Instructor vs Peer Writing Feedback in a Large First-Year Engineering Course

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***Abstract*— Over the past 40 years, developments in writing studies research have emphasized the importance of both process-orientation - incorporation of scaffolding through feedback and revision - and situativity - recognizing that knowledge is best learned within the context it is to be applied. Engineering faculty, however, often view writing in ways at odds with both of these developments: treating writing as something to be taught elsewhere or integrating writing into engineering courses without incorporating feedback or revision. This mismatch is problematic, because improving engineering students' writing is a critical problem for engineering education. Additionally, feedback is often unfeasible within the constraints of many engineering courses-instructor time and large student-faculty ratios.**

One potential way to address these concerns is to use peer feedback. An open question, however, is how instructor and peer feedback practices differ and how that difference impacts students' revising process. We present results of an empirical analysis of peer vs. instructor feedback on a writing assignment in a large first-year engineering course. Findings indicate that peer feedback was at least as effective as instructor feedback in terms of quality improvement and that trained peer reviewers give feedback that is more consistent with effective practices than untrained instructors.

Keywords—Engineering Writing, Peer Review, Formative Assessment

I. Introduction and Background

Effective written communication skills are essential for engineers, as is widely recognized in the field of engineering education and by US and international engineering professional and program accreditation organizations e.g. [1]–[3]. Since implementation of the EC2000 accreditation criteria, communication has also been explicitly required by ABET for engineering programs. Specifically, criterion 3g states that programs must demonstrate that their graduates develop "an ability to communicate effectively" [1], and even though controversial proposed revisions to ABET criteria set to take effect in 2019 have been accused of "watering down" the other professional skills, communication remains a separate and even somewhat expanded outcome [4]. Although nearly two decades have passed since adoption of EC 2000, studies continue to indicate that employers view engineering graduates as insufficiently prepared for communication in the workplace e.g. [5]. At the same time, many engineering graduates continue to separate communication skills from 'real engineering' in their conceptualization of workplace tasks, even while being aware of the centrality of those skills to their work [6], [7].

One reason for this state of affairs is that the teaching of writing is often separated from the teaching of content knowledge within engineering curricula [8, p. 260]. Many scholars [9]–[11] emphasize that writing pedagogy should be based on an understanding of writing as a *situated activity* – one in which the knowing of something is inseparable from the doing and therefore benefits from being learned in contexts similar to those in which it will be practiced [12]. Thus, separation of "learning to write" from "learning to engineer" in engineering curricula is problematic for both skill and identity development.

Even when communication and content are integrated in the same courses, this integration is often done in a way that does not support improvement of students' writing skills as effectively as it could. Best practices of writing pedagogy treat writing as a process rather than a product; this approach includes writing and revising drafts based on formative assessment (feedback) rather than receiving only summative evaluative feedback of a final product – often referred to as the "one-and-done" approach [13], [14]. Incorporating revision in the writing process is recognized as an invaluable component of improving written work, but writing assignments in engineering courses frequently neither acknowledge nor incorporate this process [15], [16]. Although there are a variety of reasons for this gap, part of the challenge rests with engineering instructors, who may not feel qualified to effectively provide feedback or who may perceive that draft feedback is unfeasible within key constraints of many engineering courses: limited instructor time and large student-faculty ratios [17].

One potential way to address these instructor concerns is to use guided peer feedback, where other students in the class provide feedback on students' writing rather than the instructor. Peer feedback can be done outside of class as a homework assignment, eliminating the burden on class time. At the same time, online tools and general guidance can alleviate concerns about instructor competence, and many universities have resources available through writing centers serving students across disciplines to assist instructors with integration of writing assignments in their classes. Equally important, recent research in domains other than engineering has also shown that peer feedback can be as or more effective

978-1-5386-1174-6/18/$31.00 ©2018 IEEE

than instructor feedback when student writing is reviewed by multiple peers rather than a single peer, potentially assuaging concerns about the utility of peer feedback [18]–[20]. Moreover, more fully integrating writing and rewriting as a collaborative professional practice could help graduating engineers more readily recognize writing as engineering work.

