

Graduate Engineering Peer Review Groups: Developing Communicators and Community

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abstract

This study investigates student perspectives of graduate engineering peer review groups (PRGs). PRGs offer an ongoing supportive community for graduate students to improve their writing, presentations and posters through reciprocal discussion-based feedback. This study considers data collected through semester surveys of PRG members over five years across two large public research universities in the United States. Each group met for 1.5 hours to review 1-3 pieces of student work each week. Students noted that the groups led to both immediate (revisions on a draft) and long term (skills, habits, perspective) communication development which spanned both receptive and productive skills. They also valued that the groups helped them improve and feel more confident in giving and receiving constructive feedback through regular practice. Importance of the groups in developing local and disciplinary community in a supportive environment was also highlighted. Students found that the community, discussion, and skills they developed helped them to be better engineers and researchers, as they saw these skills and practices as key to engineering. The interconnected development of skills, products, perspective and attitude were made possible by the PRG structure and the supportive disciplinary community it represented. The group model is recommended as a low investment way to provide graduate communication support to engineering students.

1 introduction

Writing in graduate school has been acknowledged as a critical concern for students regardless of their mono- or multilingual status [1, 2] as it is an integral part of becoming a disciplinary insider [3, 4]. Writing and communication skills continue to serve engineering students beyond graduation in both academia and industry [5-10]. However, writing in graduate school is often a source of considerable anxiety and stress for students [11], fraught with isolation and unknowns [12] that can lead to feelings of fear and failure if not addressed with transparency [13]. Fortunately, writing can become less intimidating with greater transparency in expectations and text structure coupled with supportive disciplinary communities.

The support and guidance for writing need not always come from professors or courses. The present study investigates one low-cost intervention, peer review groups (PRGs), to help engineering graduate students develop confidence and overcome the isolation and unknowns associated with writing in graduate school. This study of PRGs spans five years and two universities.

The PRG model discussed here was initially developed and implemented at one of the two universities in the study in response to a university level graduate student writing needs analysis survey. Students identified group-based support as an area of interest. Graduate writing support groups were researched, and a model was adapted and implemented by the author as the first step in establishing university-wide support for graduate student writing. The groups evolved over time in response to student need.

The graduate peer review groups (PRGs) discussed here refer to the model that evolved out of these initial developments. The review structure, described below, was adapted from that previously used at Texas A&M, which was learned about through an interview with Candace Hastings during the initial information gathering stage. The grouping principles, number of groups, number of reviews, roles and sign up calendar were modified from the original and the PRGs continue in this form at both universities.

In the first year of the program, students were surveyed about their writing needs. Of the students responding to a PRG members survey (n=30) in the second semester of the program, only half indicated that they received some form of mentorship on their writing. While most of these cited their major professor as the source, the type of mentorship was most often described as editing. Some students also identified their lab mates or more advanced students in their program as mentors who could give them advice on how to write or help them navigate the process. This further suggested that the peers in their groups might also serve as natural sources of guidance on their work.

The current study focuses on later student perceptions of the PRGs with an overview of the PRGs during the study period offered to ground the later discussion of these perceptions. However, first the PRG model is presented to provide clarity to how the PRGs work and allow others to implement similar interventions at their own universities.

2 graduate peer review groups model

The PRGs are groups of 4-10 graduate students who meet weekly to review and revise work. Each group is made up of graduate students and post docs with somewhat similar research areas (or in adjacent disciplines) rather than those in the same stage of a program. This helps to build disciplinary communities with evolving membership. Students newer to programs are able to preview the types of work they will be producing in future stages of their degrees. As students advance in their programs and attend the PRG they may act as mentors for newer students. Within the PRG, members develop expertise in reviewing. As students continue in a group, some leave the group (usually due to graduation or schedule conflicts), and others join, it builds an evolving continuing supportive community. Student research areas or methods may be related, resulting in groups that cross programmatic and departmental boundaries. This often gives students a more concrete sense of audience for their work and allows them to meet others outside of their immediate lab setting. Groups meet for a minimum of one semester but most continue for much longer given the evolving membership model. The groups were developed, coordinated, and largely facilitated by the author at both universities.

The group meetings last for 1.5 hours each week and are held face-to-face in a conference room setting with a projector. Up to two students sign up by way of a shared Google doc (see Table 2.1) to present their work each week. The group calendar in the Google doc presents one semester at a time and participants can indicate their absence, add notes, sign up to bring snacks or sign up to have their work reviewed for any week. At the first meeting of the semester, each group member shares their goals for the semester. The group, often with the prompting of the facilitator, discusses timelines, possible milestones, and deadlines related to these goals. These

discussions lead to the selection of review slots based on member goals and timelines. Some slots are also left open to allow for flexibility or longer reviews. Members sometimes add information about the work they intend to present, but they only need to add their name to secure a spot. Members can add or remove their name from review slots throughout the semester and typically keep one another informed of any changes. If someone removes their name or thinks the work they have for review doesn't feel as pressing, they inform the group by email or by posting in the group's Slack channel (more recently) so that someone else can sign up.

