Leadership Roles, Socio-Emotional Communication Strategies, and Technology Use of Irish and US Students in Virtual Teams

Abstract—Global virtual teams provide numerous benefits both for corporations employing virtual organizational forms and for individual teams and team members. However, virtual collaboration also presents some well-recognized challenges. A growing body of research has examined the process of virtual teaming and the challenges inherent in that process. This study seeks to address some of the gaps in the existing literature. Specifically, it examines leadership roles, socio-emotional communication strategies, and the use of technology to establish relational links among team members. The study focuses on virtual team collaboration among technical communication students at the University of Limerick (UL) in Limerick, Ireland and at the University of Central Florida (UCF) in Orlando, Florida, USA.

Index Terms—Collaborative learning, communication strategies, technology use, virtual teams.

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Over the past decade a great deal of research has been conducted on virtual teams. Much of the research has compared the functioning of face-to-face teams with virtual teams. However, in the modern workplace nearly all teams rely on some virtual communication to accomplish their goals. Therefore, instead of comparing face-to-face and virtual teams, we need to recognize that all teams are virtual to some degree. In order to understand the functioning of virtual teams, we should focus on the “extent of virtualness” of teams.

Martins et al. define virtual teams as “teams whose members use technology to varying degrees in working across locational, temporal, and relational boundaries to accomplish an interdependent task” [1, p. 808]. They point out the fact that recent definitions emphasize virtual teams as teams first and treat virtualness as one team characteristic. In addition to examining the extent of virtualness, there are many other aspects of team functioning that require further investigation.

This paper presents a qualitative study of three key aspects of virtual teaming: leadership roles, socio-emotional communication strategies, and technology use. Although many studies of virtual teams have already focused on student participants, leadership roles and socio-emotional communication strategies are issues that have not yet been fully examined. Therefore, the findings of this qualitative study have implications for virtual teams addressing challenges related to leadership and media selection in the workplace.

**Literature Review**

A significant portion of the research to date has focused on understanding the process of virtual teaming and on addressing the challenges inherent in the process. Kayworth and Leidner suggest that the challenges faced by global virtual teams can be divided into four major areas: project management, communication, culture, and technology [2]. These areas may interact with one another; for example, communication challenges may be related to cultural differences or to the use of computer-mediated communication technologies. In the sections that follow, we discuss each of these areas; however, we discuss communication and culture together, as they are very closely related.
**Project Management**  Team leaders are often charged with responsibility for selecting media, structuring communication, and facilitating the development of group cohesion. There have been few studies of the use of management by objective in virtual teamwork. Hertel, Konradt, & Orlikowski found a significant correlation between the quality of goal setting and the team leader’s rating of team effectiveness [3]. Kezsbom argues that virtual team leaders may have to use more rigorous project management techniques to give virtual work groups more structure. She states that there are four “team basics” for success in virtual teams:

- a sense of interdependency;
- an appreciation of the benefits of group problem-solving and decision-making to establish a common approach for getting work done;
- accountability as a functioning unit;
- and
- a common goal/mission/sense of collective purpose. [4, p. 34]

Bell and Kozlowski charge team leaders with responsibility for building a team’s culture by establishing trust, mutual respect, and obligation between team members [5]. In their examination of best practices in virtual teams, Lurey and Raisinghani also emphasize the important role that team leaders must play in establishing positive team processes and developing supportive team member relations [6]. Chase notes that to establish positive team relationships, leaders must be vigilant in order to catch early signs of problems within the team since communication breakdowns may go unnoticed for a longer period of time in a virtual environment [7]. Further, while some examples of self-managing virtual teams do exist [8], [9], most research supports the conclusion that virtual teams do require some managerial guidance [10], [11].

**Communication and Culture**  Aspects of communication and team process that have been studied extensively are interpersonal trust and group cohesiveness. Successful team formation is clearly related to issues of trust. Jarvenpaa, Knoll, and Leidner state that trust in virtual teams is related to members’ perceptions of the ability, integrity, and benevolence of their team mates [17]. Initial impressions of these qualities are likely to be developed during the team formation stage. Face-to-face meetings make it possible for team members to get to know each other on a
personal level [18]. Sharing photographs and personal information on a blog also helps to develop a shared team culture [19].

