A Framework for Collaborative Peer Review for Group-written Documents

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1. INTRODUCTION

The collaborative nature of the engineering discipline is often translated to the classroom via group project work. The positive impact of project-based learning (PBL) has been well documented in the research literature and in previous ASEE proceedings, including successful applications as described in Yousaf et. al, 2010, and Figges and Vogt, 2017. Peer response to student writing and team-based learning are well established, evidence based practices that improve student learning (Cho and Shun, 2005; Lundstrom and Baker, 2009; Hamm and Adams, 1992; Michaelson, Knight, and Fink, 2002). Nevertheless, few researchers have investigated the role of peer response activities in the context of team completed project based courses.

 While diverse models of peer response and peer review abound, the effectiveness of particular peer response activities and team assignments can vary substantially. A poorly designed or unscaffolded peer response activity can result in shallow, weak, and contradictory feedback, while a poorly designed collaborative writing assignment may end up producing work of uneven quality and conflict among project participants. As a consequence of these all too common flaws, students often view group projects and peer review activities with skepticism. Furthermore, the literature does not typically address peer review in the context of project-based team writing.

The Department of Industrial and Systems Engineering, working with the Writing Enriched Curriculum Program, has developed an innovative framework to maximize the benefits of peer response on student writing for group-written project documents. Our central contribution is not merely to affirm the value of peer response or project based learning, but to demonstrate the value of establishing review teams and a scaffolded protocol for peer response. Our framework includes a method to create independent and effective *review teams* of students (who review documents written by *project teams*); a process and materials for scaffolding and facilitating the review process in class (to balance individual insights with group-developed priorities for

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revision); and a team based feedback mechanism to continuously improve the peer review process.

The Department of Industrial and Systems Engineering at the University of Minnesota became involved with the Writing Enriched Curriculum Program shortly after it became identified as an independent undergraduate major. The pedagogical intervention described emerged from efforts to hardwire clear writing expectations and effective writing interventions in implementing an integrated and scaffolded writing curriculum.

In the remaining sections of the paper, we will explain the objectives behind the collaborative peer response process, describe the framework for review team selection, record observations and comments from students, and finally, offer recommendations for implementation.

2. LEARNING OBJECTIVES OF COLLABORATIVE PEER REVIEW

Students in several department courses, including project management, quality engineering, and senior design, are assessed (at least in part) by team projects. Enrollments in these courses range from 50-75 per semester. Each student in the class serves on a project team and works with this primary team for the full semester. Each project requires several different reports to be submitted throughout the semester. For example, in Senior Design, students first submit a Project Statement of Work, followed by a Project Plan, two Technical Updates, and, finally, a completed project report. When grading each of these preliminary project reports, instructors provided numerous comments with the intention that students will incorporate the feedback into improved future reports. However, experience demonstrated that students viewed these comments as punitive or justification of a grade, with each criticism tied to a point reduction in the report score. This is contrary to project experiences in the workplace, where project development is an iterative process that frequently benefits from critical response from colleagues, supervisors, and clients.

Thus, the authors wished to incorporate a more explicit review-revise process into the class project framework, both to improve the quality of work initially submitted and to give students a more accurate sense of the process of iteration. Initially, this was attempted through "project review" sessions spread throughout the semester, where student groups were required to present the instructor a draft of their latest report and describe their project status. However, students still primarily utilized these activities to assess what the instructor was looking for in an effort to earn a higher grade, rather than as an opportunity to materially improve their projects. Furthermore, students had limited exposure to the work of their peers, typically only during the final presentations of the semester. Thus, the project review sessions were abandoned in favor of a process that could meet the following objectives:

Objective 1: Students will improve project work through revision based on the constructive feedback from individuals not responsible for students' grades.

Objective 2: Students will consider perspective of various readers when writing project reports.

Objective 3: Students will develop the skills to critically read and assess technical work.

