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Teaching Teamwork: Online Technical Writing Courses with Engineering Students

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Abstract

Using a pragmatic approach, this case study aims to incorporate communication skills in team teaching in light of the literature, describes how communication and teamwork principles play out in online third-year technical writing courses with ethnically diverse international students and faculty from engineering and other STEM majors at an institute of technology in the USA (n = 48). The data were collected using weekly assignments for the semester-long course, and student evaluations of course outcomes. The findings showed that because students wrote weekly short analyses and received weekly feedback, they most often improved their writing skills, such as editing their writings according to American English rules, and transferred learning of rhetorical principles from one setting (analyzing other people's writing) into another setting as they learnt to work as a team of productive writers.

Keywords: computer-based learning, team dynamics, professional communication, engineering students, writing.

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Introduction

After graduation from the university, looking for a job is on the agenda of many students. Thus, higher education should prepare the students for work environments across disciplines, including engineering, through honing the required skills (e.g., working and writing in a team, given that potential employers look for teamwork skills). As Lingard and Barkataki (2011) state, teamwork is recognized as a crucial skill for engineering, given that engineering is by nature a collaborative process, and most production systems are often designed by teams; communication and teamwork abilities are required. For example, most engineering students will work with crucial cross-disciplinary technical issues, such as global warming, intelligent networks, sustainable energy development, affordable housing, and resilient infrastructure. Rajabzadeh et al. (2022) conducted research into undergraduate experiences of group work. There were takeaways from group work experiences, such as good communication skills, the positive effects of working with diverse personalities and utilizing individuals' skill sets. Most engineering and science, technology, engineering, and mathematics (STEM) instructors know that when students enter workplaces, they will need to work with interdisciplinary teams to address these complex technical issues. Deveci and Bedirhanoğlu (2022) investigated 229 civil engineering university students' metaphoric perceptions of lifelong learning. "Enhancement of occupational skills" was less frequent in the data set. Their findings suggest that students' awareness should be increased of professional and personal aspects of lifelong learning. They highlight that given the multidisciplinary nature of engineering disciplines; these skills should be on the agenda through collaboration and cooperation with various departments.

We can assign group work in our classes to help prepare students for these 21st-century workplaces that are expected to require a broad set of knowledge, skills (e.g., critical thinking, problem-solving, creativity, collaboration, and communication), work habits, and character traits (Aizenkot & Ben David, 2022). However, then university students may complain to us about group assignments that turn out to be more trouble than doing assignments individually, given that the knowledge that students should know while writing covers several dimensions, including content knowledge, language system knowledge and writing process knowledge (Tribble, 1996). Students often tend to view these assignments as just busier work, and instructors wonder why students resist group assignments that we know will help prepare them for their careers. Among language skills, writing is

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more challenging to acquire for native speakers and second or foreign-language learners across disciplines. Engineering students, who are the target group in this study, typically avoid writing classes as far as we observed in the classes, and as Alley (2022) discussed, engineering and science students entering the university have high verbal American College Testing and the standardized test scores. Still, many engineering and science students cope with their writing, and also where they may feel that course objectives and evaluations do not directly relate to their academic and career goals. However, online technical writing courses can be considered sites for integrating humanistic teamwork and communication principles that will better prepare engineering students for 21st-century workplaces that include diverse, distributed teams by identifying their needs (see for needs analysis, Onder-Ozdemir, 2014, 2018).

In the literature, group work is defined as "students working together in a group small enough so that everyone can participate in a clearly assigned learning task" (Cohen & Lotan, 2014, p. 2). Students in a group communicate about their tasks with one another (e.g., asking questions, explaining, making suggestions, or listening). The interaction may also be nonverbal, such as nodding or smiling. When instructors assign group projects, we often make an assumption that students inherently know how to work with others to accomplish a task. This assumption trivializes students' cooperative skills need to build the foundations of trust and communication that successful teamwork requires. Rather than being a trivial activity, working in groups can actually be "one of the most demanding activities we engage in during our life" (Fujishin, 2013, p. xi). As Lindgard (2010) argues,

> most engineering students are ill-prepared to function effectively on teams before they are asked to do so in a course. To solve this problem, engineering programs must directly address the teaching of teamwork skills. This is the only way to ensure the delivery of graduates with the necessary level of teamwork abilities and attitudes.

Thanks to the opportunities group work provides in higher education, such as negotiating ideas and reflecting upon their learning, group work has long been accepted as an effective learning strategy to develop group work competence and skills required for effective teamwork and employability. Thus, teachers often encourage assigning group work (see Fraser & Deane, 1977; Smith, 1996). As Sweeney and Weaven (2005) discuss, group work also facilitates deeper learning and develops transferrable social skills that can be used in related contexts, such as those skills required for effective teamwork. Instead of assigning group work because it is expected in classes these days, instructors can set up group assignments to help students learn humanistic skills that emphasize the ability to find value in their fellow team members and their collective efforts. This type of learning also relies on learning robust communication skills. Team projects can provide opportunities for students to enhance their communication skills within engineering curricula that might otherwise not adequately address communication instruction (see López-Pellisaet al., 2021; Raza & Chua, 2023; Riemer, 2007; Sheth, 2015).

