The Role of Writing in Effective Team Projects: Students and Professionals Differ

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Abstract – This paper describes the results of an NSF-funded study of 17 student teams in computer science and technical writing classes. Observations and interviews with students are contrasted with the practices of experienced professional engineers. The results suggest major differences between how students and professionals view the role of written communication in team projects. Students viewed teamwork almost exclusively in terms of verbal communication and rarely produced managerial documents such as meeting minutes and task lists—even when explicitly encouraged to do. By contrast, professional engineers see such documentation as essential to project success. Student teams also used ineffective strategies for coauthoring documents, often trying to write major sections of text synchronously as a group. Finally, student evaluations of their teammates' written contributions were often inaccurate. Recommendations for structuring classroom team projects are presented.

Index Terms – Teamwork, Collaborative writing, Technical Communication, Cooperative learning, Gender.

INTRODUCTION

The growing importance of teamwork to the STEM curriculum has led a number of researchers to conduct studies analyzing breakdowns that occur in student collaborations in an attempt to develop pedagogies that can minimize such problems. These studies have helped illustrate common problems such as the tendency of student teams to arrive at consensus prematurely [1, 2], over-emphasis on efficiency at the expense of understanding [3], gender stereotyping of women into clerical roles and men into technical roles [4-6], and a tendency for students with poor leadership skills to grab the reigns of projects [2]. This paper adds to this research base by elucidating how engineering students' avoidance and dismissal of written communication contributes to many of the major problems experienced in student teams. In pointing to written communication as the culprit of many team troubles, this paper argues that too often pedagogical materials on teamwork have focused on verbal communication at the expense of written communication. This paper draws on the researcher's experiences observing and interviewing 17 undergraduate student teams to suggest ways that writing instruction and teamwork instruction might be better integrated.

BACKGROUND

The tendency of engineering students to underestimate the importance of writing to their professions has been well-documented [7-9]. Ironically, many of the materials developed to teach students how to collaborate effectively tend to play into this misconception by focusing on a narrow set of verbal communication skills when they discuss teamwork. For instance, The Team Training Handbook developed at Arizona State University states that "most teamwork occurs through face-to-face interaction in team meetings" [10]. Other sites containing advice for student engineering teams similarly focus on a verbal team interaction skills [11-13]. Most technical communication textbooks also follow this trend by discussing collaboration in terms of conversational roles rather than written genres such as minutes, task lists, or document drafts (e.g., [14, 15]).

Where team training materials often privilege face-to-face team communication, engineering professionals describe much teamwork as taking place at a distance. Ken West, an operations research manager at a major international corporation, estimated that about 25-30% of teamwork occurs in face-to-face meetings: "the remainder of the communication takes place by exchanging documents, exchanging emails, and phone calls... and of those, email ...[is] probably the preferred way." Richard Wallace, an Industrial Engineer with over 15 years managing teams in the military, notes that approximately 25% of teams today operate entirely in distributed electronic environments and estimates that in ten years almost 75% of teams will have no collocated face-to-face communication at all. In such settings, written communication is essential.

This paper describes my experiences observing and interviewing 17 undergraduate student teams as they worked on projects in their technical writing and computer science classes. Most of the teams studied here were exposed to either readings or workshops (or both) meant to improve their collaboration skills. As is the current status quo, these materials emphasized verbal communication—for instance, by instructing students in improving their listening or compromising skills. While many more innovative teamwork curricula exist, this paper aptly demonstrates the pitfalls that can await student teams that see writing as peripheral to their team projects.
METHODS

Because this paper focuses on general trends observed over the course of several years, the methods for collecting data will be treated cursorily. Undergraduate student teams in 9 sections of technical writing and 2 sections of Introduction to Computer Science classes at a large, urban university were observed between January 2003-May 2004 as part of a large NSF-funded research project on gender and teamwork.

Participants. Of the 58 students observed on these teams, 30% were Engineering majors, 25% Computer Information Systems, 30% Biology, and 15% Social Science or Humanities. Gender breakdown was 43% female, 57% male. Ethnic breakdown was 24% African-American, 70% Caucasian, and 6% Hispanic or Asian-American.

