AC 2007-1018: ASSESSING THE IMPACT OF PEN-BASED COMPUTING ON STUDENTS' PEER REVIEW STRATEGIES USING THE PEER REVIEW COMMENT INVENTORY

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Assessing the Impact of Pen-based Computing on Students' Peer Review Strategies Using the Peer Review Comment Inventory

Abstract

This paper provides a report on a project investigating the impact of pen-based computing on students' peer review strategies. The context for the project is an introductory technical communication course for engineering students from multiple disciplines. The project investigators created three peer reviewing contexts in which to assess the impact of tablet PCs on the quantity and quality of students' peer review comments. A Comment Inventory form was then developed that allowed the investigators to categorize each comment based on comment location, content, and form. Initial results from the study are presented.

Keywords: *technical communication; peer review; pen-based computing; tablet PC*

Introduction

For many engineering educators, the challenge of incorporating communication into technical courses may be mitigated by the use of peer review; by setting students up in peer review sessions, they can read and comment on the work of others as a means to improving their own communication skills. Many of us who have employed peer review have seen the benefits firsthand.[1-5] The process of reading and reviewing the written documents of other students—submitting their own documents to be assessed by other students, reviewing documents that try to fulfill the same assignment they have written—has a measurable impact on the student's own writing. Studies of peer reviewing strategies confirm what many of us have seen in our own classrooms. The process for peer review, with few exceptions, remains the same. Students exchange drafts, use a pen or pencil to make comments on hard-copy drafts, then return the drafts to their owners. Our project focuses on an alternative method, using pen-based computing to conduct peer reviews.

Rose-Hulman Institute of Technology has enjoyed a national reputation as a leader in the field of engineering pedagogy and technological innovation. As a result of a grant from Hewlett-Packard, we were able to expand the scope of our work in these fields by implementing the use of tablet computers in a variety of classrooms: chemistry, computer science and software engineering, mechanical engineering, physics, and technical communication. In the context of the technical communication classroom, we are exploring how pen-based technology of the tablet PC impacts students' peer review strategies. Our work with tablet computers began in the winter quarter of 2004 with students enrolled in RH330 Technical Communication. This course is required of all students at junior standing in the following engineering majors: civil, chemical, computer, electrical, mechanical, optical, and software engineering. Our research questions are founded on the notion that peer reviewing conducted on paper (hard copies of draft documents) differs from peer reviewing that occurs on the writing surface of a tablet computer (an electronic copy of the draft document that the student then marks up with a pen stylus or comments on with reviewing tools in Microsoft Word). Our project is designed to determine if pen-based computing increases the frequency and quality of students' comments over paper-based reviewing or reviewing using electronic tools.

Context for the Project

Our institution is a private, primarily undergraduate institution of roughly 1850 students offering majors in engineering, mathematics, and science only. Since 1995, students have been required to purchase an institute-specified laptop computer with an installed suite of powerful software (e.g., Microsoft Office, AutoCAD, Maple). The Laptop Computer program has meant that students can use modern computing tools in their classes and for their projects while still maintaining the portability inherent in laptop devices. At present, all of our classrooms are wired for high-speed network connections, and there are wireless nodes strategically placed around the entire campus. Students use their laptops in classrooms on a daily basis in most first-year courses and in many upper-division courses.

In recent years, however, the emphasis on portability has taken a back seat to power. Each year students have expressed their desire for more and more powerful computers, devices that are capable of hosting memory-hungry applications like games and video, while still maintaining the capability to pick up the computer and take it to class (although the increasing weight of the laptop has become a concern to students who must lug it around with a couple of technical textbooks in overstuffed backpacks).

While we understand and use the power of laptops in education, we also recognize that other computing tools may be better for some student learning experiences. When pen-based computers running Tablet PC editions of Microsoft Windows became available several years ago, we quickly recognized their potential for enhancing learning experiences of students and driving curricular change. In 2003 and 2004 we received *Mobile Technology Solutions in Learning Environments* grants from Hewlett Packard Company to purchase HP/Compaq Tablet PCs. Our 4 years of experience with Tablet PCs has involved more than half of our departments and about ¼ of our students. Our use of these pen-based devices has allowed new and innovative educational opportunities for our students, as described in recent publications and presentations by our faculty, as well as in presentations at the First Workshop on the Impact of Pen-based Technology on Education (WIPTE) at Purdue University in April 2006.[6-10] In addition to the use of tablet PCs that we have experimented with in the physics studio lab, as well as courses in chemistry, computer science, and mechanical engineering, we have taught over half the sections of our required course in technical communication with tablet PCs or laptops supplemented with Wacom slates to add stylus-writing capability.