An open question, however, is how instructor and peer feedback practices differ and how that difference impacts students' revising process. Our previously-presented work [21], [22] analyzed the effect of peer review training - in-class instruction vs out of class - on the quantitative and qualitative differences between student feedback comments on a research paper. We found that while there were differences suggesting that in-class instruction led to "better" feedback comments, but that the difference did not reach statistical significance for most types of comments. Building on this work, this study seeks to answer the following research question:

> RQ: How do first-year engineering instructors and student peers differ in their practice of feedback (i.e. types of feedback) on student writing, and how do these differences help to explain draft-revision writing quality improvement (i.e. types of revisions and resulting change in quality)?

This paper addresses 1) our method for categorizing and assessing feedback and revisions, 2) differences between peers and instructors in feedback practice, and 3) the relationships between those differences and writing quality improvement.

II. Context and Motivation

The site for this study was a large first-year engineering course at a mid-Atlantic research university. The course was required for all students intending to major in Electrical and Computer Engineering (ECE) or Computer Science (CS). This intervention modified an existing writing assignment, the Contemporary Issue Report, that had previously not included feedback and revision.

Like many engineering instructors [16, p. 36], we assumed that simply including a writing assignment was sufficient to support our course objectives. The original CIR was assigned in a *one and done* fashion: students submitted a final version of their report for grading without receiving any feedback on a draft and did not have the opportunity for revision. Feedback was provided by the instructors but was strictly summative in nature. This approach is consistent with Zhu's [16] findings on integration of writing assignments in engineering classrooms. After the first implementation of the assignment, the instructors reported anecdotally that the reports were generally of "poor quality."

While we were concerned about the quality of the CIR reports, we were unsure of our ability to "teach writing," a common misgiving among engineering instructors [23]. After review of the composition pedagogy literature and consultation with a writing instructor, it was clear that the design of the CIR assignment was inconsistent with contemporary practices and with our own constructivist epistemologies: by simply giving students a writing assignment and then grading the result, we had unintentionally used the *product-centered* approach to writing pedagogy rather than the *process-centered* approach that is widely considered more effective by composition scholars. A key difference between these approaches is the role of teacher response: a product-oriented response aims to evaluate the text – summative assessment, whereas a process-oriented response aims to inform further improvements – formative assessment.

In order to effectively include peer review in the CIR assignment, it was necessary to understand 1) the attributes of effective (peer) feedback, and 2) strategies to train students to give effective feedback. With these factors in mind, the research team conducted a literature review and identified the following characteristics of "high-quality" peer feedback: it should be specific, encouraging, and helpful. These criteria were used to develop a handout and in-class workshop on effective peer review. In the larger study this research draws from, students received one of several treatments related to peer review (handout-only or in-class instruction; single-peer or multiple-peer review). in this paper, students from all peer feedback treatments were grouped together for comparison to instructors.

To establish a baseline against which to compare the efficacy of peer feedback, an additional experimental group received feedback from their instructor. Instructors were PhD students in electrical and computer engineering. Each instructor provided feedback to one 30-student section in this study, which were combined into a single treatment group for analysis. The two instructors were not involved in designing the intervention. They were given copies of the handout described above but were not explicitly told to use it; whether did use the recommendations from the handout when providing feedback is not known.

III. Method

To answer the research question, we compared peer and instructor feedback in terms of the nature of reviewer feedback (i.e. its classification based on the analytic framework described below), and the nature of authorial revisions (i.e. their classification based on the codes described below). Due to the size of the data set it was possible to make these comparisons quantitatively using statistical analysis techniques. As a result, the study design is overall quantitative in nature because it uses a quasi-experimental design in which the goal is to statistically compare the effect of various treatments across several quasi-experimental groups [24, pp. 15–16]. However, the data—texts—are inherently qualitative in nature [25], [26]. Likewise, the objects of the study—feedback on and revision of writing—involve the construction and communication of meaning by the participants. The impact on the proposed study is significant: the goal of making statistical comparisons across treatment groups requires quantitative data, but the data in the set are inherently qualitative in nature. Therefore, it is necessary to transform the data from qualitative to quantitative in a way that is compatible with quantitative analysis techniques, a process well-suited to a method called Qualitative Content Analysis [27].