Effective communication and the development of a shared culture during the team formation stage make it possible for teams to establish what Meyerson et al. have termed "swift trust". "Swift trust" is analogous to the behavior of film crews, presidential commissions, and cockpit crews who are groups of experts with clearly defined roles who come together to perform a common, finite task [20]. Iacona and Weisband studied trust in teams of business students and found that high levels of trust were developed and maintained as the result of effective, project-focused communication among all members early in the life of the project [21]. Coppola, Hiltz, and Rotter found that trust developed in online courses where a positive social atmosphere and predictable patterns of communication were established early in the semester [22]. Jarvenpaa and Leidner found that swift trust formed as a result of initial actions and frequent task and social communication. Social communication early in the project helped facilitate trust, but only when strong, task-oriented communication was in place as well [10].

Group cohesiveness is the result of the development of trust and of a shared culture. However, it is also related to shared understandings among team members. Dickey et al. argue that miscommunication among team members in a virtual environment is the result, not of lean communication channels, but of a lack of shared understanding among the individuals communicating. They suggest that text-based communication can result in shared understandings, but that the development of mutual knowledge may take longer in a virtual setting [23]. Similarly, Sole and Edmondson argue that the construction of situated knowledge is vital to the effective functioning of virtual teams. They found that knowledge situated in different organizational sites inhibited collaboration in geographically distributed teams. They suggest that both technological resources (such as electronic directories of specialist knowledge) and social approaches (such as periodic inter-site visits) can be used to raise awareness of and increase access to situated knowledge for members of virtual teams [24].

Knowledge sharing and other communication issues can be complicated by cultural differences among team members. National culture has been found to affect
interaction in virtual teams [25], [26], [27]. Vogel et al. found that those student
teams who were particularly attuned and accommodating to aspects of national and
professional culture had the most successful outcomes [28].

However, diversity in virtual teams is not limited to differences in national culture.
While some early studies found that status effects were reduced in virtual team
interactions [29], [30], other more recent studies have found that virtual groups
recreated social hierarchies in an attempt to preserve status differences [31], [32].
Gender differences also have a bearing on virtual team interactions. Both Savicki et
al. and Lind found that women were more satisfied with their experiences in virtual
teams than were men in the same teams [33], [34].

**Technology**  Studies of communication in virtual teams have examined the
importance of selecting the right technology for the most effective communication
[12], [13], [14], [15], [16]. For example, Baker found that the addition of video to
audio-based communication resulted in better decision making by virtual teams [12].
Huang et al. studied the use of a group support system (GSS) by undergraduate
students participating in virtual teams. They found that a GSS with a goal-setting
structure helped foster better team cohesion, better team commitment, and a better
climate for collaboration than a GSS without a goal-setting structure [13]. Hedlund et
al. examined the decision-making processes of teams in a computer-mediated
environment. They found that while face-to-face communication was more beneficial
at an earlier stage of the decision-making process, media that filters social cues led to
better decisions at a later stage when the team leader is likely to be distracted by
social cues with low validity [14].

Much of the research on technology use has focused on comparisons of lean media
and rich media. Lean media are those communication technologies that allow for
limited socio-emotional cues. Those technologies that allow for immediate feedback,
nonverbal cues, and personalization are categorized as *rich media*. Many of the
communication challenges faced by virtual teams are attributed to the lack of rich
media communication [35], [36].
However, despite the fact that it is not a rich media technology, email is frequently the communication medium of choice for virtual teams. Grosse reports that the global executives she surveyed used email for approximately 75 to 80 percent of their communication [37]. Email has several advantages for communication, particularly in international teams. When communicating via email, team members have more time to edit their messages, and therefore, it is easier for individuals who are not using their native languages to communicate clearly with one another [38]. Further, the lack of nonverbal cues and the resulting social distance may be desirable when handling negative feedback from a leader to a team member because it allows them both to take time to consider how best to express themselves [39].

Sole and Edmondson have argued that rich media are not necessary for the exchange of social information. They state that teams can develop social relationships and exchange information just as effectively using lean media, but that such social relationships will take more time to develop than they would using rich media [24].

**Directions for Further Research** Although much research has been done on virtual teamwork, there are many significant gaps in the existing literature. Martins et al. point out the need for further research on leadership in virtual teams. They suggest that researchers should focus on “how leaders define roles, structure interactions, motivate effort, evaluate performance, and provide feedback” [1, p. 821]. They also suggest an examination of how the extent of virtualness affects the quality of leader-member interactions.