Literature Review

Our inquiry into the effect of these technologies on student peer review practices intersects two distinct traditions of research. Most obviously important are those papers examining peer review practices with the latest emergent technologies of their time. However, our methodology, based on categorizing the form, content, and placement of comments, also draws on the work of a number of researchers in both composition studies and professional communication who have extensively analyzed the generic features and social functions of commentary on student writers from various readers.

Computer-Mediated Peer Review

The initial outpouring of research on technological mediation of student peer review occurred in the early 1990s: with the rapid proliferation of the Internet and the appearance of networked classrooms at a growing number of universities, instructors found a variety of ways to incorporate computers into their classes' peer review sessions. Early research focused on the logistics of whether and how computers could profitably facilitate peer review, most often highlighting the disruptive or discouraging complications created by computer mediation, even while discovering the ways in which it might open the peer review process to new possibilities. Van der Geest and Remmers, in what may be the first study of electronically mediated peer review, conducted simultaneous computer-mediated and traditional peer-review sessions in a scientific writing course. The only consistent effect they found among the students using computers for peer review was a tendency to focus on technical difficulties rather than course content.[11] Peckham, finding similarly that "disruptive" consequences were more prevalent than "constructive" ones, urged that computer-mediated peer review be blended with more traditional techniques.[12] Marx, writing about a cooperative program in which student writers at distant universities responded to one another's work, perhaps offered the most positive conclusions on the technique in the early 1990s, but still reported mixed results. He found that the lack of proximity led to more rigorous adoption of an editor's "critical terminology" and viewpoint, but also to a frustration at their inability to engage in direct face-to-face conversation.[13]

Such articles often simultaneously assessed available software available for peer review and collaborative writing such as PREP-EDIT or Daedalus[11, 12]—based around commentary and collaboration tools now integrated within most mainstream word-processing software—or on approaches that did not require specialized software, such as exchange of comments via email or chat rooms. Perhaps most noteworthy in the findings of these studies is the frequency with which, regardless of the details of the virtual environment, instructors encountered difficulties familiar to any practitioner of peer review. For instance, Sirc and Reynolds noted the extent to which discussions of documents subordinated "focused, coherent negotiation of a text's meaning" to phatic utterances; that is, the document under review tended to serve primarily as a locus for social performance, as students attended to the demands of politeness and of positioning themselves within peer groups.[14]

Thus, the existing literature on computers and peer review tends to suggest that the communication medium affects the nature of students' responses to one another's writing only insofar as it transforms the primary elements of the rhetorical situation itself—for instance, if students write to a new audience outside of their own classroom community.

The nature of our own research questions, though, introduces complications beyond the scope of these studies: in using tablet PCs to conduct peer review in several different fashions, we're not simply comparing a situation in which student peer review is mediated by computers to one in which it isn't; we're equally interested in whether the tablet hardware and stylus-based interface produces notable differences to the results obtained with conventional software editing tools in a typical point-and-click environment (as well as those obtained with pen and paper).

Varieties of Response to Student Writing

To study the comments that students crafted with these media, we needed a system with which to categorize those comments. Among the basic distinctions in the literature are the following:

- Elbow and Belanoff, drawing a distinction that is later adopted by Smith, distinguish *reader-based* comments from those that are *criteria*-based.[15, 16]

- Keh bases her distinctions primarily on whether comments address "surface features"/ "lower order concerns" (mechanics, grammar, spelling) or "higher order concerns."[17]
- Smith identifies a number of comment types devoted to *judging* and a smaller number of comment types devoted to *coaching*; Brannon and Knoblauch make a parallel distinction between *directing* and *facilitating*.[16, 18]
- Studying tutors in writing centers, Mackiewicz investigates whether tutors couched their comments as explicit *directives* or as *hints*.[19]