Communication as a Basis for Teamwork

Because all communication reflects human relations, most technical professionals understand that communication is more than simply a neutral conduit to convey information from one person to another. Kmiec and Longo (2017, p. 8), for example, argue that communication is the foundation of human communities:

> Humans are social creatures, and communication is the means by which humans identify themselves and each other, express their needs and desires, share knowledge, and interact to achieve goals. Communication is a ubiquitous feature of human communities. It is a behavior that creates society and enables groups of people to organize and accomplish complex tasks.

Fujishin (2013) also underscores the importance of communication for building relationships and accomplishing cooperative actions: "The purpose of life is founded in our relationships with others during this lifetime. The primary way we initiate, develop, and maintain these relationships is through the communication process" (p. 38). In team settings, communication is the medium for people to build interpersonal relationships that enable them to address the task, topic, and social dimension of teamwork.

These humanistic communication skills are not only valuable for students to be successful in their academic teamwork, but our students are also learning skills that employers will look for when hiring recent graduates. To help ensure that students learn these skills, the Accreditation Board for Engineering and Technology (ABET) specifies that graduates of engineering programs should have demonstrated abilities to "function on multidisciplinary teams" and "communicate effectively" as two of their eight general program criteria (n.d.).

ABET sees these "soft" skills as being important for young professionals to be "capable of leading the way in innovation, emerging technologies, and in anticipating the welfare and safety needs of the public" (n.d.). In the estimation of ABET's group of engineering professionals, therefore, teamwork and communication skills are vital to not only a person's individual success but also to our collective ability to address complex, global issues.

Professionals working in specific disciplines also acknowledge that they look for strong communication and team skills when hiring recent graduates (Ballinger, 2017; Dominguez et al., 2023; Llopis, 2012; Smith, 2000; Veis, 2017). For example, Ben Amaba from IBM Complex Systems states, "Software engineers need good communication skills, both spoken and written. They need analytical capability, and they need to be able to manage a project from end to end while working well with their colleagues" (Platt, 2011, para 9.) This statement was underscored at the December 2016 Federal Data in Action Summit in Washington, D.C., where panelists discussing the Future of Data Science Education and Recruiting reported that communication skills were the most important qualification they looked for when hiring for technical positions. "For data science to be effective, the panelists argued, they need people who can articulate the data in a way that makes it understandable for the rest of us" (Mitsch, 2017, para 4.). The skills of acquiring how to communicate technical information to people in different disciplines are also the basis for strong teamwork abilities. With strong interpersonal communication skills, teams can become groups in which people learn from each other and teach each other based on each member's area of expertise.

Working with Distributed Teams

Communication and teamwork have proven to be both rewarding and challenging work skills in face-to-face settings, where people have had millennia to come up with workable solutions to interpersonal communication challenges. These face-to-face team settings are still important for building interpersonal relationships. However, more and more engineering professionals find themselves working on complex global issues with people in different locations. These distributed teams are necessarily supported by information and communication technologies (ICTs) that enable both synchronous and asynchronous global communications. Kimble (2014) finds that these ICTs pose new challenges for team functioning:

> The desire to communicate and work with others in groups is part of human nature, but the rapid development of communications technology […] has added a new dimension to this basic desire. Within a single generation, we have moved from a fixed location, one-to-one communication by telex and telephone to a whole range of different possible modes of communication, all of which have been opened up by the sudden and rapid expansion of digital networks. […] The challenge to us as human beings is in how we adapt and respond to these new opportunities (p. 14).

Communication and teamwork skills are as fundamental to distributed team functioning as in face-to-face teams (McHenry & Krishnan, 2022; Staggers et al., 2008). In fact, distributed teams rely more on sophisticated, technology-mediated communication than face-to-face teams, both as a way to overcome cultural (Messer, 2016; Shachaf, 2008) and disciplinary challenges (Gajendran, 2012; Hassell, 2015; Sarker et al., 2011). Adding ICTs to the mix of communication media on distributed teams also adds complications on top of any language, culture, or personality differences that are inherent in global teams.

When distributed teams include members worldwide, communication is especially complicated. To be effective, team members must first "establish a basis for the effective exchange of their varying capabilities" (Siebdrat et al., 2009, para 13). If the team members are primarily native English speakers, establishing this basis is less complicated than in groups that include non-native English speakers whose team participation may be compromised because of this language dynamic. Despite these complications, multi-lingual distributed groups are becoming more and more frequent as organizations seek to address complex global issues. In her study of globally distributed team communication practices, Goettsch (2016) finds that non-native English speakers had more challenges in the areas of language, culture, technology, and collaboration. Her six recommendations for building relationships in these teams included increased informal communication, personal sharing, tolerance for pauses and slower communication, active listening, and awareness of the possibility of miscommunication. Watkins (2013) suggests formalizing the team's communication patterns by establishing a "communication charter" that sets out "norms of behavior when participating in virtual meetings" (para 5) to help ameliorate language and cultural challenges.

Working on distributed, cross-disciplinary, and global teams presents interpersonal challenges that can only be addressed by first establishing strong teamwork and communication skills among members. Engineering

instructors have sometimes sought to include these skills in content-area courses. However, these "soft" skills are unlikely to be addressed without explicit instruction due to the requirements of covering content material in a specific major. After all, these instructors are experts in their discipline but in areas that directly study teamwork and communication, e.g., organizational communication, small group dynamics, or human communication theory. Thus, it is not surprising that "soft" skills like teamwork and communication are not explicitly taught in most engineering classes. This gap in necessary skills training provides an opportunity for humanities and communication instructors to address teamwork skills explicitly in courses, such as third-year technical writing and first-year composition.