To achieve the objectives, we implemented a peer response framework in three sequenced core classes, taken by all majors through their junior and senior years. With this repeated exposure to the framework, students have multiple opportunities to participate in the peer response process (3-5 per courses), and the level of complexity and openness to student choice increasing as students move through the curriculum. For example, students' first experience with the process is in reviewing a 2-3 page Problem Definition document for a Quality Engineering project. After repeated practice in Quality Engineering, and subsequently Project Management, the students are well-versed in the process and capable of providing valuable feedback when they respond to their classmates' Senior Design project reports.

Being cognizant of the academic environment, there were also several limitations in place while developing the peer response framework:
- The peer response component will not add incremental *student workload*.
- The instructor will maintain control of all aspects of student *grades*.
- Students will have positive *incentive* to provide critical and constructive feedback.

The guiding principles were addressed as follows.

Student workload: All peer response activities take place during the class period. Additionally, students are given time during class to read and discuss the feedback they receive from their reviewers.

Grades: The students' responses provided through the peer review process are formative and constructive to students' efforts to revise and improve their documents before submitting the final version for grading. The course instructor is independently responsible for grading all student work – the student reviews are not a component of the project grades. This encourages students to provide critical feedback, which is perceived as beneficial rather than punitive to project teams. The teams have an opportunity to improve their papers based on the feedback before it is graded. It also prevents any need to calibrate or account for "fairness" of the student responses.

Incentive: Participation as a reviewer in the peer response process is a component of a contribution score in each course. Students may only miss class on a response day due to an

excused absence. Furthermore, students include their name on their responses, so there is accountability to provide useful feedback. Even in the absence of grades and points, the need to sign off on an assessment increases the social pressure to produce effective work. Student teams also rate the value and quality of the feedback they receive, closing the loop to establish a virtuous cycle of continuous improvement. This differs intentionally from unscaffolded pair-and-share reviews (which tend to focus on surface error and can suffer from the desire of Minnesota undergraduates to "be nice"), blind review processes (which can increase hostility and encourage loafing) and from graded peer review (where instructor feedback on peer review accuracy and the expert/novice power difference undermines the peer-to-peer collaboration typical in industry).

3. COLLABORATE PEER REVIEW METHODOLOGY

Review Teams

As stated, students in several department courses, including project management, quality engineering, and senior design, are assessed in part by team projects. Each student in the class serves on a project team and works with this primary team for the full semester. Each of the members of the project teams is assigned to a different 'review team' for peer response activities. Creation of review teams requires careful preparation before the first peer review session. For simplicity, given N project teams, we label the project teams Project-1,...., Project-N and, similarly, the review teams are labeled Review-1,..., Review-N. In this framework, the team Review-1 will review the documents of project team Project-1, the group Review-2 will review the documents of Project-2, and so on.

Review teams are created to meet the following criteria:
1. No student is on the review team for his/her own project.
2. No two students from the same project team are placed on the same review team.
3. Each review team contains the same number of members as the corresponding project team.

In practice, review teams are created using a spreadsheet with three columns: Student Name, Project Team, Review Team. The spreadsheet is prepopulated with student names and corresponding project team numbers, and is sorted by project team number. Starting from the top, the Review Team column is filled with consecutive numbers, from 1,...,N, skipping the number if it is equal to the student's Project Team number. Some minor adjustments may be required at the end so that Review Teams have the appropriate number of members, but this method has been performed in a few minutes for classes up to 70 students.

A sample review team assignment for 5 groups of 3 students is shown in Table 1.

Several benefits accrue from creating Review Teams with these characteristics. First, because no two students in a Review Teams are on the same Project Team, students are not tempted to utilize time with their review teams to discuss their own projects. Furthermore, each Project Team of k members will be collectively reviewing k other projects. While each student reviews only one project, the members of the team collectively review the breadth of other students' work to evaluate and bring ideas back to their own teams about what they identified as virtues or pitfalls in other projects

In our implementations, students have remained on the same Review Team for the duration of the project, so they are always reviewing documents from the same Project Team and can see the project progress. Students tend to become engaged in the success of the project they review, and this motivates them to give more critical feedback. An alternate approach would be to assign students to different Review Teams for each peer review. A benefit would be that students would gain exposure to more projects. Additionally, if an initial team contained relatively weak student reviewers, the corresponding Project Team would have the opportunity to receive more useful feedback from a different Review Team in the next peer review.