In an attempt to capture as many of these areas as possible, we paid particular attention to two more extensive taxonomies of comments. Our most fundamental model was Straub's division of teacher comments into five *focuses* (correctness, style, organization, content, and context) and nine *modes* (corrections, criticism, qualified criticism, praise, commands, advice, closed questions, open questions, and reflective statements).[20] In examining the more specific linguistic forms taken by our students' comments, we also consulted Mackiewicz's subdivisions of non-directive comments: hints (evaluations, general rules, and elisions)[19] and compliments (formulaic and non-formulaic—those that rely on "sequences of language that people have heard and said many times before," and those that exhibit "a novel coherence").[21]

Procedure for Inventorying of Peer Review Feedback

The site for the first iteration of our study was two sections of the Technical Communication course taught by Williams during the winter quarter of the 2005-06 academic year (48 students). The impact of tablet PCs and pen-based computing on peer review strategies was measured in three contexts: conventional peer review on paper, peer review using reviewing tools in Microsoft Word, and peer review using the pen stylus on the tablet PC

Conventional Peer Review **--** First, students were asked to perform peer review on the hard copy drafts of other students using an evaluation rubric developed by the course instructors. Students were asked to mark up the drafts they were reviewing and complete the evaluation rubric. Both the marked-up draft and the rubric were returned to the instructor at the end of the peer review session (one 50-minute class period set aside for peer review). The instructor for the class then retained copies of the marked drafts and accompanying rubrics.

Peer Review with Reviewing Tools in Microsoft Word **--** Second, students were asked to complete a peer review of another student's draft using the reviewing tools in Microsoft Word. This second peer review experiment was conducted with a different course assignment than the first experiment. As in the case of conventional peer review, this review was also conducted in class (50 minutes). Students were then asked to post their marked-up digital copies of the drafts to the Angel Learning Management System, the LMS used on the Rose-Hulman campus. Instructors then printed the drafts including the student comments onto hard copy for use in the research. While students were so given an evaluation rubric to accompany their reviewing work for this assignment, instructors did not require students to turn them in, either electronically or in hard copy.

Peer Review with Tablet PC **--** Third, students cut and pasted several paragraphs of a third assignment onto a slide in DyKnow Vision Software, the collaboration-facilitating software we have been using in conjunction with the tablet PCs. Each student then marked up the draft on a slide using the capabilities of the pen stylus. In this assignment, students were provided with an evaluation rubric, but again, they were not required to submit the rubric with their completed reviews. Students were given the 50-minute class period to complete their reviews.

In order to quantify the number of student review comments made and to qualify the nature of those comments, we developed a Comment Inventory based on previous research in the field of peer review commentary.

Description of Peer Review Comment Inventory and Procedure

Our comment inventory provides a consistent space (either electronic or print) for recording and tabulating students' peer review comments in reference to where they are physically located (placement), content, and linguistic form. When we initiate an inventory of a set of peer-reviewed papers, we first provide a number to each paper in the set. The first slot on the comment inventory, as reproduced in Figure 1, identifies the paper being inventoried; a separate inventory is completed for each paper.

	Paper ID													
	Place	Content					Form							
	End	MUGS	RDC	Personal	Org.	Reqs.	Correction	Directive	Compliment	Criticism	Rule	Question	Reflection	Graph/Ind.
1														
2														
3														

Figure 1: Peer Review Comment Inventory Form

The numbers in the left-hand margin (beginning with "1" and continuing consecutively) correspond to numbering that we add to each peer-review comment that has been provided on the paper. Each comment is given a number; when a comment is clearly compound (containing multiple comments within a single area or end comment block), it is broken down into multiple, separately-numbered units.

The remaining cells on the form allow the person performing the inventory to identify the nature of the each comment by three criteria: Placement, Content and Form. The person performing the inventory must identify where the comment is placed, the kind of content the comment contains, and the form the comment takes. The remainder of this section describes what information is recorded in the inventory to describe each comment's placement, content, and form.