Teaching Teamwork and Communication Online

Learning to be effective team members in global, online environments is a skill that instructors can address explicitly in their content area courses. Especially since COVID-19, online education has been used significantly to deliver education at universities worldwide. Thus, self-sustaining online courses should help. Recently, Kuo and Fitzpatrick (2022) have highlighted the assessment of the impact of contextual influences on online higher education. They proposed three instructional design guidelines: (i) building a knowledge-based course structure, (ii) preparing flexibility in design, and (iii) promoting adjustability in modular design. Online courses are especially appropriate for teaching distributed teamwork skills because these learning environments more closely replicate virtual workplaces than traditional, face-to-face classrooms (Solheim et al., 2010). By including this type of distributed teamwork instruction in online courses, instructors provide opportunities for students to experiment and even fail as they strengthen their interpersonal skills (Solheim et al., 2010). Participating in online communities is second-nature to our university students, who come to their courses already prepared to learn more about online interpersonal communication skills. In 2009, a MacArthur Foundation report on digital media and learning found that people aged 18-32 were "actively involved in […] participatory cultures" characterized by "low barriers to […] civic engagement, strong support for creating and sharing creations […] [They] also believe their contributions matter and feel some degree of social connection with one another" (Jenkins, 2009, p. xi). In the intervening years since this study, the students in this research context have only become more adept with and comfortable in networked environments. They come to the classes ready to refine and deepen their interpersonal communication skills (see Moran, 2016, for a discussion of millennials as digital natives). These students also benefit from technology-enhanced learning that engages them as active participants. They will be in workplace teams after graduation (Jones & Fox, 2009; Sarkar et al., 2017).

Technology-mediated learning environments are largely read-write media, which lend themselves fundamentally to writing instruction. In fact, Warnock (2009) argues that because online writing courses require "students to learn to use writing to interact with others" (p. xi), they are perfect environments for students to strengthen their written communication skills while they learn other course content: "The [Online Writing] OW course forces an environment that is not just writing intensive but also often writing [exclusively]. As writing teachers, we could not ask for a better lab or workshop to help […] students develop their ability to communicate using the written word" (p. xi). In these online environments, engineering and writing instructors can design course structures that foreground reading and writing instruction, which form a basis for teaching teamwork and communication. Online course tools as simple as asynchronous discussion boards can provide robust environments for students to strengthen their communication and collaboration skills. In her study, Young (2008) finds that incorporating asynchronous boards into courses enhances student learning and results in higher grades when students actively participate in these online discussions. Tai et al. (2018) describe how this discussion tool can emulate peer-to-peer collaboration in engineering programs to underpin course instruction and perform future professional communication practices. Chadha (2018) also found that online collaboration in courses could "enhanc[e] student deliberative performance" in politics courses and could further "be used to complement a variety of disciplines" (p. 1), in which, unlike face-to-face class environments, all students are required to participate in online environments, which means that students need to develop skills to collaborate productively with their peers despite their personal differences. Although online collaboration can have some advantages, such as flexibility, many dimensions of interpersonal communication may be missing in online classes, such as the loss of empathy between students due to the absence of face-to-face communication, which causes interpersonal communication not to work effectively (Putri Anzari & Pratiwi, 2021). For example, it may lead to some obstacles regarding interpersonal skills and relationships, given that instructors in online classes may feel that their connection with students is limited, without much energy transfer that happens more naturally in the face-to-face classroom, such as feeling less support because of the physical disconnection with the classmates and teachers; lack of a sense of community, body language or someone's energy (see Bazylak & Weiss, 2017; Davis et al., 2019; Pacansky-Brock, 2016). When instructors acknowledge that this online collaboration requires stronger interpersonal and professional communication skills, they can build instruction on these topics into their courses.

As Griffin and Minter (2013) suggest, instructors can integrate assignments using social media and other online tools that students regularly use outside of class and using more formal tools in their course management system (see also Harris & Greer, 2016, for details about designing writing instruction into online courses).

In addition to written assignments, engineering instructors can use instructor- and student-created video content to model and reinforce professional collaborative communication. In a study by Greene and Crespi (2012), for example, students found video content in business courses reinforced their understanding of course content, in addition to finding information presented in this format to be entertaining and relevant. These researchers further report that their students had some challenges managing video technologies. However, the students in the context of this study are currently more adept at creating videos with mobile devices, which should largely overcome this barrier to content production. Speaking on the use of video in her K-12 classroom, Clark (2018) found that this medium helped to "make student thinking visible, give every student a voice, and easily share work" (as cited in Passut, 2018, para 1) – all skills that can translate to workplace collaboration.

Newer technologies can supplement teamwork instruction, both through web-based meeting tools and audio content. Web-based meeting platforms, which are routinely used in workplaces, can be helpful for students to create a sense of proximity with their distributed team members. Examples of these platforms are Cisco WebEx, Adobe Connect, or even Skype (see McLaughlin, 2018 for more information on meeting platforms). Audio tools can also facilitate verbal collaboration skills, both through instructors modeling professional verbal communication to students and through students practicing these skills in peer-to-peer communication. Audio tools can also help visually challenged students participate more fully with multi-media content (for information on inclusive design, see Burgstahler, 2017; D'Onfro, 2018; Rabidoux & Rottmann, 2017).