Student Name	Project Team	Review Team
student 1	1	2
student 2	1	3
student 3	1	4
student 4	2	5
student 5	2	1
student 6	2	3
student 7	3	4
student 8	3	5
student 9	3	1
student 10	4	2
student 11	4	3
student 12	4	5
student 13	5	1
student 14	5	2
student 15	5	4

Table 1: Sample Student Teams

Peer Review Process

The steps of the peer review process are described in this section. Figure 1 in the Appendix provides a visual representation of the movement of students in groups through the process.

Several documents are referenced in this section; these documents will be more fully described in the following section.

Preparation:
Step 0: Review teams are created and communicated to the students.

Before class begins, project stations are created around the classroom, and labeled with the appropriate project number (1,...,N). Typically, this is done explicitly for the first Peer Review of the semester, and students remember the Project Station locations for the remainder of the semester.

Phase 1: Independent Document review

Step 1: Project Teams leave drafts of their document at the appropriate project stations. For example, a member of Project Team 1 places k drafts of their document at station 1.

Step 2: Students sit at the project station corresponding to their Review Teams. For example, the students in Review Team 1 sit at Station 1.

Step 3: All students review drafts independently, using the provided *Peer Review worksheet* (Figure 2 in Appendix). Students are also encouraged to write feedback directly on the drafts, if they feel it will be helpful to the project team.

Phase 2: Group discussion
Step 4: Review Teams discuss the draft and each review team member's individual feedback. As a group, they decide the Top 3 priorities they recommend the Project Team focus on in revision. A recorder from the Review Team writes the *Review Group summary* (Figure 3 in Appendix) with the Top 3 recommendations. All feedback is left at project station.

Phase 3: Revision
Step 5: Students move to sit at the stations corresponding to their Project Teams. Teams review the feedback on the Review Group summary, the Peer Review worksheets, and additional feedback written on the drafts. As a team, they discuss the feedback and plan for revision.

Step 6: Project Teams complete an *Evaluation of Reviewers* (Figure 4 in Appendix) worksheet to provide constructive feedback on their reviewers.

Peer Review Documents

Importantly, students rely on a scaffolded set of written instructions to facilitate the peer review process. Samples of each of the following three documents is available in Figures 2-4 of the Appendix. The content of the first document, the Peer Review Worksheet, is constructed based on the content and expectations of each project assignment. The other two are the same for every peer review.

Peer Review Worksheet

The Peer Review Worksheet is a series of questions to guide the student reviewer as they read the draft. A well-prepared Peer Review Worksheet is critical for the peer review process to be successful. Characteristics of the Peer Review Worksheet include:

1. Easy for reviewer to use while encouraging critical responses.
   - Questions are sequenced to be answered as the reviewer reads the document.
   - Asks open-ended, descriptive questions to encourage detail and specificity.

2. Useful to the Project Team
   - Characteristics are aligned with the rubric used to grade the document.
     - Asks reviewer to identify and describe elements that the instructor will be looking for, according to the rubric.
   - Identifies areas where reader is not interpreting the document as the Project Team intended:
     - Some questions ask the reviewer to restate elements of the document in their own words.
     - Some questions ask the reviewer if they are convinced by an argument in the document, and why/why not.
   - Provides concrete recommendations for improvements to the project.

Student reviewers are required to include their names on their Peer Review Worksheet. This builds motivation to provide useful feedback to the Project Team. A key benefit of the Peer Review Worksheet is its role in eliciting critical feedback from students, beyond the responses about grammar and formatting that come most easily to many of them.

Review Group Summary

A valuable element of the Peer Review Workshop is for the individual students in a Review Team to discuss their individual evaluations of the document. In addition to the typical teamwork accomplished by project teams, these review teams bring heterogeneous perspectives to a

concrete task, promoting metadiscursive commentary to justify their readings and perspectives. Because students first read the document and complete the Peer Review Worksheet individually, all students in a Review Team will have a perspective on what works and what needs improvement in the document. The second phase of review gives time for a discussion among the Review Team members, as well as instruction to prioritize the reviewers' recommendations by selecting the Top 3 priorities for revision.