The data set consists of draft and final reports from each participant as well as feedback from either peers or an instructor. These were transformed in two phases:

1. Extract and classify feedback items from the drafts
2. Score draft and final reports based on the assignment criteria

In the following subsections, we first describe Qualitative Content Analysis [27], [28] and how it is used to transform data in general terms. Next, we describe how we used it to analyze the peer and instructor feedback as well as revisions and quality improvement based on that feedback.

A. *Qualitative Content Analysis*

Qualitative Content Analysis (QCA) is "a method for systematically describing the meaning of qualitative material […] by classifying material as instances of the categories of a coding frame" [27, p. 1]. Crucially, the method is designed to transform qualitative data such that descriptive and inferential statistics can be used on the quantized data [29, pp. 62–63]. QCA uses procedures and terminology similar to grounded theory and other qualitative techniques, but there are significant differences between the methods [27], [28], [30]–[32]. The first part of Schreier's QCA method is the development of the coding frame. The second part is the process of analyzing the data. For textual data, this process consists of three stages: Unitizing, Categorizing, and Coding. They are executed sequentially but can be iterative within each stage.

1) *Coding Frame*

The coding frame is the lens through which the researcher peers at the data when conducting QCA. It is similar to a codebook but is more highly structured and always hierarchical. The frame consists of one or more main categories (also called dimensions), each with two or more subcategories. By comparison to quantitative data, the dimensions are analogous to variables and the subcategories are analogous to levels of those variables. There are three requirements that apply to the structure of the coding frame: unidimensionality, mutual exclusivity, and exhaustiveness. Some indicators that unidimensionality has been violated include subcategories that are not instances of the dimensions, and subcategory names that repeat under different dimensions. [27, pp. 72–78]. The coding frames for this study are described below.

2) *Unitization*

Unitization is the first stage of QCA once the data set has been compiled and the initial coding frame developed. The data set is first divided into analytical units, which are then divided into coding units. Analytical units are the highest-level units that will be compared after the QCA process is complete. Coding units are the chunks of the analytical units that will be assigned to subcategories from the coding frame. For example, if a researcher is studying how the main themes of articles in the New York Times changed over the course of a decade, the analytical units might be newspapers and the coding units articles; in interview research, interviews are usually the units of analysis and coding units might be individual turns [27, pp. 130–131].

Units should be well-defined: unitization definitions and rules should be based on the nature of the data and the research question being answered. If units are based on natural divisions in the data set, formal definitions can be used; this is typical for units of analysis. Where distinctions are more ambiguous, a set of rules based on formal, thematic, or a combination of both criteria is necessary. The output of this stage is codable units.

3) *Piloting and Coding*

In the piloting stage, the initial coding frame is applied to a subset of data. The purpose is to ensure that the theoretically-derived coding frame makes sense with the data. The researcher first applies the coding frame to a small subset of the data to ensure that the categories are sufficiently well-defined. If there are dimensions or sub-categories that need to be added, removed, or modified, the coding frame is revised at this stage. After the coding frame has been revised, multiple coders apply the coding frame to subset of data, and an inter-coder reliability check is performed using a statistic such as Cohen's Kappa or percent agreement. The result of this stage is a validated coding frame. Finally, in the coding stage, the validated coding frame is applied to the rest of the data. The output of this stage is nominal or ordinal data that can be used for quantitative analysis.

B. *Applying QCA to Feedback*

In the first phase of data analysis, we applied the qualitative content analysis process described in the previous section to the corpus of feedback items. To assist in conducting the analysis, we used Atlas.ti 8.0 [33], a computer-assisted qualitative data analysis (CAQDAS) software tool. Unitization and coding of feedback were conducted as described below.