Placement

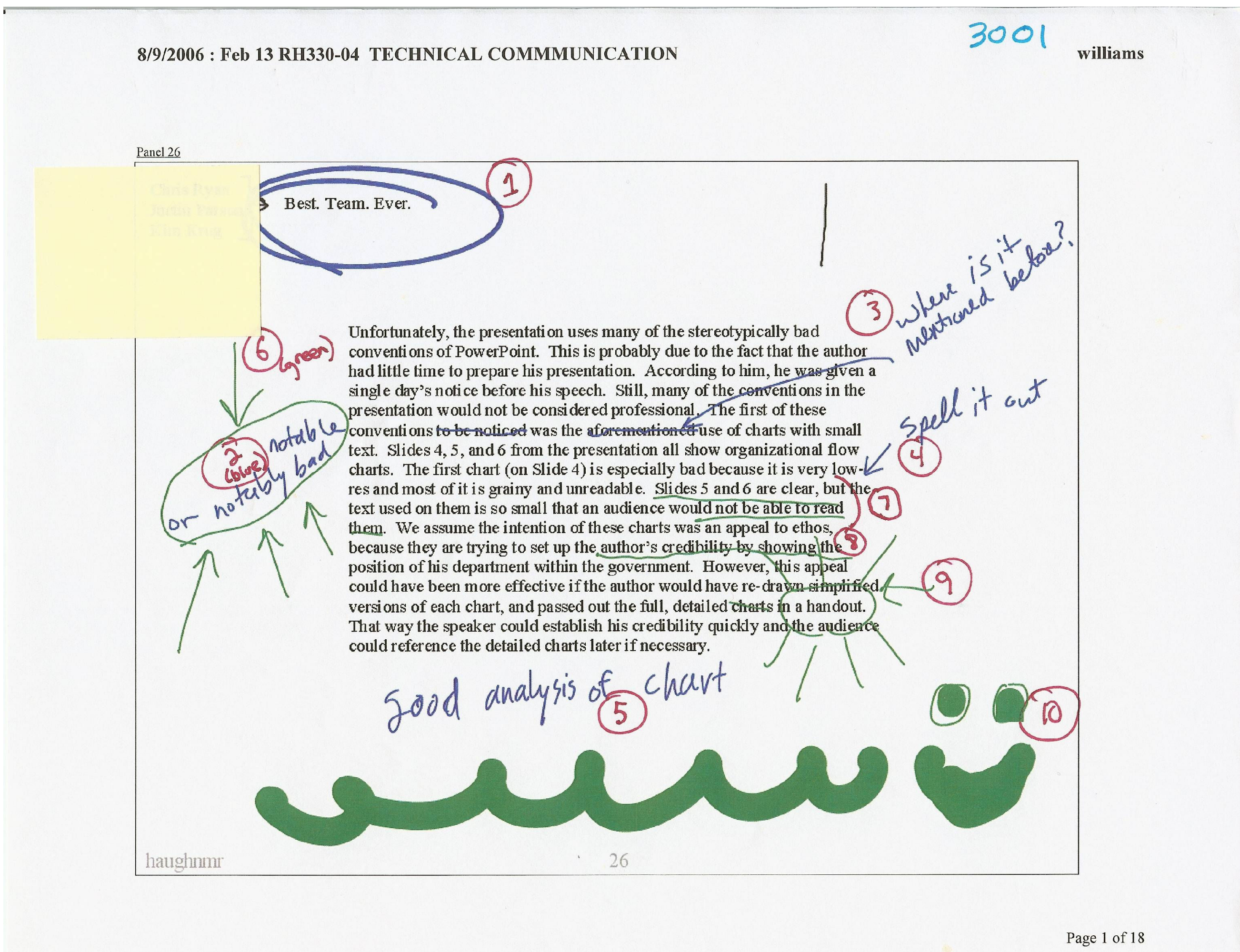
We are interested in recording whether the comment occurs at the end of the document, or in the margins: a concern that applies in both paper and electronic commenting formats. Because the majority of comments are in the margins, the inventory contains a single column to be checked if the comment was an end comment; if this column is not checked, the comment is assumed to be a marginal comment. In analyzing our data, it is possible to look for correlations between content or form of a comment, and whether it occurs in the margins or as part of an end comment.