Table 2.1 Sample PRG sign up calendar excerpt

| Absent/Late | Date | Review 1 | Review 2 | Snack or Notes |
|--------------------|-------------|-----------------------|-----------------|------------------------|
| | 3/11 | NameA- defense slides | | |
| NameA- conference | 3/18 | Name C | NameB | |
| | 3/25 | NameB | | 3MT deadline this week |

The usual weekly meetings consist of two reviews. At the start of the review, the student introduces the work, stage in writing it, where it is going, the expected audience and the type of feedback for the group to focus on. The work is usually writing, presentation, poster or figure at any stage of the process. The work is projected on the screen so that the whole group can view it together. If it is writing, line numbers are used to make it easier to reference. Usually, the student reads it aloud, paragraph-by-paragraph, pausing after each paragraph or set of paragraphs for verbal feedback from the group, depending on the focus of the feedback and type of work. The use of the projector and read-aloud keeps group members focused. The feedback is discussion-based and all activities take place within the meeting time. No work is reviewed outside of the group meeting. The group verbally gives feedback as requested by the presenter while the presenter takes notes or revises, often co-constructing these revisions with the group. The presenter may also ask the group specific questions or answer those asked by reviewers. At times, discussions refer to more generalized revision techniques and members have been seen to reference revisions from previous meetings when commenting on new papers or describing changes they had made to a paper. The facilitator also comments on the work, facilitates student-to-student communication, takes notes and finds related resources for the group.

3 setting, participants and data collection

Data was collected on the PRGs over a five-year period across two large public research universities in the United States. The first four years were collected from a university-wide PRG program while the final year was collected from an engineering school specific program at the other university. Data were pooled across the two locations for analysis and are not separated or compared by location. Only data from engineering students are analyzed in the present study.

The graduate engineering PRGs considered in the present study covered a number of engineering disciplines: chemical, aerospace, computer, biomedical, biological, civil, industrial

and systems/information engineering. One to three engineering-specific groups met each semester during the study period. Each group met weekly for 1.5 hours and reviewed 1-3 pieces of student work per meeting in a discussion-based format focused on constructive feedback and revision following the model described above.

Individual students remained in a PRG for a minimum of one semester. Often, they continued with a group for multiple semesters. Not continuing with a group typically occurred because a student left the university (e.g. graduated), had conflicting demands on their time (e.g. family responsibilities, demanding projects), or had schedule conflicts. Of the students included in the study, the maximum continuous attendance was 3 years, and the maximum span of attendance was 4 years.

During the study period, 216 reviews were documented through electronic forms-based sessions notes kept by the author during each meeting, though more reviews occurred. Individual students brought their work for review as many as 27 times. Reviews spanned a variety of types of work, but research articles (also found as thesis or dissertation chapters) were the most common, accounting for 38% of reviews that documented type of work. Proposals (17%) and presentation (16%) were the next most common types of work as see in Figure 3.1. More than a third (38%) of the 138 reviews documenting section focus centered on an introduction (see Figure 3.2), an area students often find difficult to write. The most common concerns that students sought help with were clarity, flow, and organization, as seen in Figure 3.3.