1) *Unitization of Feedback*

The unit of coding for peer feedback is the *feedback item.* These feedback items were classified by applying the coding frame to them. In order to do this, it was necessary to define what constitutes an individual feedback item. Segmentation rules used a multi-pass procedure combining formal and thematic criteria [27, pp. 134–137].

1. On the first pass, feedback items were segmented based on visual separation.
2. Next, feedback items were subdivided if they contained more than one idea unit, a "self-contained message on a single problem" [34, p. 268].
3. Finally, because complete sentences are the smallest meaningful unit appropriate for the research paper genre, direct edits or proofreading marks that were within the same sentence were combined.

Several units of analysis were used: feedback items, commented drafts, and received drafts, which combine all feedback received by a particular author. The data are naturally divided into these units, so this simple definition is sufficient to define the units of analysis.

2) *Coding of Feedback*

The coding frame for feedback items was developed based on prior empirical work classifying peer and expert feedback, drawing specifically on Straub and Lunsford [35], Smith

Taylor and Patton [36], and Patchan, Schunn, and Correnti [37]. The frame contains five dimensions: mode, tone, focus, localization, and type. Focus and localization are properties of the comment referent; mode and tone refer to the meaning-related qualities of the comment itself; type differentiates end comments vs margin comments. Edits are a unique case: they are a type of feedback and need to be captured in the coding frame, but they are not comments per se; therefore, edits are not assigned a focus, tone, or type and are inherently implementable and localized. Edits, therefore, distinguish *feedback items* from *feedback comments* (from here referred to simply as *comments*). In other words, a feedback item is either an edit or a feedback comment, and only comments are classified on the other dimensions of the coding frame.

TABLE I. OVERVIEW OF CODING FRAME DIMENSIONS

Dimension	*Definition*	*Subcategories*
Mode	Level of control the reviewer exerts over author's text	Edit, Authoritative, Coaching, Readerly
Tone	Affect of the comment's language	Negative, Neutral, Qualified, Positive
Focus	What the comment refers to in the document	Form, Content, Technical, Extra-Textual
Localization	Where the comment refers to in the document	None, Implicit, Explicit
Type	Physical location of comment in document	Margin, End

a) Mode

The mode dimension considers the form, content, and voice of the comment itself. Straub and Lunsford [38] developed the concept of mode to better capture differences in meaning, teacher role, and control that are not accounted for when considering only superficial form and voice of comments. Subcategories of mode include edit, authoritative, coaching, and readerly.

Mode reflects both the implied role of the reviewer and the degree of control the comment exerts over the text. This is illustrated by the following four comments about moving a paragraph to the introduction:

"Put this in the introduction"

"I think you should put this in the introduction"

"You might consider putting this in the introduction"

"Putting this in the introduction will allow the reader to more easily understand the rest of the paper."

The first comment directly commands the author to make a change; it exerts a high level of control over the writing and would be coded as authoritative. The second and third comments are both suggestions on the surface; they both appear to exert a medium level of control. However, the phrasing "I think" shifts the agency to the reviewer and in practice exerts a higher level of control while "you might" gives the writer agency; they would be coded as authoritative and coaching, respectively. The final comment takes the perspective of the audience and would be coded as readerly.

b) Tone

In Straub and Lunsford's [38] original conception of mode, there were more categories in the evaluative modes than in the definition presented above; for example: negative evaluation, qualified negative evaluation, and praise. We separated this into its own dimension because any comment could be phrased negatively or positively, and the effect of that phrasing may have some effect independent of mode. This separation of mode and tone is further supported by feedback models developed by cognitive psychologists which differentiate between a comment's promotion of *understanding* vs. *agreement* [19, p. 377], which correspond to the cognitive, or thinking, and affective, or feeling domains of constructivist learning theory, respectively [39], [40]

c) Focus

The subcategories of the focus dimension are also adapted from prior classification schemes [35], [41] and include form, content, and extra-textual. Form comments refer to features of the text at the word, sentence, between-sentence, or sub-paragraph level. Form comments are about word choice, mechanics, document design, or layout and other surface features of the text. Content comments refer to larger issues in the text such as organization, ideas, and development. The content category is further subdivided into prose content vs. technical content, which differentiates between comments that could refer to any paper and comments that are assignment-specific. If they reference specific portions of the text, it is at the sentence or paragraph level and higher. Extra-textual comments are those that do not refer to anything within the text.