Content

Classifying the nature of the content of the comments has been an important but challenging aspect of our work on this project, and we have drawn heavily on both the prior literature and our own teaching concerns in developing our categories.

Content—MUGS

One content area we wished to isolate is that to which we apply the acronym *MUGS*, standing for mechanics, usage, grammar, and spelling. The comments put in this category are frequently called surface features or lower-order concerns.[17]



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Unfortunately, the presentation uses many of the stereotypically bad conventions of PowerPoint. This is probably due to the fact that the author had little time to prepare his presentation. According to him, he was given a single day's notice before his speech. Still, many of the conventions in the presentation would not be considered professional. The first of these conventions to be noticed was the aforementioned use of charts with small text. Slides 4, 5, and 6 from the presentation all show organizational flow charts. The first chart (on Slide 4) is especially bad because it is very low-res and most of it is grainy and unreadable. Slides 5 and 6 are clear, but the text used on them is so small that an audience would not be able to read them. We assume the intention of these charts was an appeal to ethos, because they are trying to set up the author's credibility by showing the position of his department within the government. However, this appeal could have been more effective if the author would have re-drawn simplified versions of each chart, and passed out the full, detailed charts in a handout. That way the speaker could establish his credibility quickly and the audience could reference the detailed charts later if necessary.

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Figure 2: A student's peer reviewed document, prepared for inventory

Content—RDC

RDC on the comment inventory sheets stands for Rhetorically-Driven Content analysis, corresponding to what many have called higher-order concerns.[17] We teach the course with a rhetorical emphasis, by which we mean students are taught to evaluate communication by the degree to which it successfully adapts to its rhetorical situation: its audience(s), genre (communication type), purpose, topic, and specific context (recognizing that communication does not occur 'in a vacuum'). Rhetorically-driven content analysis, then, will comment, for example, on whether the technical level of a passage is appropriate (or too high or too low) by reference to elements of the rhetorical situation: the intended audience's technical background; the intended genre's conventions about technical level; and/or the relevancy of the content to the author's purpose. Judging the value of peer review feedback is often a matter of focusing on these types of RDC comments, too often neglected as students focus instead on the easier-to-deal-with surface level concerns. By grouping this class of comments together in one category, we hope to obtain a useful single number for ease of reference in analyzing the nature of the feedback our students have provided to each other using different technologies. We consider this our "trump" category: if the comment has some of these elements, that's where we put the check mark.

The remaining columns under "Content" allow us to account for student comments that are merely *Personal* in nature (such as "Wow, I didn't know that!); or comment on the *Organization* of the paper without connection to rhetorical situation (such as "It seems to jump around a lot."); or simply respond to *Requirements* of the directed peer-review process (such as highlighting key words on a résumé that correspond to a job ad).

Form

The last set of categories on our inventory sheet classify the linguistic mode of the student's comment, drawing heavily on Straub's and Mackiewicz's work.[20, 19] The peer-reviewer might actually attempt to fix the problem (*Correction*), offer a *Directive* about what s/he believes should be done, offer a *Compliment* or *Criticism* of the writer's work, articulate a writing *Rule*, ask a *Question,* or simply offer a *Reflection***.** We also added a category for *Graphical/Indicator* to account for non-verbal peer-review markings that were not corrections, such as simply drawing arrows, underlining, or doodling.

Preliminary Data

Currently the preliminary data we have collected represents a small sample size of student papers. Despite the small sample size, we are hopeful that performing additional inventories and increasing the data pool will bear out our initial observations and conclusion.

Figure 3 shows our initial inventory of papers:

- 23 papers from the Conventional Peer Review context (CPR)
- 24 papers from the Word Peer Review context (WPR) that includes both the work of reviewers who used the pen input method to add their comments and the work of reviewers who used the keyboard input method
- 24 papers from the Tablet PC Peer Review context (TPR)

The set of WPR papers was then broken down into two additional tables: a group of pen-input comments only and a group of keyboard comments only.