As highlighted in the literature by Vesikivi et al. (2019, p. 520), "although team teaching has been applied and studied already in the 1970s, there is no single universal definition for it." However, there are discussions in the literature. For example, to Katzenbach and Smith (2001), a team refers to "[…] individuals brought together for a certain task, goal or objective, engaged in frequent face-to-face interaction to execute a task, while the individuals are mutually interdependent on each other about the outcome of the task and its execution." Buch and Andersen (2015, p. 28) highlight that "team and project work is often considered to produce cohesion and identity." Thus, teamwork often stimulates personal and professional growth, autonomy, collectivity, solidarity, and well-being. To hone communication skills, education methods and curriculum need to be revisited to provide students with opportunities, such as team teaching, and a chance to study, work with real-world problems and have the freedom to make their own mistakes and discuss. In engineering, projects are often performed around tasks and project managers coordinate. Project members are assigned due to their expertise in specific technical fields that match specific tasks within the project. Hence, teams are formed. In this study, a team has three elements which are common goals, complementary skills, and responsibilities. Team members, who are engineering students in this study, pursue a common goal and develop a collaborative environment during online education. Team teaching provides engineering students with the opportunity to obtain feedback and support from peers, which creates a collaborative atmosphere and encourages their active participation in knowledge generation and sharing. In this study, team teaching, which has been used interchangeably with teamwork, refers to the ability to work in teams that involves a considerable amount of collaborative practices in online writing courses in engineering at the university, which is possibly the most important skill to possess in working life (Vesikivi et al., 2019).

Pragmatism is a philosophical school of thought highlighting that an idea or proposition is real when it meets the needs for practical applicability, functionality, and workability (Idiong, 2023). Using realistic, practical, and participatory aspects, drawing on John Dewey (1859-1952), the present study utilized a pragmatic approach in higher education where education and learning are social and interactive processes and the teacher's responsibility is more of a facilitator than an educator. In the pragmatic approach, context (e.g., online technical writing courses) and receiver (e.g., engineering students) are significant during interaction (see Aijmer, 2013; Zeleňák, 2006). As De Felice et al. (2023) state, we acquire new information, mainly in social contexts, through the transformation of information. Adult learning typically occurs in social contexts and relation to peers, colleagues at work and/or mentors. In this study, as a communication process, in social interaction, engineering students spend time together during online technical writing courses, which involve verbal and non-verbal communication. Thus, students have been provided with an embracing learning milieu where they can learn how to write in English and realize their potential using teamwork in online technical writing courses.

Using a pragmatic approach, in which engineering students work in a team to explore their experience, knowing and acting are shaped through social interaction and being active in online writing classes; the present

study aims to incorporate communication skills in team teaching in online classes in light of the literature, describes how communication and teamwork principles play out in an online third-year technical writing course at an institute of technology in the USA with an ethnically diverse international student body and faculty. The focus is junior-level technical writing at an institute of technology, where we have students from engineering and other STEM majors, along with business majors. Our motivation for conducting this study is to share how teamwork can empower engineering students and experience reciprocal support for collaboration rather than competition among students, which is believed to enhance course satisfaction and foster student competence and autonomy in education (see Barkley et al., 2014).

Methods

Participants and Teaching Communication Principles in a Third-year Technical Writing Class

The student body and faculty in this study both rank among the most ethnically diverse in the USA, with representative groups, including African American, Latino/a, Asian, and White. Over 20% of the student body are international students from at least 41 countries. As a whole, the student body and faculty are predominantly male (College Factual, n.d.). The classes in this study were online and are generally filled with 24-25 students each semester. The first author in this study was the coordinator of online writing courses and responsible for teaching and the second author was the observer and facilitator to practice teamwork. Both were teaching engineering students, so they were familiar with engineering students' needs. In this study, convenience sampling was chosen to involve participants because of the close proximity to the first researcher in this study because they were in her classes ($n = 48$). This study was a case study to capture the context and lived reality of engineering students (Duff, 2008; Stake, 1995).

We should note that Altınmakas and Bayyurt's (2009) findings revealed interrelating educational and contextual factors that may affect undergraduate writing, including students' perceptions about academic writing and disciplinary-specific text genres and prolonged engagement with the academic context and discourse. Considering these factors and our teaching context, the following six learning objectives in the course syllabus were present in this study:

1. Understand and explain the four rhetorical principles: audience, purpose, organization/arrangement, and discourse community.
2. Analyze and explain how these four rhetorical principles influence authors' writing decisions in technical documents.
3. Analyze writing situations and apply these four rhetorical principles in your own technical documents.
4. Analyze and explain how these four rhetorical principles influence your technical writing decisions.
5. Understand and apply team-building techniques in an online team environment.
6. Write effective technical prose that is mechanically correct and professionally appropriate.