Evaluation of Reviewers

To close the loop on feedback, the Project Team is asked to evaluate the participation and advice from members of their Review Team. They give a basic evaluation of each individual reviewers' feedback (Extremely Helpful, Helpful, Not Helpful), as well as the summary. They are also asked to provide feedback on what was most helpful from the reviews, as well as what suggestions they have for the reviewers so that their feedback is more helpful in the next round.[2]

4. OBSERVATIONS

Although not designed as an object for a pre/post intervention study, the implementation of the collaborative peer review framework has had recognizable benefits in the classroom. Students consistently reported that the quality of feedback they received was good or excellent, particularly as they became more comfortable offering descriptive feedback and more familiar with the expectations of the project genres.

While we did not gather numerical data on impacts on scores or use a 'control' group to contrast outcomes, the co-author observed the effects of the intervention with and without the response process.

First, students embrace the peer response process. While a few students are defensive to receiving feedback in the first few iterations, and by the senior design course, students look forward to peer response sessions. They ask reviewers to be as critical as possible, and they feel accountable to provide constructive feedback.

Second, the quality of work delivered through student projects, as well as the quality of writing in student reports, has improved. Knowing that peers will read and comment on their work has provided a positive peer pressure influence for students to provide high quality work for reasons beyond a grade.

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[2] It is interesting to note that almost always, the suggestions for improvement include making feedback more critical and more specific.

Third, students gain practice at receiving and responding to peer feedback in a way that is decoupled from a grade. This is a critical skill in the workplace, and student reactions to feedback evolve from defensiveness in the first few iterations to welcoming by the time they reach senior design, as they view the feedback as a positive influence to improving their work.

Additional benefits include students completing their initial drafts of projects earlier than previously and engaged in both more revision (more changes made) and better revision (changes made improved document quality). In the Senior Design course, students reported both effective collaboration and reported that feedback they received was useful.

The only significant downside we have experienced is a slight reduction in course content due to the reallocation of class time to peer response. However, the trade-off in terms of student experience through improved project learning is significant.

5. CONCLUSIONS AND RECOMMENDATIONS

To validate the results of our pilot, future research could include measures of participation and engagement (comments on drafts, participation in Review Team discussions, participation in revision discussions in Project teams), embedded assessments of conceptual understanding related to assignment tasks or assessment of task proficiency, attitudinal measures of group process, and empirical measures of changes in student writing through the drafting process. In addition, research opportunities exist to examine the effect of our intervention on student identity formation and inclusion in engineering education. As with any pedagogical intervention, the persistence of these effects may be hard to demonstrate. Similarly, some of the effect on conceptual knowledge and document quality may simply be an effect of slightly increased time on task.

Pragmatically, our framework has relied on face-to-face interactions and the use of class time. It was clear that multiple opportunities for review and revision had the greatest effect on students as both critical readers and effective writers, which implies both that the effects of review activity are cumulative and that a "one-off" review activity would likely result in a minimal effect. Although we were concerned that students would be apprehensive regarding critical feedback, the opportunity to review the reviewer provided students with a mechanism to ask specific questions and probe for greater detail.

We recommend that, if implemented, the framework be used repeatedly, both within and across several courses, so that students gain proficiency with the process. The framework also requires considerable planning for the instructor: review teams must be created prior to class, a Peer Review worksheet must be created for each peer response session, and course content must be shifted in the semester to allow dedicated class time for the session.

We believe that there is an opportunity for a community of practice for group-based peer response activity, so that the engineering education community can continue to develop, assess, and improve this framework.