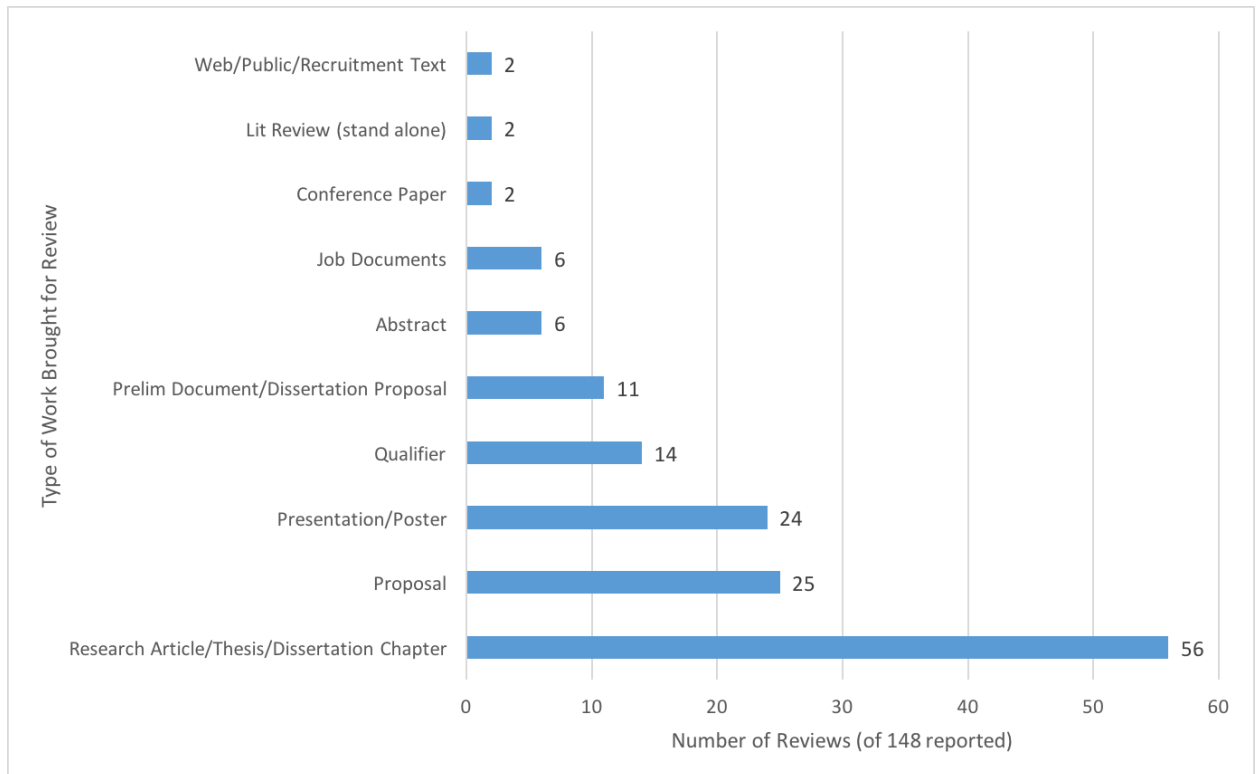


Figure 3.1 Type of work brought for review

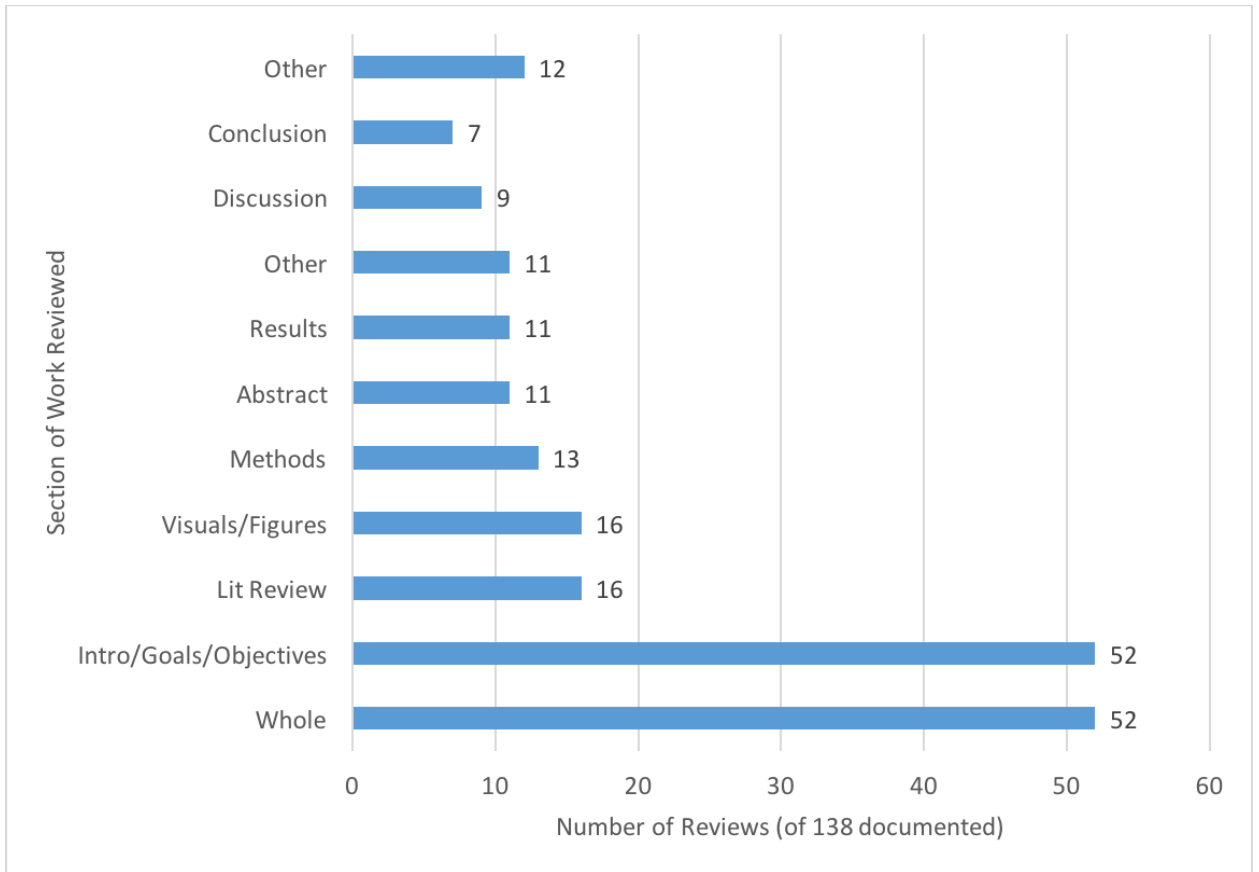


Figure 3.2 Section of work reviewed in PRG meetings

Note: More than one section could be the focus of a given review.