The data were collected using weekly assignments for the semester-long course, and student evaluations of course outcomes. In the present study, during the first half of the semester, students learned to master and apply four rhetorical communication principles: audience, purpose, organization/arrangement, and discourse community- (see Kmiec and Longo (2017) for a rationale and more information on using these principles to teach technical writing). These students' first assignment was to write an introduction of themselves that included descriptions of "five great things to do in your hometown." Because this assignment was based on the expertise that students bring with them to class, which is engineering, they could all accomplish this introductory task. Because they posted these assignments to a discussion board shared by everyone in the class, students also recognized the purpose of this first assignment as introducing themselves to other members of the online class. As teachers, we can also become familiar with students' writing skills from this initial assignment.

In their second assignment, students revised their previous descriptions of things to do in their hometown to address architecture majors at our school, an audience of people with whom the students should be personally familiar. In addition to completing this revision, students were also asked to describe what changes they made in their description to accommodate their new audience and persuade them to visit their hometowns. We are more interested in their analysis in this second assignment than we are in the changes to their descriptions because the

analysis began our instruction in the first two rhetorical principles: audience and purpose. Students were supplemented the writing assignment with reference articles on these two topics, especially when preparing technical documents.

As Johns (2002) highlights, genre-based pedagogy can offer students explicit and systematic explanations of the ways language functions in social contexts. Students can understand the ways they use language to orient to and interpret particular communicative situations and employ this knowledge for their education. Textual conventions are often subject to community constraints, and the students need to consider working within these boundaries. Form, as well as other text features, is considerably affected by the conventions of a genre. Thus, for the next two weeks, students studied the four rhetorical principles in relation to a series of articles that all addressed elements of the course topic, which was nuclear fusion energy production. In these weeks, the concept of organizational strategies to the first two rhetorical concepts of audience and purpose was also added when this study was conducted. Students learned simple strategies for organizing writing and recognizing these strategies in sample popular science articles (see Jones, 2017 for sample strategies). The first article the students in the context of this study read and analyzed was from the *MIT Technology Review*, which covered innovations in nuclear fusion for an audience similar to my students. The second article was from *The New York Times* and focused on the business aspects of our topic. Assignments ask students to write about the audiences, purposes, and organization strategies in each article. In week 4, students also compared the article writers' decisions in weeks 3 and 4 for presenting information to accommodate their particular rhetorical considerations. They explained why each author made different decisions about how to present facts relating to nuclear fusion based on the authors' audiences and purposes.

In weeks 5 and 6, students read about the concept of discourse communities that form over a common goal and that establish regular roles and patterned ways of interacting […] Because these communities have members with regular and repetitive behaviors and responsibilities, they tend to adopt specific lexis […] and to develop habitual patterns for those individual communications that represent regular action (Kmiec & Longo 2017).

Students added this rhetorical concept to analyze research articles posted on the website of a company leader in developing equipment to generate clean energy through nuclear fusion. These articles represented the type of knowledge base and genres that were discussed in the readings about discourse community. Students also compared the writers' decisions in these formal research articles to the decisions writers in weeks three and four made when writing to more popular audiences. Although the topic content in the research articles was highly technical (nuclear physics) and was unfamiliar to most of my students, they were able to recognize and discuss the writing decisions authors made using the rhetorical concepts we covered.

In week 7, students read a lengthy popular article on nuclear fusion from *Time Magazine* and compare the writer's decisions to those made by research article writers. Students practiced their analytic skills for all four rhetorical concepts to compare these articles with very different audiences, purposes, and discourse communities. Students wrote about decisions that authors made about what content to include or exclude and how to organize the content to accommodate their intended audiences and achieve their purposes. By this point in the semester, students should have a solid mastery of these concepts and be able to apply them to analyze other people's writing. They were also writing analysis papers each week and sharing them with the entire class on weekly discussion boards. Their work was graded on a regular schedule each week and feedback was provided based on weekly grading criteria that had been available to students at the beginning of the semester. They knew how they would be graded before they started their assignments.

This brought us to the midterm of the semester in week 8, and students individually wrote an investigative report on the four rhetorical communication principles: audience, purpose, organization/arrangement, and discourse community. Their assignment was to help students in our class next semester (their audience) learn about these four rhetorical principles (their purpose), given that "writing skill requires a long period to develop" (Atasoy, 2021, p. 214). Students were asked, "to demonstrate what you have learned about these topics and how they relate to communication in a professional or academic setting." In addition to the grading criteria, additional readings about writing an investigative report to provide a structure for the type of report we expected them to produce were also provided.

Teaching Teamwork in a Third-year Technical Writing Class

In the second half of class, students were assigned three-person teams based on their class standing at midterm. The three students with the highest course grade at midterm were in a team, the next three students by grade were in the next team, and so on. All assignments in this half of class focus on learning to work in teams to complete their final assignment, which was a team report addressing next semester's students to tell them what they would need to know about audience, purpose, organization, and discourse community to become better writers and get a good grade in the class. These weeks-long, coordinated assignments helped integrate teamwork instruction into the course content versus addressing these social skills as an add-on to other technical writing material. Teamwork and communication skills would help prepare students for success in workplaces upon graduation. Being able to articulate their knowledge about teamwork helps graduates communicate their job readiness in a market where nearly 79% of employers look for teamwork skills when they interview applicants, according to a 2016 survey cited by Aoun (2017). This survey also showed that 70% of employers looked for written communication and problem-solving skills, both of which students also strengthened in this online technical writing course.