Teams. All student teams contained 3-4 members. Because the focus of the research was on gender, 13 of the 17 teams observed were mixed-gendered, 3 contained all men, and 1 contained all women.

Projects. The projects observed ranged from short, 3-week projects involving the creation of a series of technical brochures to semester-long projects involving a range of deliverables centered around the creation of a website (e.g., project proposal, design report, usability survey). Half of the projects observed involved the creation of a website and over two-thirds involved the creation of a technical proposal—often to justify design decisions made by the group. Most projects also involved a class presentation.

Instruction in Teamwork. Most of the classes observed were assigned to read a chapter on collaboration from a technical communication textbook (the book used varied from class to class). In addition, over half of the classes participated in an hour-long workshop that involved students in watching and analyzing videos demonstrating problematic student team interactions. While these videos were marginally successful in influencing some undesirable student team behaviors, they did not seem to prevent many teams from subsequently experiencing undesirable procedural conflicts that detracted from the project [16].

Student Observations and Interviews. Observations consisted of a researcher attending all student team meetings and taking detailed notes. Approximately 75% of meetings were either videotaped or audiotaped. In addition, researchers received copies of all emails, written drafts, and internal team documents and obtained individual biweekly process diaries from all team members. At the end of the project, individual interviews were conducted with team members.

Professional Interviews. Interviews were also conducted with four upper-management engineers with at least 15 years experience managing teams. These included a computer systems specialist, civil traffic engineer, industrial engineer, and an operations research manager. Both government and private sectors are represented. Professionals were asked about their experiences working on and managing teams and the role of writing in both their job and in teamwork. Names of both professionals and students are pseudonyms.

OBSERVATION 1: TEAMS FAILED TO PRODUCE USABLE TASK SCHEDULES

Few experienced collaborators would ever embark upon a project without at some point at least putting tasks and due dates in writing. However, what may seem like common sense to many was not at all intuitive to the students observed. Few student teams made a written task schedule and even fewer maintained this task schedule with updates as the project progressed.

Moreover, the task schedules that some teams did produce when required often looked like Table 1:

Table 1: Task schedule created by a student team

<table>
<thead>
<tr>
<th>Date</th>
<th>Task Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/12</td>
<td>Complete project plan</td>
</tr>
<tr>
<td>3/24</td>
<td>Analyze data</td>
</tr>
<tr>
<td>3/29</td>
<td>Completion of mockup site</td>
</tr>
<tr>
<td>4/6</td>
<td>Completion of proposal</td>
</tr>
</tbody>
</table>

This task schedule is clearly missing several elements: the team has failed to specify many important steps in the process and, most importantly, has failed to associate names with tasks. Such oversights make the schedule virtually useless for coordinating team efforts or holding individuals accountable for work. However, underspecified task schedules such as found in Table 1 were not unusual. In fact, the instructor of this class, who did not comment on this schedule, failed to notice that many teams had avoided assigning task to specific individuals until I pointed this out after the class had ended.

The consequences of failing to produce and maintain a viable most notably manifested themselves near the end of the project when students waited until the instructor-mandated deadline was imminent before completing their work. This created an impossible situation for students whose pieces of the project depended upon the completion of earlier work. These students had few resources for resolving their problems since—without a written task schedule— instructors had little basis for intervening in the project.

The absence of a task schedule also meant that many conflicts that should have taken place at the procedural level took place instead at the product level where they appeared much more difficult to resolve. For instance, one team experienced conflict when the student who had drafted the team's proposal felt that it was ready to turn in, while another student wanted to add more information. This produced a tense discussion over the merits of the current draft that might have been avoided if the team had simply budgeted in opportunities for multiple members to contribute to the document at the start of the project. Another team, because of miscommunication, ended up with two students producing independent drafts of their report with no plans for resolving the very significant differences between the two approaches.

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**Observation 2: Teams Operated Without Documenting Meetings**

Many of the instructors whose classes were observed explicitly required or strongly encouraged teams to take minutes of their team meetings. Some instructors required that the position of official minutes-taker should rotate among team members. In other classes, a permanent minutes-taker was assigned.