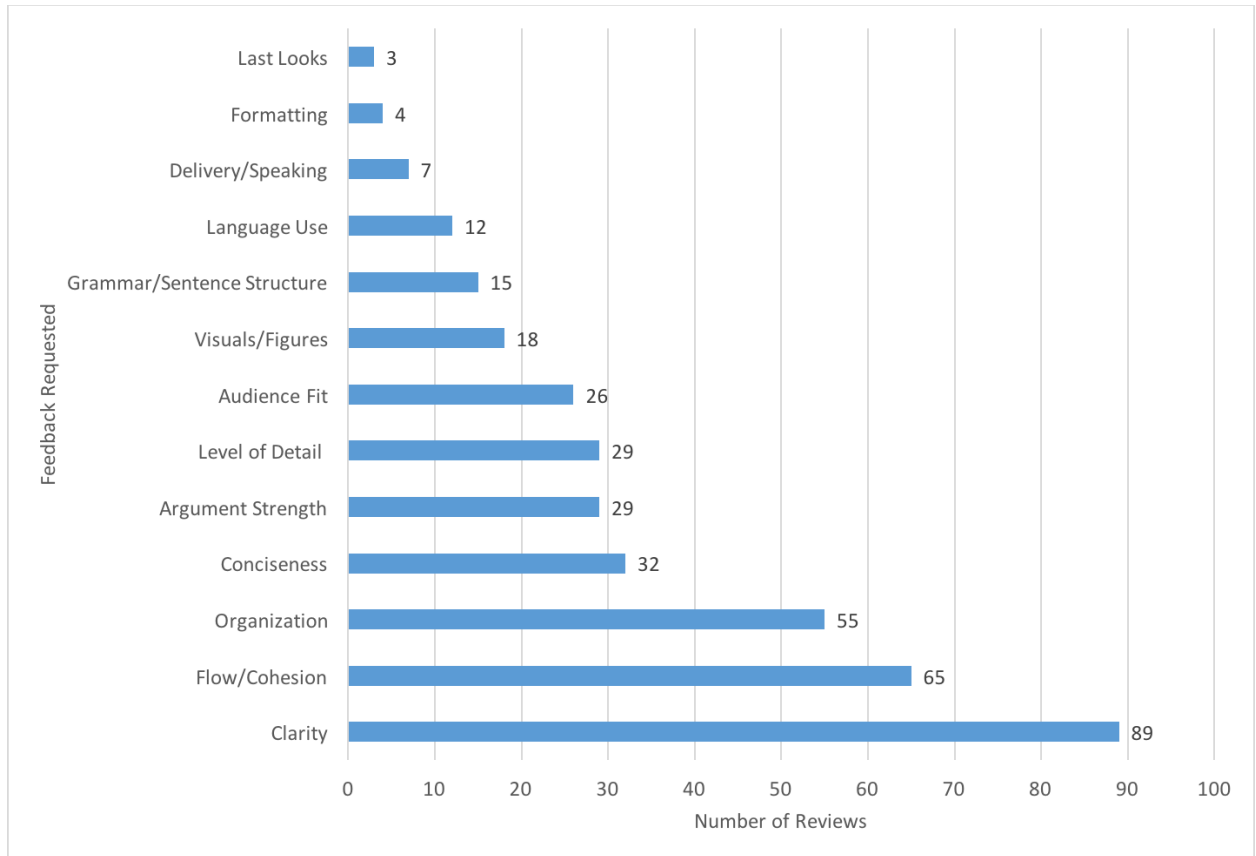


Figure 3.3 Feedback concerns across PRG reviews

Notes: Number of reviews covers 148 reviews. Out of 216 reviews with session notes, only 148 included a sortable field for feedback focus. Reviews could focus on multiple types of feedback, typically not more than 3.

At the end of every semester (fall, spring, and summer), surveys were administered to group members to gauge their perceptions of the groups, refine practices, and identify benefits for graduate students. The findings below focus on responses by engineering graduate students to open-ended questions on these surveys over a period of five years.

Responses were coded by the author in Dedoose (cloud-based qualitative research software). The initial round of coding involved in vivo coding, where responses were labeled using wording from the response, and content coding. Similar codes were linked together and nested under broader codes. Eventually through an iterative process, codes were grouped and key themes were identified.

4 findings

Analysis showed that student responses centered gains in communication development, changes in perspective, increased motivation, and development of supportive disciplinary communities as core outcomes of their participation in the PRGs.