Another related area in need of additional study is the interpersonal process of team members and socialization within teams, including an examination of how team members evolve into the roles they play in their teams. Ahuja & Gavin have begun to study this aspect of virtual teaming [40]; however, more study is needed to understand how group cohesiveness is developed and maintained. Related to this study of team interaction is the consideration of how team members perceive the social presence of various media and which media they prefer for establishing social relationships [41]. The conflicting findings related to the need for rich media suggest the need for more study of this aspect of virtual teamwork.
The Current Study  This study seeks to address some of the gaps in the existing literature on virtual teams. Specifically, the study examines leadership roles, socio-emotional communication strategies, and the use of technology to establish relational links among team members. The study focuses on virtual team collaboration among technical communication students at the University of Limerick (UL) in Limerick, Ireland and at the University of Central Florida (UCF) in Orlando, Florida, USA.

Although numerous studies have been conducted with students, this study makes a significant contribution to the study of virtual teams in academic contexts by focusing on research questions that address some of the gaps in the existing literature. The findings also have implications for practitioners, particularly for corporate managers of virtual teams and developers of online collaboration tools.

The specific questions this qualitative study will examine are:

- Do members of virtual teams assume team roles, even when they are not pre-assigned by teachers or corporate managers?
- Do virtual team members employ particular communication strategies?
- Do virtual team members find certain technologies more useful than others?

Methodology

In this section, we describe the composition of the virtual teams, the technological support that was provided to the students, the deliverables the students were required to submit, the research instruments we used, and our data analysis techniques. Since virtual teams are commonplace, and most technical communication practitioners will work in a virtual team at some point in their careers, a rich description of our study will be valuable for students, teachers, researchers, and practitioners [42], [43].

Virtual Team Composition  Over an eight-week period in the Fall semester of 2006, 26 students from the University of Limerick (UL), Ireland, and the University of Central Florida (UCF), Florida, USA, participated in a virtual team project to design web sites about aspects of intercultural communication. The 16 UL students were postgraduates, taking either a postgraduate Diploma in Technical Communication or an MA in E-Learning Design and Development. The 10 UCF students were senior-
level undergraduates majoring in English/Technical Writing. Although the UL students were at postgraduate level, they came from a variety of interdisciplinary backgrounds, and did not have advanced expertise in Technical Communication.

Students were grouped into seven teams, with one or two UCF and two or three UL students per team. Each team had three to four members, and to the greatest degree possible, we tried to ensure a balance of gender and location in each team (see Table I). To protect the students' anonymity in this paper, each team has been allocated a number and each individual in each team, a letter. For example, team member 1 in team 1 is referred to as 1a, team member 2 in team 1 is referred to as 1b, and so on.

Table I: Virtual Team Characteristics

<table>
<thead>
<tr>
<th>Team</th>
<th>Location</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team 1</td>
<td>2 UL, 1 UCF</td>
<td>2 male, 1 female</td>
</tr>
<tr>
<td>Team 2</td>
<td>2 UL, 2 UCF</td>
<td>1 male, 3 female</td>
</tr>
<tr>
<td>Team 3</td>
<td>3 UL, 1 UCF</td>
<td>2 male, 2 female</td>
</tr>
<tr>
<td>Team 4</td>
<td>2 UL, 2 UCF</td>
<td>2 male, 2 female</td>
</tr>
<tr>
<td>Team 5</td>
<td>2 UL, 1 UCF</td>
<td>2 male, 1 female</td>
</tr>
<tr>
<td>Team 6</td>
<td>3 UL, 1 UCF</td>
<td>2 male, 2 female</td>
</tr>
<tr>
<td>Team 7</td>
<td>2 UL, 2 UCF</td>
<td>2 male, 2 female</td>
</tr>
</tbody>
</table>

**Technological Support** Students were encouraged to use the Sakai Virtual Learning Environment (VLE) to manage their teamwork. Within this VLE, we created a unique worksite for each team, and a worksite for the whole group. Worksites function in a similar way to course or module sites in any VLE: each team had a set of tools (including tools for discussion, chat, and file sharing) in their worksite, which only the team and the instructors could access. Students participated in regular online discussions in Sakai during and outside of scheduled class hours.