When engineering and STEM instructors prepare students for 21st-century workplaces, Aoun (2017) argues that students will not succeed "unless they are both highly collaborative and socially accountable to each other" (p. 39). Students can learn these humanistic skills through teamwork, but only if instructors structure the learning environment to teach these skills explicitly. In addressing this need to teach teamwork explicitly in online courses, Staggers et al. (2008) suggest that to fully capitalize on the potential of this environment for "the development of layered literacies […] students must learn effective teamwork skills. […] To achieve this goal, we offer a variety of team-building exercises designed to help each group through what some theorists believe are the necessary phases of team development" (p. 473).

Aoun (2017) calls this type of knowledge "human literacy" and finds that it is one of three literacies – technological, data, and human – that 21st-century universities need to teach under a rubric he calls "humanics" (p. 55) and argues that these are the literacies that differentiate human from artificial intelligence. Further, it is these literacies that prepare students to optimize human capabilities that will be necessary for future workplaces where humans cooperate with intelligent machines.

In addition to including more intelligent machines, future workplaces employing distributed teams will include people with more diverse backgrounds than 20th-century workplaces. Students will be working with people who have a "diversity of perspectives, including ones that challenge their presuppositions. Only through the full and respectful inclusion of people of different backgrounds, identities, and creeds can we learn, cooperate, and create to our full potential. Divided communities are weaker than unified ones" (Aoun, 2017, pp. 59-60). Fujishin (2013) also finds that teams with a range of experiences and perspectives can come up with innovative approaches to problems:

> Heterogeneous groups provide far greater perspectives, experiences, information, and skills than homogeneous groups. […] the different ideas, backgrounds, and ways of doing things increase the probability of making better decisions, solving problems, and being more productive in the long run. (p. 13)

Online courses can provide a robust environment for students to learn the human literacy skills that they will need in 21st-century workplaces where they will work with diverse, distributed team members, as well as intelligent machines.

When considering how to teach teamwork and communication skills in online classes, instructors need to keep in mind that if they have a diverse group of students, these individuals' cultural backgrounds will impact their reaction to the course: "Accordingly, cultural dimensions of learning need to be adequately addressed in designing and delivering instruction. […] Cultural attributes can affect online presence and learner perception" (Zhu, 2011, p. 13). In addition, instructors need to plan explicit team-building assignments to help students learn how to maximize team diversity and encourage the type of innovative problem-solving that employers value in their workplaces (see Staggers et al. (2008) and Morrison (2012) for examples of these course team-building structures). In the online technical writing class, we used chapters and exercises from Fujishin (2013) to teach teamwork and interpersonal communication skills during the last half of the semester.

During five weeks in this half of class, students read chapters in the Fujishin (2013) book and addressed questions each week asking them to share ideas about topics, such as listening to each other, solving problems as

a group, managing discussions, creating a cohesive group, and managing conflict. These topics emphasized the significance of communication and interpersonal understanding to build a foundation of trust for achieving team goals. In week 9, for example, each team member completed a self-inventory of their personality characteristics relating to teamwork. All three team members then shared their personal inventories and discussed how their characteristics might affect team functioning. They completed this assignment without judging themselves or other team members; they simply shared information about themselves as a way to get to know each other and build trust.

In week 10, teams read about group problem-solving in a chapter that includes information about decision-making techniques, steps for reaching consensus, sample discussion questions, and an agenda for students to follow in a problem-solving exercise. We assigned teams this problem, which was the final team assignment: "What should we tell next semester's Technical Writing 352 students about audience, purpose, organization, discourse communities, and creating successful teams?" Because each team member addressed this same question in their midterm investigative report, each one of them had expertise on this topic and a different perspective to bring to their problem-solving session. The team learned to listen to each other, reconciled their different ideas, and came up with a preliminary plan for how to approach their final assignment.

In week 11, the team topic was building cohesive teams. Students learned about the social dimension of team building and how this could be personally and collectively rewarding. Fujishin (2013) explains this as ways you can create caring and build a social dimension within your problem-solving group that encourages cooperation and productivity. "If group members discover some level of personal success, connection, value, support, and trust during the process […], they will more likely experience a social dimension that produces a cohesive group" (p. 154).

Students read about building personal success, connection, value, support, and trust among group members this week. They also considered the dangers of groupthink when teams are too cohesive and lose sight of different perspectives. The assignment for this week asked each team member to articulate a personal goal they would like to accomplish with the team this semester. Often, these goals were based on the self-inventories they completed in week 9. Team members then shared their goals with each other, and the team wrote a status report on how they would help each other achieve their goals.

For the next two weeks, teams drafted and posted their final reports for the next semester's students. We send them comments for revision during this phase of the class. In week 14, students continued to revise their reports and also read about managing group conflicts. This study included information on different approaches to managing conflicts, as well as setting out three types of conflict: substantive, procedural, and interpersonal. Specific steps were described for dealing with each of these types of conflicts. Finally, seven guidelines for encouraging group collaboration were explained to achieve "a common goal with a collective sense of purpose, sharing, and trust" (Fujishin, 2013, p. 181). Teams then wrote about a procedural and substantive conflict they dealt with during the semester and how they addressed it to strengthen the social dimension of the team. In this week, students learned that team conflicts could be opportunities for learning from different perspectives and encouraging innovation when these conflicts were approached with a spirit of cooperation and trust.