4.1 promoting multilayered communication development

The structure of the PRGs promoted multilayered communication (writing, speaking and visual design) development amongst engineering graduate students. Group members reported not only positive immediate impacts on their work from direct feedback but that their work also improved from the feedback process. As they applied what they saw to future work, they became more aware in their writing and ultimately improved as engineering communicators. They additionally cited skill development across multiple modes of communication and types of audiences as well as confidence gains. Of common note were the benefits of not only being able to give constructive feedback but becoming accustomed to and better at receiving and applying constructive criticism. Group members described the PRG process as benefitting their communication development in multiple ways and transforming the way they thought about and approached their communication tasks.

4.1.1 improved work through multiple perspectives

Group members regularly cited the feedback they received as leading to an improved quality in their work. The feedback was denoted as good, great, helpful, useful, valuable, critical and constructive. They also cited receiving a substantial amount of feedback on their work. Students noted improvement primarily centered on clarity, organization, and flow but also described improvements at the sentence level in phrasing and grammar. These areas are consistent with the most common areas student asked for feedback on during reviews.

Group members noted that the multiple perspectives provided in the group review structure had particular value. Students reported that “peer review by a group of people allows you to receive, give, and observe many different styles of feedback,” and that “a diverse group will correct things you don't recognize”. The continued exposure to multiple perspectives helped students view their work in a new way. One student shared, “it makes me think [about] my communication in a more critical way, as different people have different points of view to the information being presented.” Students noted that the group had helped them develop audience awareness as they were “better able to anticipate how others may perceive what” they present and helped them to “think of a way to present more clearly to people in different backgrounds.”

4.1.2 growing as communicators

Students frequently noted that the PRG helped them become “more effective communicator[s].” This ranged from general statements on improving writing and presentation skills to more specifics on elements they felt they improved on or gained confidence in. More general comments noted learning from peers “how to write a paper better” or “more clearly express” their thoughts in writing or tips on academic or engineering writing. Students identified the PRG structure as specifically contributing to their development. One called the PRG “an invaluable way to improve your writing skills, both by having people evaluate your own [work] and by evaluating others’,” and went on to say that “while writing was the main focus, the PRG's could also help in this way with presentations, posters, etc.”

Students also offered more specific areas where they noticed improvement in their

communication skills. One student noted that they were more confident writing opening sentences in their research papers and were becoming “okay with cutting material and removing long sentences,” identifying a change in practice and perspective. Another noted they had developed “more effective writing skills (i.e. such as word choice and optimization),” and their “ability to have good logical flow when writing and presenting.” Flow and organization were mentioned by a number of students. One commented, “we have worked on organization quite a bit in the PRG, so I feel like that has made my presentations and papers flow better.” On a more conceptual level, a student stated that they now knew “how to build the whole article toward different purposes,” and another said they had gained an “understanding of the different contexts for work.” A few tied their progress to tangible outcomes. For instance, a student shared an accomplishment, saying, “I had a paper win a ‘Best in Conference’ award this semester, and I attribute a good part of that to PRG.” Throughout the PRGs students regularly shared such successes and cited the group’s role in helping them reach such achievements.

4.1.3 transfer & self-evaluation

Students saw their development as communicators not only in immediate terms but in their ability to transfer their new knowledge and skills to situations in the future. Students noted that the improvement in their own writing came about in part from “reviewing and listening to other people’s comments.” For instance, one student commented, “I have reviewed several papers from peers and it helped me outlining my paper.” Another student recounted how they applied their knowledge gained in the PRG, stating, “I learned to keep in mind common issues that people have when they bring their work for review. In my current writing, this forces me to resolve those issues - or identify them better on my own. One example of such issues is long sentences. Now I know to think of clever ways to break up those sentences or remove unnecessary adjectives or trailing descriptions that separate the noun from the verb.” Such transfer from common feedback was mentioned in other comments as well, such as “The PRG has helped me when doing my own writing by encouraging me to more fully consider some of the things we commonly give feedback on during the group - things like transition sentences and overall organization.”

This transfer helped students develop the ability to self-evaluate their own work as they reconsidered their own writing and presentations with the group in mind. One student commented, “talking about the process of reviewing work makes self-review easier, and also helps present a more polished first draft of materials which is good for presentation to the major professor.” Another wrote, “the act of giving feedback on the writing and presenting of others helped me to be more critical when thinking about my own work.” The development of critical self-evaluation in communication also went beyond the immediate context of creating work and helped students think about academic communication more broadly. For instance, a student stated, “I think I learned to think critically about what makes good academic writing. PRG also sparked a few conversations outside of the scheduled time about technical details of writing.” The shift in thinking about writing extended beyond the work they brought to the group as students engaged with others and critically applied what they’d learned in future situations.