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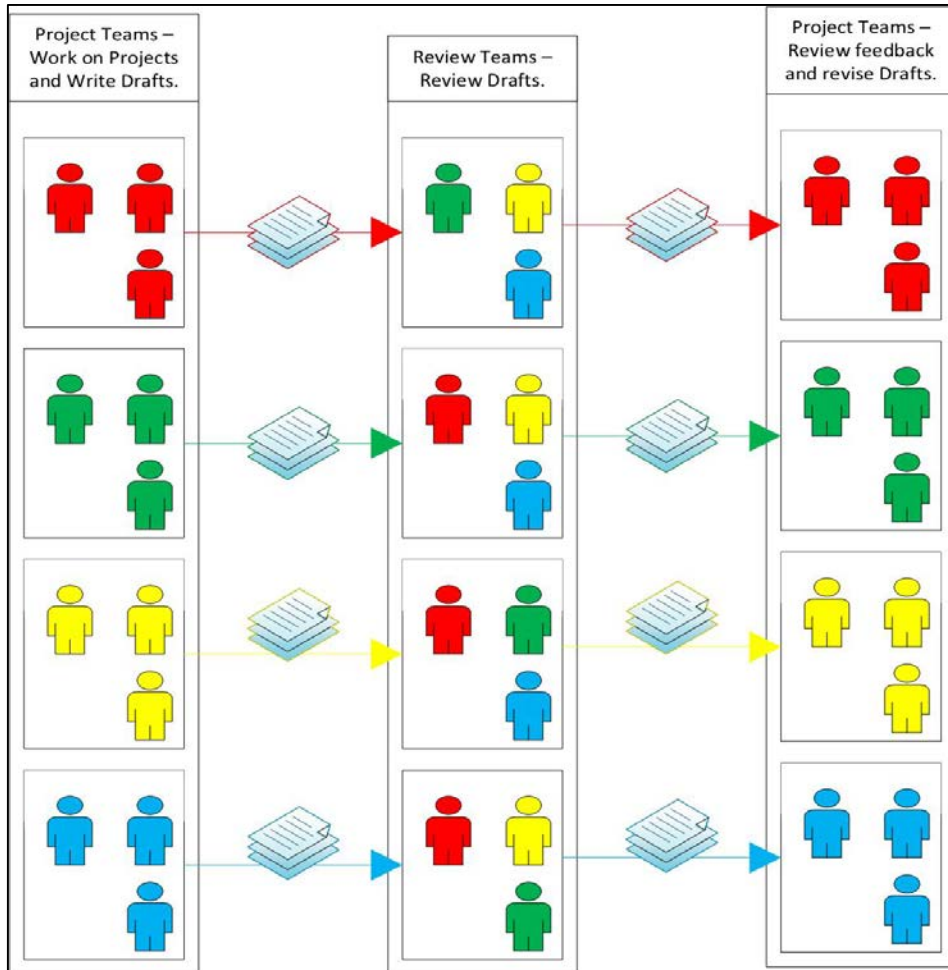
Figure 1. Visual diagram of group peer review process.

Project Reviewed_____	Reviewer_____
PROJECT BACKGROUND	
In your own words, what problem did the project attempt address?	
Was the team successful in addressing the problem? Why or why not?	
PROBLEM-SOLVING AND ANALYSIS	
What industrial engineering tools/methods did the team use?	
Were the tools/methodologies being applied correctly, and in the appropriate contexts? Why, or Why not?	
What data was used for the analysis?	
How was this data obtained and validated?	

Figure 2. Sample Peer Review Worksheet

Peer Review Workshop: Review Group Summary

Project Reviewed: _____

Document Reviewed:_____

Top 3 priorities for revision:

1	
2	
3	

Write any additional comments on the back of this sheet.

Figure 3. Sample Review Group Summary

Peer Review Workshop: Evaluation of Reviewers

Project Reviewed: _____

Document Reviewed:_____

Reviewer	1: Extremely helpful	2: Helpful	3: Not helpful
Summary from Review Group			

Extremely helpful: "We will make changes that we wouldn't have otherwise made thanks to this feedback, and our project quality will improve."

Helpful: "This is good feedback, but we were already thinking about these things."

Not Helpful: "This feedback is not specific or relevant enough to have any impact on our project."

What was most helpful from the reviews?

What changes could the reviewers (or project team) make so that their reviews are more helpful next time?

Figure 4. Evaluation of Reviewers