kind of writing the students are doing, who would be expected to read it, and where and why a reader would normally encounter such writing.

1. For the paper they will be writing while participating in the Reader Project, my students should imagine that their final product would be:

Published in a scholarly or professional periodical such as (list up to 3): *(e.g., American Economic Review, Family Practice News, Bioscience, William and Mary Quarterly, NASA Tech Briefs)*	
Published in a venue for non-experts such as (list up to 3): *(e.g., The New Yorker, , Scientific American, CDC public health brochure)*	
A workplace document intended for... *(e.g., National Science Foundation, a project manager, the CEO)*	Management
Other	

2. Students should imagine that the primary readers of their work would be:

Experts working in fields such as (list up to 3): *(e.g., biochemistry, child psychology, civil engineering or architecture, any health sciences)*	
Professionally invested non-expert(s) such as... *(e.g., state senators, administrators, board members, members of allied fields)*	Managers, (Decision Makers) Engineers (Technical Feasibility)
Lay readers with an interest in... *(e.g., science, contemporary politics, popular music, environmental concerns, art history)*	
Other:	

3. The form of writing is conventionally called a
e.g., journal article, book review essay, policy memo, grant proposal, op-ed, design report)

(1) Project Proposal and (2) Design Report

4. In a couple of sentences, explain to students *why* a typical reader would read the kind of writing they will be doing:

Typical audience members would be evaluating a project for its potential impact, feasibility, and cost to implement. They are using the documents to perform cost/benefit analysis and determine if a particular project is worth pursuing.

APPENDIX C

FEEDBACK GUIDELINES FOR READERS

Leave the work in the student's hands. In general, editing tools such as "Track Changes" are good for collaborative writing but less-well suited to helping students become better writers, since students can be tempted to passively *accept* your suggested changes rather than deciding for themselves which changes to make. Students will learn more if you can help them *recognize* where changes are needed, rather than doing the changing *for* them.

Instead of telling the student what to do, describe your reactions to what you read. Let the student know where you can follow the ideas and where you get lost; where you're engaged and where you're bored, confused, or frustrated; where you find an argument compelling and where you're skeptical. It's fine to do this without suggesting specific changes to address those issues; in fact, that's what we expect you to do most of the time. That said, there will be many occasions where students can benefit from your advice.

Give advice where it seems warranted, but try to do so in terms of principles students can apply in the future, rather than as only fixes to specific problems in their paper. For example, instead of this: "You should insert a sentence here that says…," try this: "When I read this kind of paper, I want to see an explicit statement of the question or problem that will be addressed so I can understand where the paper is headed. Is that something you might do here?"

Let students know what's working! While you will want to let students know about difficulties you have trying to make sense of their drafts, you should also let them know what's good. These comments will encourage them to keep doing the things they're doing well. Even brief comments such as "This is clear" or "OK, I'm following you here" or "That's pretty convincing" give students valuable information.

Respect and Privacy

Many times the students are a bit nervous about sharing works-in-progress. Always keep your student's work private, and be kind as they learn this skill of receiving feedback before they have a finished product.