Results and Discussion

We should note that results were as reported by the students in their reflections about what they learned; there was no outside evaluation of the "results." As for the outcomes after fifteen weeks, teams handed in their final team reports for next semester's students at the end of the class. Most students made good progress as professional colleagues and technical writers, which is in line with previous studies (Barkley et al., 2014; Lingard & Barkataki, 2011; Marin-Garcia & Lloret, 2008). From our perspective of teaching technical writing for over 20 years, we could see that the semester-long focused on four rhetorical principles allowed students to analyze over and over again the writing choices in professional settings and the outcomes of authors' writing decisions. Because students wrote weekly short analyses and received weekly feedback, they most often improved their writing skills, as well, such as sharing a common vocabulary of terminology, being familiar with the writing style, and deploying the skills learned in teamwork effectively to plan plant design and processes. These are huge projects performed by a group and not by an engineering student. Additionally, by the end of the semester, they transferred their learning of the rhetorical principles from one setting (analyzing other people's writing) into another setting as they learnt to work as a team of productive writers.

In their last assignment, students responded individually to these questions asking them to reflect on what they learned about rhetorical principles and teamwork:

- Who is your audience and how did you accommodate their needs? Are their ways in which you did not accommodate their needs?
- What is your purpose for writing and how did you achieve it? Are their ways in which you did not achieve your purpose?
- How did you organize your material for your audience and purpose? Why is this organization strategy effective or ineffective?
- How would you describe the discourse community within which you are writing? How is your text appropriate or inappropriate for your discourse community?
- What is the main thing you learned this semester about working in a group? Why is this important and how might you use this experience in the future?

All in all, our evaluation of students' improvement came from (i) our observation of their weekly team assignments, given that we have been teaching writing for over 20 years and have evaluated many students' writing and also (ii) engineering students' self-evaluation from the last question of the final reflection assignment in this study, which was "What is the main thing you learned this semester about working in a group? Why is this important and how might you use this experience in the future?"

Below is a sampling of students' analyses of what they learned about accommodating their audience and purpose and the writing strategies they used in their final report:

> *The needs of the audience included information about what the course is and what is the real-life application of the course. For this, we compiled all the analyses each group member had done before the midterm. This gave us an idea of what each member had learned in the course and how their thinking process worked. By doing so, we were able to write about what the course taught us and hence what the future students will be learning. We also wrote that the teachings of the course were used in writing the research proposals and presentations we had to write for our STEM classes. (Student UR in Spring 2018)*

> *The purpose of any written work relates back to the question: what was the author trying to inform or explain to his or her audience? In our case, the purpose of the report correlated with our group's primary goal, which was not only to educate upcoming students and summarize what we learned this semester to current students but also to show how much we grew as a team. We definitely achieved this purpose by providing adequate and relevant information to all of our audiences in a simple manner; rather than giving too many specific details, my group and I firmly believe that it is best for any upcoming students to take these concepts at the most basic level and apply them when they actually take the class during the upcoming Fall semester. (Student DF in Spring 2018)*

Here is a sampling of students' analyses of what they learned about accommodating their discourse community and their writing decisions in their final report:

> *The discourse community that my team is writing within is a community of students taking* Technical Writing *352 currently. We all share our current goal of informing next semesters* Technical Writing *352 students what they need to know to be successful in this course. We all share Moodle as a form of common communication because everyone can see everyone else's work, and we can also message each other to enhance our ability to communicate further. Everyone within the community (the class) also shares a common vocabulary of terminology we have learned throughout the semester. To demonstrate this class as a discourse community even further, the students taking the class next semester can be seen as the novice who are new to the field of technical writing, followed by the students taking the class currently who are in the middle ground between novice and expert. Finally, Dr. X is on the expert side of the community. (Student DZ Spring 2018)*

> *...Being that this is the discourse community in which we are writing, it was important to us to use a writing style that is effective and professional to be taken seriously by people who take writing seriously. (Student RB Spring 2018)*

Here is a sampling of students' analyses of what they learned about teamwork in completing their final report:

> *As we came from diverse backgrounds, we all learned new things about each other, which was another benefit of the group activity. I feel that M… might have had a hard time since I come from India and S… from South Africa, so we both use British English. Though the language wasn't much different, our sentence construct and grammar were different than what M… would use. M… had to teach us how to write in American English. By the end of the semester, both me and S… were able to edit our writings according to American English rules and I see that as an added personal achievement. Working in a group is important since when we graduate and go out into the corporate world to work, we will always have to work in groups. For example, as a Chemical Engineer, I will have to plan plant design and processes, and these are huge projects done by a group and not by an individual. Hence, to work efficiently, I will have to deploy the skills I learned in this course. (Student UR Spring 2018)*

The data sample above suggests how a student may benefit from a diverse background in international teamwork in the class. The student's awareness of differences in sentence construct and grammar is apparent and how they collaborated in editing their writing using American English rules. All in all, the data showed us how online teamwork might benefit both work writing and increased awareness of collaboration in engineering.