What the instructors failed to specify, however, was that the notes or minutes should be circulated to team members after the meeting. Thus, although teams often had an officially designated minutes-taker, these minutes were largely ignored. When I asked students in their final interviews why they had not circulated minutes, most suggested that such circulation was unnecessary because their teammates were also taking notes. Thus, because students saw their teammates writing down key information, they did not feel the need to follow up by circulating a common document. These students did not appear to consider the possibility that different group members could have been writing down different information or that, as one professional put it, "you can say one thing to five people and they will interpret it five different ways" (interview with Richard Wallace, 2/23/05).

In those situations where students did email minutes to the team, these minutes were generally ineffective because they were so poorly organized. Many students adopted a transcript style of note-taking in which they basically reproduced the entire conversation in the order in which it occurred. This transcript style of note-taking can be contrasted with a more action-oriented style of minutes, common in professional teams, in which "action items" are listed at the top of the minutes followed by a summary of important decisions and information to be discussed at the next meeting. Unlike these action-oriented minutes, the transcript style common in many student teams was time consuming and did little to focus the team's efforts. It is no wonder then that most teams abandoned this practice after the first few meetings.

Not surprisingly, given their treatment of note-taking as a transcript of the conversation, most students identified note-taking as a secretarial task in their final interviews (a view that many technical writing textbooks seem to reinforce). However, when I asked engineering managers who takes the notes for their project teams, they answered that engineers with expertise related to the project—and not secretaries—usually took notes for the team. Moreover, they stressed that ultimately it is the project leader's responsibility to see that notes are distributed after meetings—preferably as soon as possible: "At the end of the meeting, what should happen, there should be a page that says, all right at some point in time...you're gonna do this, you're gonna do this, and you're gonna do this....The person who is project manager, project leader, whatever, that particular person better make sure that it's written down." (Interview with Ken West). Another engineering manager similarly agrees that meeting minutes are "absolutely critical in moving forward. Otherwise you take one step forward and four steps back and one step forward and four steps back" (interview with Richard Wallace, 2/23/05).

**Observation 3: Teams Underutilized Asynchronous Writing Strategies**

Perhaps one of the most surprising findings to emerge from this research was how often students met face-to-face to work on tasks that would have been better coordinated through email. Engineering students were just as likely as those from other majors to fall into this trap. Often, when assigned to write a project proposal or user report, students would meet as a team not just to brainstorm about what would go into the document, but to actually write the document itself. Such face-to-face writing, as other research has also found [17], frequently led to tension since it is virtually impossible to have three or four people gather around a computer or paper document and enable all to have equal input. In such situations, many ideas are censored because of pressure to complete the task within the time frame of a team meeting.

Moreover, this over-reliance on face-to-face collaboration leads to many scheduling problems. Many student groups scheduled out of class meetings when they had no agenda or articulated reason for meeting. Such out of class meetings often produced resentment as team members with difficult schedules felt pressured to meet at times that were inconvenient for them. One group, given 30 minutes in class to collaborate, spent nearly all of that time trying to schedule a meeting out of class—which ended up being at 11:00 at night.

Student teams were not only more likely than their professional counterparts to try to write synchronously as a group, but they were also less likely to use asynchronous strategies that involved revising other teammates' work. In a detailed study of how writers collaborate, Posner and Baecker [17] identified four basic co-authoring strategies:

1. **Joint:** several people simultaneously work on the entire document, thus sharing joint control.
2. **Parallel:** several people independently work on individual sections of a document. (also referred to as independent)
3. **Centralized:** one person maintains responsibility for writing the document; others may offer suggestions or criticism.
4. **Relay:** one person works on the document and then passes it along to another team member for revisions and additions, and so on (also referred to as sequential).

Table 2 contrasts the co-authoring strategies used by the 17 student teams I observed with those used by professional writers from a range of fields. The data on professionals comes from interviews and surveys described in [17] and [18] and (unlike the observations of student teams) is self-reported data. While the settings and projects are not, of course, directly comparable, Table 2 does provide a rough indication of differences in how experienced and inexperienced writers choose to collaborate.