d) Localization and Type

Localization indicates whether a comment "explicitly refers to the location of the issue" [37, p. 1100]. Research has shown that localized comments are more likely to be understood and implemented, but are also weakly correlated with lower revision quality [19], [37]. Many previous studies were restricted to end comments [18], [34], [37], [42], often due to the design of online feedback systems used. In this study, however, peer feedback comments were given using tablet PCs which allowed students to use digital inking tools that approximate the pen-on-paper feedback more commonly used by instructors. This affordance allowed for both types of comments, and students were not explicitly instructed to use either one, although the model feedback provided on the peer review handout included both.

Like end comments, margin comments can be explicitly localized in the comment text, but unlike end comments, margin comments can also be implicitly localized by proximity to the issue being commented on. On the other hand, margin comments are more likely to have a low-level (form) focus rather than a higher-level (content) focus.

3) Coding of Quality Improvement

To calculate quality improvement, an instrument based on the original assignment rubric was used. For each rubric attribute, the rater evaluated whether the changes present affected that attribute negatively, none or negligibly, positively, or very positively. Very positive is distinguished from positive in that a rating of very positive indicates that the changes present improved that rubric attribute by at least one rubric category; for example, a draft that would be rated "marginal" in organization and a final that would be rated "proficient" in organization was rated as "very positive." Finally, the rater assigned the draft report a letter grade, so analysis could control for initial quality, since a draft report with poorer-quality has more room for improvement when revising.

Once all reports were rated, an improvement score was computed for each dimension. The ordinal rating for each attribute within the dimension was transformed to a numeric score by assigning values to each category (Negative = -1, None/Negligible = 0, Positive = 1, Very Positive = 2).

4) Trustworthiness

It is crucial in all research to establish the quality of the methods employed. For quantitative instruments, the accepted criteria are validity and reliability [24]. Because of the explicitly interpretative role of the researcher in qualitative studies, Lincoln and Guba [43] developed the more robust concept of "trustworthiness" to ensure quality and to show that findings are "worth paying attention to." Trustworthiness is established by demonstrating credibility, dependability, confirmability, and transferability [44]. Credibility, analogous to internal validity, refers to whether the research measures what it purports to measure. Dependability, analogous to reliability, refers to how consistent a measurement is. Confirmability roughly equates to refers to the scientific standard of objectivity and refers to "potential for congruence between two or more independent people about the data's accuracy, relevance, or meaning" [45, p. 2]. Finally, transferability refers to the extent to which a study's findings can be extrapolated to other contexts. Although transferability of the results are limited by the single-site single-course nature of the study, the site and course were typical of first-year engineering programs at large research universities, supporting transferability to other contexts.

In this research, we used standards for each of these four criteria developed specifically for content analysis [27], [46] to establish the trustworthiness of the results. First, credibility was ensured by using a codebook based on a preexisting framework that is well-established for use with similar data [47, p. 15]. Dependability was established by having a subset of the data coded by two coders and using chance-corrected agreement coefficients [46, p. 284], a process described in detail in the next paragraph. This process also helped to establish confirmability by using a second coder who was not familiar with the theoretical foundations of the study and therefore would base coding decisions more completely on the codebook rather than their expert interpretation. By using this *intercoder* reliability (where the goal is maximal agreement among coders based solely on the codebook and training) rather than *interrater* reliability (where raters are experts whose differing interpretations are valued and closely examined) the likelihood that these results could be reproduced independently is increased [46, p. 283]. The single-institution study site and course focused on ECE/CS students is a potential threat to transferability; however, the large size of the program [48] and participant pool should help mitigate this threat.