The gains of online teamwork are clear in each line of the students and the benefits to engineering students' careers when they graduate:

> *By making students work in teams for the second half of the semester, students learned to work better alongside others through experience. In particular, I learned how to accommodate the individual personalities of others and, through communication, work together to create something more complete than what could be done by myself. To us, this is important because I have learnt that a team consists of people with their own individual ideas and situations. While multiple people may not always be on the same wavelength, through effective cooperation, these differing perspectives can come together to make something great (Student TM Spring 2018).*

> *The main thing that I learned this semester about working in a group is that it is not simple. Working in a group can be more challenging than working alone. Also, I got to meet two awesome individuals whom I didn't know about before, D… and Y... I'm so glad that Dr. X set the class up this way so that we could learn about each other and get nice teamwork done in real-time. The key to successful group work is sharing ideas or thoughts about the project with all the group members and resolving conflicts by following certain guidelines that depend on the type of conflict. This is important because in the future, as an engineer, I may be working with people that I don't really see too often or at all, and all I'll receive from them is a file of some sort (Student KL Spring 2018).*

At the end of the semester, students were able to analyze their writing decisions and communicate their ideas in a manner that reflects their maturing professionalism. When we looked back to their first assignments about their hometowns only 15 weeks earlier, these assignments mostly sounded like they came from engineering and STEM students who considered their technical writing class as just another required – and mostly irrelevant – class to get through on their way to graduation. After teaching nine sections of this course, which refer to nine 15-week classes, we were satisfied that by the end of the semester, the students in the context of this study were more engaged with their writing and sounded more like young professionals than mostly uninterested students. These students mastered rhetorical concepts they could use to analyze their future communication situations. They practiced effective skills to accommodate those situations. They expanded their abilities to explain and justify their decisions. These students were becoming members of their professional discourse communities. They would become technical professionals with human literacy skills to contribute to their 21st-century workplaces.

Conclusion and Pedagogical Implications

Though elucidating a 15-week online third-year technical writing course at an institute of technology in the USA, this case study utilized the process and techniques elucidated here in conducting international student teamwork in engineering. In the first half of class, students learned and applied four rhetorical communication principles, namely audience, purpose, organization/arrangement, and discourse community. In the second half of class, students were assigned three-person teams. Weekly writing assignments accompanied by feedback were

performed to measure students' technical writing trajectories and gains. The findings showed that despite diverse backgrounds and challenges (Shokirova et al., 2022), international students had many gains, such as learning new things about each other, resolving conflicts when they occurred, sharing a common vocabulary of terminology, becoming familiar with the writing style, and utilizing the skills learned in teamwork effectively to plan plant design and processes in engineering. They also transferred their learning of the rhetorical principles from analyzing other people's writing into another setting in a team. The findings obtained in this study suggest that to cultivate students' communicative ability, communication skills in team teaching in online classes can improve teaching and learning how to write by empowering learners to write in a team more strategically and effectively, which can help students apply their knowledge to practical situations. The activities in this case study boosted students' motivation to be involved actively in activities and reflect. The steps described above have encouraged engineering students to practice teamwork skills and improve the quality of collaboration among team members, which can be replicated across disciplines in mainstream classrooms worldwide. We can plan, implement and analyze pedagogical practices for online writing classes that support and enhance student learning. Also, we should provide students with opportunities for a sufficient amount of writing practice after observing their needs. More attention should be attached in the engineering curriculum to providing such lessons around teamwork. We should note that this study was conducted in the US, and the findings were limited to engineering students. Further studies can be conducted across countries and disciplines to provide new insights into online writing classes and teamwork.

Code of Ethics

Ethical approval was obtained from Bursa Uludağ University Research and Ethics Committees (Social Sciences and Humanities Research and Ethics Committee) with session number 2022-08 on 30.08.2022. All the participants took part in this study on a voluntary basis, and their identity was kept confidential.

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Takım Çalışmasını Öğretmek: Mühendislik Öğrencileri ile Online Teknik Yazma Dersleri

Öz

Pragmatik bir yaklaşım kullanan bu çalışma, literatür ışığında çevrimiçi sınıflarda takım öğretiminde iletişim becerilerini birleştirmeyi amaçlamış olup iletişim ve takım çalışması ilkelerinin, ABD'deki bir teknoloji enstitüsünde mühendislik ve diğer STEM alanlarında eğitim alan, etnik çeşitliliğe sahip uluslararası öğrencilerin yer aldığı çevrimiçi üçüncü yıl teknik yazma dersinde nasıl rol oynadığını açıklamaktadır. Bu çalışmada veriler, yarıyıl boyu süren teknik yazma dersi için haftalık ödevler ve dersin öğrenim çıktılarına ilişkin öğrenci değerlendirmeleri kullanılarak toplanmıştır. Bulgular, öğrencilerin haftalık yazdıkları yazılar üzerinde kısa analizler yazmaları ve haftalık geri bildirim almaları nedeniyle yazma becerilerini büyük oranda geliştirdiklerini ve retorik ilkelerini öğrendiklerini, bir ortamdan (diğer insanların yazdıklarını analiz ederek) başka bir ortama aktardıklarını ve öğrencilerden oluşan bir üretken yazarlar ekibi olarak çalışmayı öğrendiklerini gösterdi.

Anahtar kelimeler: bilgisayar destekli öğretim, takım dinamiği, mühendislik öğrencileri, teknik yazı