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**Table 2**

<table>
<thead>
<tr>
<th>Co-Authoring Strategy</th>
<th>Student Teams</th>
<th>Professional Writers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint</td>
<td>0%</td>
<td>77%</td>
</tr>
<tr>
<td>Parallel</td>
<td>5%</td>
<td>17%</td>
</tr>
<tr>
<td>Centralized</td>
<td>0%</td>
<td>5%</td>
</tr>
<tr>
<td>Relay</td>
<td>95%</td>
<td>10%</td>
</tr>
</tbody>
</table>

Table 2 contrasts the co-authoring strategies used by the 17 student teams I observed with those used by professional writers from a range of fields. The data on professionals comes from interviews and surveys described in [17] and [18] and (unlike the observations of student teams) is self-reported data. While the settings and projects are not, of course, directly comparable, Table 2 does provide a rough indication of differences in how experienced and inexperienced writers choose to collaborate.
Table 2: Percentage of student and professional teams (from [16, 17]) using various co-authoring strategies.

<table>
<thead>
<tr>
<th>Group</th>
<th>Joint</th>
<th>Parallel</th>
<th>Central</th>
<th>Relay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students (n=17)</td>
<td>53%</td>
<td>82%</td>
<td>41%</td>
<td>12%</td>
</tr>
<tr>
<td>Professionals (n=63)</td>
<td>22%</td>
<td>59%</td>
<td>44%</td>
<td>35%</td>
</tr>
</tbody>
</table>

Note: Because multiple strategies could be used in a single project, percentages do not add to 100.

Table 2 indicates that while both students and professionals favored the parallel co-authoring strategy (in which individuals work independently on sections of the document), students were significantly more likely than their professional counterparts to try to write jointly as a team, \( \chi^2(1)=6.2, p<.05 \). As mentioned above, this over-reliance on the synchronous joint writing strategy was responsible for many of the problems observed on student teams.

Students differed from professionals not only in their over-reliance on joint, synchronous writing, but also in their underutilization of the relay strategy. The relay strategy of passing a document back and forth between multiple team members is an effective method for combining the input of team members such face-to-face meetings, as mentioned above, were often tense situations where equal participation of all team members was not possible. Many students seemed to conflate performance in these face-to-face meetings with written contributions. Thus, students who were silent during the meeting were also not credited for the written work they completed outside of the face-to-face setting; on the other hand, highly vocal students were sometimes praised as strong writers despite not completing any actual writing for the project.

While written work was often overlooked or misattributed, technical work was not. Team members always accurately identified who completed technical tasks and (unlike writing) always saw tasks such as substantial contributions to the project. Thus, while writing was often invisible or unnoticed work, technical contributions and verbal contributions in face-to-face meetings were highly visible.

Such invisibility of writing in student teams contrasts with its high visibility in professional settings. Rene Stone, a former computer systems specialist with 18 years of experience, claimed that although she began her IT career as a programmer, she was quickly moved out of that role because her communication skills were so valuable. She explained that writing was a "specialization. It was really a ticket to advancement for me" (Interview with Stone, 3/4/04). Ken West, an operations research manager, similarly claims that written communication skills are a "big plus" and worries that he should be delegating more writing tasks so his subordinates can be promoted. Thus, where students generally paid little attention to their teammates' writing skills and consistently rated written contributions as less important to the project's success than technical ones, professional managers perceived writing—and not technical skills—as what could make an engineer stand out. As Stone puts it, "you go nowhere if you have a programmer with his nose in the computer and nothing else happens….If you have someone who’s a poor communicator you miss half the details."

**Observation 5: The Invisibility of Writing Disproportionately Hurt Women**

Consistent with other research [4-6], the women in the projects observed here completed a disproportionate amount of the writing for their teams. In their final interviews, students described secretarial work as including minutes-taking, revising documents, and often drafting documents. By contrast, leadership was most strongly identified with communicating in face-to-face meetings. Moreover, students nearly always ranked producing written reports and documents as less important to the project than technical work. Thus, the written work that women were most likely to perform was also the work least valued by the team.

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Unfortunately, this misperception was not corrected by most instructors who, when they assigned individual project grades, tended to rely upon evaluation forms or comments provided by teammates. Such evaluations were biased not only because students undervalued the work of producing written documents, but also because they were likely to overlook or misattribute such work in the first place.