4.2 developing vital skills & perspective in constructive feedback

In addition to discussing communication skills such as writing and presenting, students saw the PRGs as specifically helping them to develop vital skills in giving and receiving critical or constructive feedback. Students highlighted that “one can get just as much out of learning how to review another person’s work and articulate changes as they can get from having their own work reviewed.” Students found the process of giving feedback to be “interesting” and that it helped them “learn to take criticism and give criticism in a constructive way,” and “better give constructive criticism.” They found this to be “valuable experience” and often valued this aspect above the discrete writing skills they felt they developed. One student stated the PRG aided in “thinking about how my writing will be critically reviewed by others.”

Students noted that giving constructive feedback was something they were now able to do as a result of the PRG stating, for example, “I was also able to communicate what I thought could be improved on in other people’s work.” Students also mentioned that they gained “experience critically evaluating the writing of another scientist/engineer that does research,” in an unfamiliar field and that they were, “better able to articulate critiques”. Students felt that the review process of the PRG also “improves the way you approach and think about writing”. This included reconsidering the writing process and making it easier to just write the first draft because they would expect to revise it several times.

4.3 providing motivating structure

In addition to reframing their thinking, group members saw the PRGs as helping them develop writing habits and motivation. The accountability and structure provided by the group’s sign up and review process was noted as a particular asset. Students noted that the structure helped them “complete work earlier” and “avoid procrastination”. This led to productivity gains as one student articulated, “it’s helpful to force yourself to produce writing results every so often and get feedback. I felt I was more productive and efficient with my time because of it.” Another student noted how the structure helped break down longer projects, “Being able to have accountability for big projects to provide a more reasonable timeline, and to have these projects improved by valuable and diverse input from individuals in the group that improves the final copy of the deliverable.”

Beyond providing self-imposed deadlines for longer projects, the groups helped students gain confidence and “comfort in showing unfinished work to others.” One mentioned, “I feel like it is very useful to become comfortable sharing your work with others and that it is a good motivator for continuing to make progress on your own work.” Thus, as a result of group participation, students changed their perspective and approach to writing so that they were writing more often and getting feedback earlier as they became more comfortable showing earlier stage or partial drafts.

4.4 gaining perspective through shared works in progress

The sharing of works in progress for review benefitted everyone in the group. For many, this helped them to see that they were “not alone” in dealing with writing issues. One student mentioned that it was “reassuring to see that everyone else [was] struggling too.” This helped to normalize that graduate level writing was a process and that it didn’t come naturally or easily to

most students. It helped to “see where others have difficulties in writing and how they were helped in the meetings.” According to one student, “PRGs made research writing much less intimidating.” This seems to be in part because the PRGs made the earlier stages of writing more visible and members were able to see the process that went into what many had previously primarily only seen in final form through published articles. The combination of transparency and the PRG structure seems to have fostered confidence, motivation and productivity. Responses noted that the PRGs could function as a type of ice-breaker on research writing and push “newer grad students to start digging in to writing and publishing.” One stated, “For me as a beginner of writing, it was a little bit of a pressure to discuss about writings, but the pressure affected me positively.”

New students especially mentioned how seeing a variety of work and being in a group with students from varying years of experience helped introduce and acclimate them to engineering writing at the graduate level. They especially appreciated the exposure to different “mediums and ways of presenting information at different stages,” and “hearing the writing advice and experiences of older students.” This allowed students to preview work they would be doing in future stages of their programs and benefit from insights offered by more advanced students who had already successfully completed the type of work newer students were currently pursuing. Students at all stages found the exposure to a variety of work to be helpful. One response noted that one of the best aspects of the group was “exposure to the ways that different fields of engineering think; seeing different types of science writing and how they are done, especially if you haven't done one before.” Students cited learning how to construct particular documents, such as proposals, figures, and research papers, from seeing and discussing the work of others in the group.

The discussion-based set up of the reviews led to additional benefits as well. Students shared that this helped them better articulate their ideas and learn to read, understand, and parse papers and content beyond their immediate specialty. For students for whom English, the language of their graduate education, was not their first language, the PRGs offered additional benefits. While these students mentioned that the PRG helped them with clarity and wording in their writing and the ability to “see what native speakers would understand from the writing,” the discussion set up also provided the opportunity to develop academic listening, speaking, and discussion skills. Speaking skill development was noted by all students. However, for this population, the experience was sometimes different. One student noted that “at least for international students, this could be a good chance to discuss academic topics in broad range of academic disciplines,” and “a good opportunity” to participate in “and observe others’ conversation in academic topics.” This was particularly significant for students who rarely discussed their research in English due to isolating research practices or the predominant language of their lab.

4.5 creating vital community

In addition to developing as communicators, group members cited the community created by the PRGs as a vital aspect. Members saw the PRGs as a “community to help each other,” and an opportunity to “communicate and improve together,” and “support each other.” Some saw the group as being like having “fun with friends,” and several cited the community and people in the

group as some of the best aspects. One member mentioned that they “felt like we built a community; got to know about other areas of research and meet new friends in engineering.” This community was critical to the success of the model and to the development of constructive feedback skills. One student stated, “It provided me with a community that I could trust to improve my work, without evaluating me as a person, which I haven't found elsewhere in grad school.” Without such trust, the PRG would not have been successful and it is unlikely that students would have found as many benefits to participation. The community aspect of the PRGs is key to their success.