Dependability, or reliability of measurement, is one of the more challenging aspects of qualitative research because the act of coding inherently involves some amount of subjective judgement on the part of the coder. This is somewhat simpler when using *a priori* (deductive) coding, but it is still necessary to have multiple coders independently analyze a subset of the data and determine the extent to which they agree. An appropriate *chance-corrected coefficient* of agreement or covariation should be used rather than simple percent agreement [46, p. 283]. For nominal data, the most widely-accepted coefficient is Cohen's Kappa, a measure of agreement; for ordinal, ratio, and interval data, Krippendorff's Alpha, a measure of covariation, should be used – although Kappa is also considered acceptable for ordinal data [46, p. 284].

After defining the coding frame and unitizing the feedback items to be analyzed, a random number generator was used to select a subset of feedback items to be coded by a research assistant. The minimum recommended threshold for Cohen's Kappa is 0.6, while some scholars recommend 0.8 [46, p. 284]; the higher threshold was achieved for all feedback dimensions in the coding frame except mode (likely because mode category definitions are more subjective), which still met the lower threshold.

For quality improvement, 20 draft-final pairs were coded by a research assistant. A random number generator was used to determine the sequence of analysis of the reports. This helped to ensure validity of the ratings because the rater was unaware of the treatment group the report was from. Krippendorff [28] recommends a minimum Alpha threshold of 0.8, with values between 0.667 and 0.8 acceptable for "tentative" conclusions. Intercoder reliability fell into this tentative range for all dimensions. The intercoder reliability achieved is in line with the previous work on which this analysis is based, which notes that intercoder reliability for writing is generally low [18, p. 333].

IV. Results and Discussion

This study compared the use of peer and instructor feedback to enable a process-oriented approach to a writing assignment in a large first-year engineering course. Over the past 40 years, developments in writing studies research have emphasized the importance of both process-orientation – incorporation of scaffolding through feedback and revision – and situativity – recognizing that knowledge is best learned within the context it is to be applied. Engineering faculty, however, often view writing in ways that are at odds with both of these developments: treating writing as something to be taught elsewhere – such as a technical writing course offered in the English department, or when integrating writing into engineering courses doing so without incorporating feedback or revision. This mismatch is especially problematic, because improving engineering students' writing – both as a professional skill and as a means to professional identity development – is critical problem for engineering education.

Even if the aforementioned epistemic and pedagogical beliefs are overcome, a significant barrier remains: integrating writing assignments (especially those incorporating feedback and revision) into disciplinary courses is very resource-intensive in terms of instructor time. In large classes, these resource constraints could make incorporation of these assignments impossible. Recent research examining the use of peer feedback on writing assignments in disciplinary courses has shown that it can be as or more effective than instructor feedback [18], [34], [49]. Given 1) the importance of writing for engineering education, 2) the importance of situativity and process-orientation in contemporary writing pedagogy, 3) the resource barriers to integrating process-oriented writing assignments in engineering courses, and 4) the promising research on the effectiveness of peer review of writing in other disciplines, there is a need to better understand peer review within the context of engineering courses.

To address this need, we conducted an analysis comparing instructor and peer feedback in a large first-year engineering course. Using data from a quasi-experimental intervention, we used Qualitative Content Analysis techniques to examine how peers and instructors practice feedback (i.e. the nature of reviewer feedback) and the efficacy of the revision process in terms of quality improvement between participants' draft and revised reports. In the following sections, we discuss the major findings and situate them within the existing literature.

A. *Quality Improvement from Peer vs Instructor Feedback*

In order to validate the assumption that peer feedback is a valid substitute for instructor feedback, we compared the draft-to-revision changes in quality between students receiving instructor feedback to those receiving peer feedback. As shown in Table II, students who revised their drafts based on peer feedback did not statistically-significantly differ in quality improvement from those who revised based on instructor feedback. **Thus, the first finding is that peer feedback was at least as effective as instructor feedback in terms of quality improvement**.