Paper group:	Conventional Peer Review (23 papers)								
	Correction	Directive	Complimer	Criticism	Rule	Question	Reflection	Graph/Ind.	Total
MUGS	40	9	1	4	0	1	0	2	57
RDC	1	23	10	22	0	25	0	0	81
Personal	0	0	2	0	0	0	3	0	5
Org.	0	4	1	1	0	1	0	3	10
Reqs.	4	4	1	2	2	4	0	24	41
Total	45	40	15	29	2	31	3	29	194

Paper group:	Pen and Keyboard in Word Peer Review (23 papers)								
	Correction	Directive	Complimer	Criticism	Rule	Question	Reflection	Graph/Ind.	Total
MUGS	55	3	1	8	1	7	0	1	76
RDC	1	15	19	5	0	16	0	0	56
Personal	0	1	6	0	0	0	5	0	12
Org.	0	1	2	0	0	0	0	0	3
Reqs.	1	24	18	4	1	7	4	13	72
Total	57	44	46	17	2	30	9	14	219

Paper group:	DyKnow Peer Review (24 papers)								
	Correction	Directive	Complimer	Criticism	Rule	Question	Reflection	Graph/Ind.	Total
MUGS	9	5	0	3	0	1	0	9	27
RDC	0	2	15	2	0	9	0	2	30
Personal	0	0	2	0	0	0	0	6	8
Org.	0	4	0	0	0	0	0	1	5
Reqs.	1	7	4	2	0	2	0	22	38
Total	10	18	21	7	0	12	0	40	108

Paper group:	Pen-based comments only (14 papers)								
	Correction	Directive	Complimer	Criticism	Rule	Question	Reflection	Graph/Ind.	Total
MUGS	15	3	3	2	0	2	0	1	26
RDC	1	10	15	3	0	5	0	0	34
Personal	0	0	1	0	0	0	2	0	3
Org.	0	1	0	0	0	0	0	0	1
Reqs.	0	13	13	2	0	4	1	5	38
Total	16	27	32	7	0	11	3	6	102

Paper group:	Keyboard comments only (9 papers)								
	Correction	Directive	Complimer	Criticism	Rule	Question	Reflection	Graph/Ind.	Total
MUGS	40	3	1	6	1	5	0	0	56
RDC	0	12	5	2	0	12	1	0	32
Personal	0	0	5	0	0	0	3	0	8
Org.	0	1	2	0	0	0	0	0	3
Reqs.	0	6	5	2	0	2	2	8	25
Total	40	22	18	10	1	19	6	8	124

Figure 3: Compiled Data from Peer Review Inventory

From the preliminary data collection, we have concluded the following:

1. In the Conventional Peer Review (CPR) context, students tend to focus on "RDC" comments, possibly due to the nature of the Peer Review assignment itself. Students were instructed by the professor to mark up the authors' drafts with specific symbols in order to indicate the presence or absence of particular RDC features.

2. In the Word Peer Review (WPR) context, "MUGS/Correction" comments were most frequent with the use of the keyboard, while "Compliment" form comments appeared most frequently with the use of the pen.

3. In both the CPR and WPR contexts, students were instructed to address "Requirements" in their peer review comments (to denote, for instance, if the author had included a thesis statement). This would explain the high frequency of "Requirements" comments in both CPR and WPR contexts.

4. In the WPR context, the use of the pen in Word did not increase the frequency of graphical comments, while the frequency of "Compliment" comments did increase with the use of the pen.

5. In the Tablet PC Peer Review context, students wrote fewer comments, but their comment form tended to be more "Graphic."

In all contexts, students exemplified very little interest in citing a "Rule" or providing "Reflection" for their authors. In addition, we expected that students would move gradually away from "MUGS/Correction" comments and toward "RDC" comments as they grew more comfortable with the RDC comments and used them in the context of the course.

Conclusion

In addition to the information we are collecting regarding peer review, we have also conducted attitudinal surveys to evaluate students' usage of various computer technologies both pre- and post-course and their perceptions of the effectiveness of pen-based computers as a peer review tool. As we continue to compile the Peer Review Inventories and increase the data pool, we anticipate being able to confirm the impact of pen-based computing on both the frequency of student comments and/or the quality of student comments. This analysis will be the subject of future presentations and papers.

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