4.6 building confidence as engineers & researchers

The community and skills that students developed helped them feel more confident in their roles as engineers and researchers. Students mentioned feeling this way as they identified as not the only one with issues in writing and in developing as communicators. Concerning feeling more confident as an engineer, one student stated “I can communicate what I want to get across more effectively, which leads to more productive conversations and discussions with my major professors, fellow grad students, etc.” Another student also mentioned taking their skills back to their lab, “when other people ask me to provide feedback on their writing in lab I feel confident I can provide them with some helpful comments.” Another connected their communication development with engineering and research skills, commenting, “it has exposed me to the process of reviewing material I may be slightly less familiar with, which I feel is important in terms of critically reviewing a new process.” This was not the only student to connect their communication development and engineering/research skills, as another put it, “It is a great way to get different perspectives for and improve your own work, both through getting yours reviewed as well as reviewing peers' work. This review process is a critical part of the scientific research method.” Students centered communication skills, including the ability to critical review work and information, as being vital components of what it meant to be an engineer and a researcher. Since the PRGs allowed them to develop and practice these skills with other engineering researchers in a way that they found themselves transferring to their research contexts, they felt the PRGs helped them to gain confidence and develop as engineers and researchers.

4.7 validating membership in disciplinary communities

Students also mentioned that working with other engineers in the group and discussing their work helped them feel more like they were part of a disciplinary community. The feeling of validation as part of the engineering or research community in part came from feeling “more connected to some of the other research that is going on in the department” and being “able to understand and discuss other engineering concepts and research.” One student mentioned a common reason for feeling like part of their disciplinary community as being “able to explain [their] work to a group of students in other engineering disciplines.” The structure of PRGs may have allowed students to more easily recognize their expertise as they explained their work to those outside their immediate lab group in a reciprocal constructive environment and answered questions as others developed interest in their work. One student stated that the sense came from feeling “more connected with peers across campus and because [they] [did] meaningful work in improving each other's writing.” Thus, the validation was part community and part collective

action that had a positive impact in that community. The PRGs provided a forum for students to develop a local community, be accepted by that community, and to develop their participation in a larger disciplinary community and feel validated as engineers and researchers.

5 conclusion

The PRGs provided a valuable incubator for engineering graduate students to develop key communication skills in a supportive environment that provided local and disciplinary community. Students saw value in the immediate and long-term communication development they achieved through the groups. This included improved immediate work as well as the skills, habits, and mindset to craft improved work on their own in the future. They additionally valued and achieved practice and development in both giving and receiving constructive feedback. In addition to feedback and productive communication skills, students found value in receptive skills as they developed listening, reading, and parsing skills specific to research. All of these skills were seen as being valuable beyond the immediate context of the PRG and students implemented their skills in their labs and graduate programs as they worked on their own and with others. Students saw the supportive community developed in the PRG as critical to its and their success, but also noted that this community, the discussion, and the skills they developed helped them to be better engineers and researchers that could succeed in their graduate programs and beyond, as the groups helped them practice skills key to engineering.

The findings suggest that positive changes in perspective, skills, products and attitude were all made possible by the PRG structure and the supportive disciplinary community a PRG represents. These changes are likely interconnected, as seen in simplified and summarized form in Figure 5.1 and Figure 5.2. The perspective provided by participating in a PRG and the awareness it develops seem to drive other outcomes as well. But the other changes also work in an interconnected way with one another. Brought together, these positive changes, the supportive environment and the practice in the structure of the PRG came together to help students feel more like confident engineers and researchers that were part of a disciplinary community. However, without a supportive environment and a reciprocal community, these outcomes seem less likely.