TABLE II. COMPARISON OF QUALITY IMPROVEMENT FROM PEER OR INSTRUCTOR FEEDBACK

	Instructor		Peer		
	M	SD	M	SD	sig
Overall Quality	4.00	4.50	4.78	5.22	0.3791
Mechanics Quality	0.69	0.73	0.68	0.82	0.9762
Technical Quality	2.38	3.72	2.68	4.05	0.6613
Writing Quality	0.93	1.36	1.41	1.72	0.0955

*p < 0.05 **p < 0.01

These findings are consistent with and extend existing literature and supports the conclusion that multiple peer feedback is a valid substitute for instructor feedback in this context. Several studies [18], [50] have compared quality improvement resulting from instructor, peer, and multi-peer feedback in undergraduate psychology courses with similar results: multiple-peer feedback results in the largest improvement in quality. Patchan et al. [20] found a similar effect in an introductory physics course: students receiving peer feedback showed a statistically significant improvement in quality versus those receiving feedback from a teaching assistant. Although this result was expected, the present study is the first to empirically demonstrate this effect within the context of first-year engineering or, for that matter, any engineering course.

B. *Differences Between Feedback Given by Peers and Instructors*

The second finding is that trained peer reviewers give feedback that is more consistent with effective practices documented in writing research than untrained subject experts. As shown in Table III, peer feedback had statistically-significant differences in feedback distribution in all five dimensions of the coding frame when compared to instructor feedback.

Within the mode dimension, feedback in the peer group tended to use higher-level modes, shifting away from edits and authoritative comments toward readerly. Similarly, peers gave fewer form-focused comments, instead making more content-focused comments, both prose and technical. While only 3% of instructor comments were positive, 22% of peer comments were. In each of these cases, then, peer comments were more consistent with effective practices documented in writing research than instructor comments.

V. CONCLUSION

This study supports the extension of previous research to the context of engineering. Previous research on peer feedback has shown it to be an effective substitute for instructor feedback in non-engineering contexts [18], [49], [51]. The findings are evidence that these results are also applicable in a first-year engineering context. This suggests that several problematic status-quo aspects of engineering communication curricula – the typical separation of communication and content learning [8, p. 260], adoption of a "transmission model" of communication [11, p. 614], [52] and challenges for improving these practices due to resource constraints such as limited instructor time and large student-faculty ratios [17] – can be addressed by using peer feedback to enable the adoption of process-oriented writing assignments in engineering courses. Addressing both the separation of "learning to write" from "learning to engineer" (i.e. treating engineering writing as a *situated activity*) and the common product-centric perspective [15], [16] could improve both skill and identity development for engineering students.

TABLE III. CROSSTABULATION OF FEEDBACK FEATURES AND SOURCE

	Total Items		Instructor		Peer		sig
	N	%	N	%	N	%	p
Mode							< 0.0001**
Edit	1069	33%	310	53%	759	29%	
Authoritative	1325	41%	217	37%	1108	42%	
Coaching	453	14%	46	8%	407	16%	
Readerly	357	11%	10	2%	347	13%	
Focus							< 0.0001**
Form	769	36%	136	50%	633	34%	
Content	1134	53%	110	40%	1024	55%	
Technical	165	8%	16	6%	149	8%	
Extra-Textual	67	3%	11	4%	56	3%	
Tone							< 0.0001**
Negative	57	3%	15	5%	42	2%	
Neutral	1200	56%	154	56%	1046	56%	
Qualified	467	22%	96	35%	371	20%	
Positive	411	19%	8	3%	403	22%	
Type							< 0.0001**
Margin	1574	74%	168	62%	1406	76%	
End	561	26%	105	38%	456	24%	
Localization							< 0.0001**
None	455	21%	95	35%	360	19%	
Implicit	555	26%	24	9%	531	29%	
Explicit	1126	53%	154	56%	972	52%	

*p < 0.05 **p < 0.01

ACKNOWLEDGMENTS

The authors would like to thank Molly Scanlon and Jean Mohammadi-Aragh for their roles in designing the intervention and collecting the data described in this paper.

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