While the tendency to delegate writing to women can hurt women's grades on school projects, it may actually be a benefit in the workplace. Rene Stone comments, "Ironically, from what I've heard, in technical training in undergraduate computer science (which I did not go through—I learned mostly on the job), the emphasis is on programming skills….When you have mixed-gender teams, the males will make the females do all the writing because they sneer at that and they think the hard stuff is really programming. Ironically, in the work place, immediately I was pulled out of programming after a year because I wrote and talked and I knew how to talk to users."

RECOMMENDATIONS

The problems documented here illustrate the need to emphasize the importance of written communication to teamwork. Many students lack the most basic understanding of how professionals use written documentation to manage team projects. Moreover, students often select ineffective models for co-authoring documents, tending to overuse synchronous methods of co-authoring that often result in unproductive team conflict [17]. Even students with junior and senior status evidenced these misunderstandings. Thus, while the following recommendations are most appropriate for team projects assigned in entry level classes, even advanced classes may benefit from implementing some of these suggestions.

1. Evaluate project managers by the internal documents they produce.

Task lists, schedules, and meeting documentation are all managerial documents that help keep the team on task. However, students are prone to see the writing of such documents as secretarial work. By clearly evaluating team project managers on the quality of such documents, teachers send a message that written documentation is an essential, managerial task.

In introductory classes, the instructor should also provide examples of such documents. For instance, it should be clarified that a task schedule should have a column for the name of the person(s) to complete the task. Students should also be shown an example of effective project meeting minutes organized around "action items" so they understand that minutes are not a transcript of the conversation, but a managerial document that holds people accountable for tasks, thereby ensuring that the team makes progress.

2. Provide students with a breakdown of roles that emphasizes written deliverables.

Because students often have no idea where to begin in assigning roles and tasks, successful project assignments will specify these for students. For instance, an assignment asking students to produce a website for a particular client or user group might involve the following roles:

- **Information architect** who interviews users about site needs, proposes a site information structure, and drafts the information architecture section of a design rationale document.
- **Graphics Designer** who proposes a site layout, produces graphic elements according to the client's needs, and drafts the layout and graphics section of the design document.
- **Coder** who creates and implements a site that accords with the design rationale and drafts instructions for maintaining the site.
- **Project Manager** who writes the group's project plan and task schedule, circulates minutes from team meetings, drafts introductory and concluding sections of the design document, and tests and edits the website and all documents for functionality and user-friendliness.

Each role described above is associated with specific written deliverables. Even the coder and graphics designer must produce written documents in addition to code. Such distribution of written work across all team members prevents the marginalization of writing and helps remind students that writing is central to engineering work.

3. Instruct students in different co-authoring strategies and clarify that asynchronous collaboration is also teamwork.

Student teams need to be dissuaded from the joint writing strategy and encouraged to use more asynchronous coauthoring models. Too many students seemed to think that a group project entailed completing much of the work synchronously. Instructors should directly address this misconception by explaining that face-to-face meetings are useful for the rapid exchange of ideas and for coming to consensus, but not for writing large sections of text.

Because the ideal collaboration and co-authoring strategies vary greatly from project to project and depend upon the type and complexity of the document(s) and the non-writing tasks involved in the project, instructors may find it useful to make strong recommendations about what co-authoring strategies students might use. In particular, instructors may want to design assignments that require students to use a relay method of co-authoring since many students did not seem to understand this model of co-authorship.

4. Make written reviews of teammates' writing a deliverable.

Students were often reluctant to suggest revisions to their teammates' work. To counter this tendency, instructors should
construct assignments so that students are clear that constructive comments and revisions based upon these comments are essential parts of the project. If instructors required students to turn in copies of their written replies, students would be motivated to complete this task. Implementing such a practice would not only more closely mirror professional practice, but should also lead to improvements in collaboration that are reflected in the quality of the final product.

5. Assign individual project grades that are based upon written evidence turned in at the end of the project.

There is clearly no easy way to persuade STEM students of the importance of writing to their careers. However, requiring evidence of students' written contributions—which may include drafts, meeting minutes, or emails—will at least direct students' attention to the role writing plays in facilitating teamwork. Moreover, by requiring written documentation of contributions rather than relying on team members' peer assessments, instructors can help reduce some of the gender bias that appears when students evaluate their teammates' contributions.

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