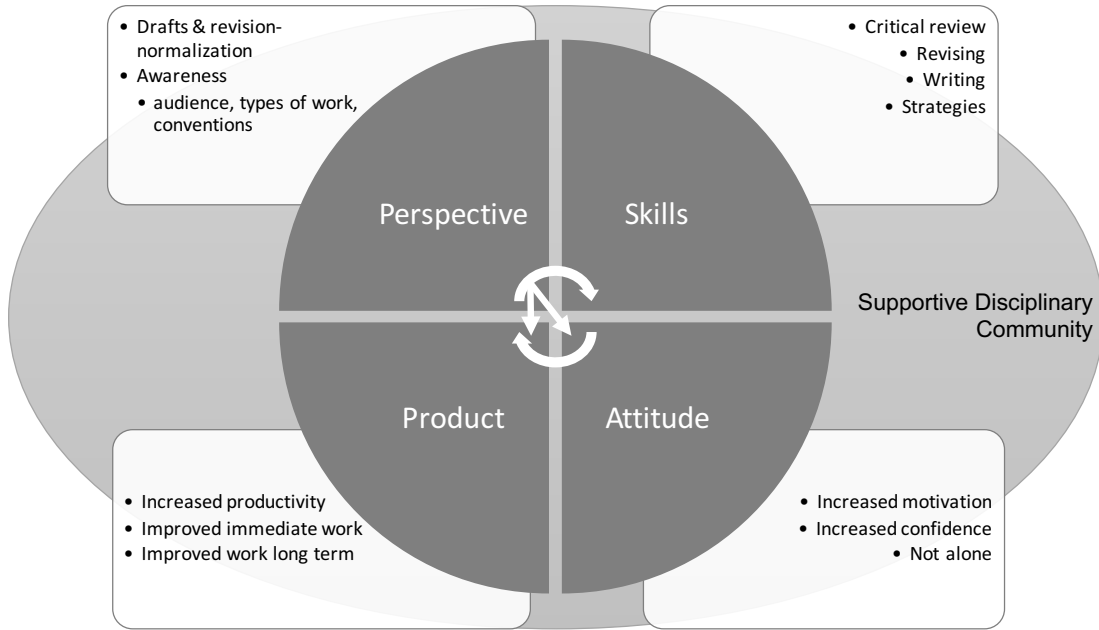


Figure 5.1 PRG Outcomes

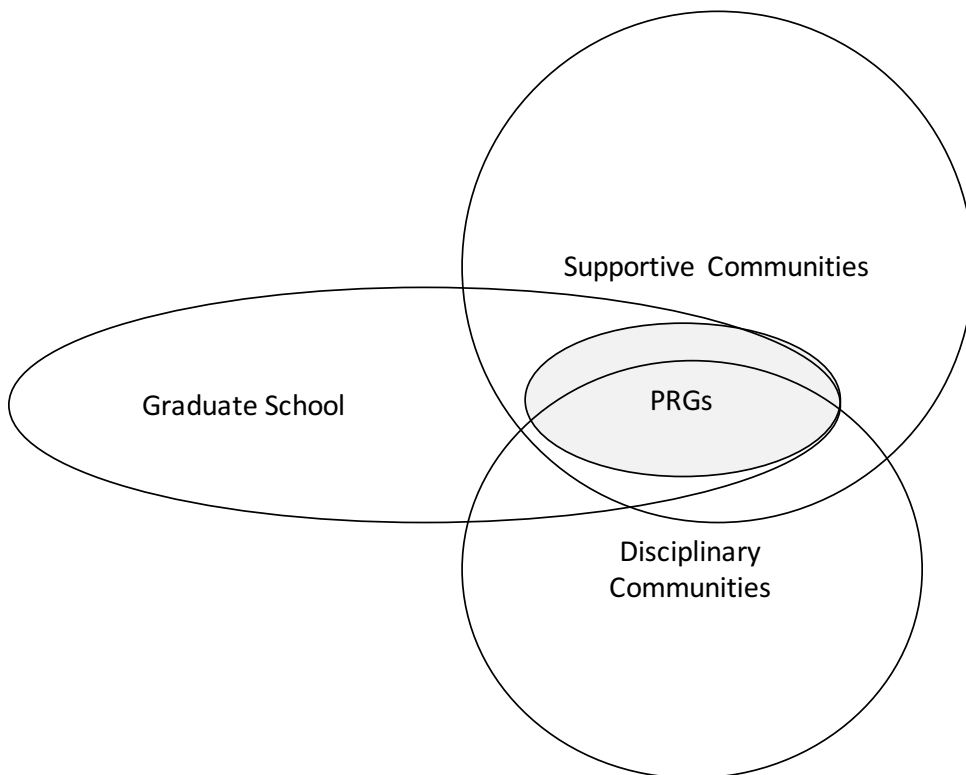


Figure 5.2 PRG as supportive disciplinary communities

Future work might consider a more detailed investigation of how a PRG develops and is situated as a supportive disciplinary community. What contributes or detracts from this designation and when are students most likely to experience it? The practical aspects of PRG make up could also be explored. This might include a careful study of the group dynamics and interactions and how a facilitator could best manage groups for the benefit of their members.

Further, research might more carefully consider the role PRGs could play in a student's development as an engineer and researcher. One student's comment concerning the PRG as the only venue for constructive feedback where it seemed like members were not judging them as a person suggests there is a need for more supportive constructive communities in graduate engineering programs. Understanding how PRGs serve the needs of students with varying lived experiences could help shape engineering graduate student support and programs in ways that benefit students. Perhaps there are lessons from PRGs that could be applied to other areas of graduate engineering with more detailed study. The current study only focused on open-ended survey responses. More detailed studies might consider including analysis of audio recorded meetings, individual or small group interviews, and analysis of meeting notes to offer a richer understanding of PRGs.

The PRGs as discussed here seem to offer a number of benefits for engineering graduate students. Other programs might consider using the model described here and adapting it for their own contexts to help graduate students form supportive disciplinary communities that help them grow in their perspectives on communication and as communicators of engineering.

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