Although the VLE was intended as a primary means for communication within the teams, students did have access to some rich media communication technologies. We organized for all students to attend two videoconferences, one at the start and one at the end of the project. The first videoconference gave teams an opportunity to "meet," put faces to names, and find out about each other. We set "ice-breaker" questions about experience of teamwork and collaboration, which all teams had to
address during the kickoff videoconference. During the second videoconference, teams presented their web sites to other teams and their instructors.

Additionally, students were encouraged to use online telephony software. Although UL could not support this option on campus, some Irish team members had access to online telephony tools on their home computers.

**Project Deliverables** Once students were organized into teams, we issued a project specification document describing the four main team deliverables:

- Project proposal submitted one week into the project, to convince the instructors that the team had a viable plan for completing the virtual team project.
- Progress report, submitted in the third week, outlining progress to date.
- Team web site on an aspect of intercultural communication.
- Individual project wrap-up report describing personal experiences of and contributions to the project, and reflections on virtual teamwork.

**Research Instruments** Three sources of data were available to help us to answer the research questions. We gathered qualitative and quantitative information through Pre- and Post-Surveys and through VLE data.

We issued Pre- and Post-Surveys at the start and end of the project. Students completed these individually. The Pre-Surveys were designed to gather data on each student’s prior experiences of:

- Using online collaboration technologies, since collaborating online would be fundamental to their success in the project.
- Working in teams and virtual teams, since such experiences, positive and negative, would likely inform their attitudes to virtual teamwork.

The Post-Surveys the students completed were discursive reports; by the end of the project they were better-placed to write about various themes that had emerged in their teams, such as:

- Their communication strategies.
- Their use of technology to collaborate.
• Their perceptions of the advantages and disadvantages of working in virtual teams.
• Their satisfaction on completion of the project.
• Their recommendations for future projects.

We obtained permission from students to analyze their VLE usage to gather information on aspects of their collaboration. For each team, we analyzed the number, nature and content of messages within their individual worksites, to determine how teams used technology, how leaders emerged and led teams, and how team members communicated during the project.

Data Analysis  As outlined in the literature review, our study aimed to answer several questions that we had identified as gaps in the existing research on virtual teams. Whilst our methods were primarily qualitative, we did gather some quantitative data on the number of postings per team and the extent of technology usage. We were also able to measure tools preferences across teams. Since Sakai offers students a range of communication options, we were interested in which tools were used, and for which types of communication.

Our qualitative methods were based on grounded theory, a method first discussed by Glaser and Strauss [44]. Grounded theory “follows from data rather than preceding them” [43, p. 204]. This method involves an interpretative analysis of data: the researcher identifies relevant themes from the literature, from their own theoretical perspectives, and/or from experience, carefully reads all of the data, codes the data, and compares the data to a theoretical model. As Glaser and Strauss note, “the procedures of grounded theory are designed to develop a well integrated set of concepts that provide a thorough theoretical explanation of social phenomena under study” [44, p. 5].

Our primary qualitative data were gathered from each team's VLE usage and from their Post-Survey comments. We coded the postings and comments using an adaptation of Curtis and Lawson’s [45] behavior categories. The coding schema we used, however, was based on the research questions we wished to answer. Therefore,
we coded them according to students’ references to team roles, socio-emotional communication strategies, and technology use (see Appendix 1 for a selection of coded messages).

**RESULTS**

This section describes the students’ technology use, team roles, and socio-emotional communication. Within each of these sections, we also discuss the teams’ overall satisfaction with the virtual teamwork experience. At the end of this section, we present our analysis of the results.

**Technology Use**  Teams had access to the following tools in their team worksites: an Announcements facility, Discussion Forums, a Chat room, a Wiki, and a Resources area. A short description of each tool is provided below.

*Overview of Sakai Tools:* The Announcements facility enabled students to post news and project-relevant information to the worksite. Students could choose to send an email alert when adding a new announcement. Six of the seven teams used this feature.

Each team worksite had three Discussion Forums, designed to facilitate asynchronous communication: Questions, Class Discussions, and a Student Lounge (for non-work exchanges). Although all teams used the Discussion Forums for project-related activity, given the five-hour time difference between Orlando and Limerick, it is surprising that these forums were not used more extensively. Only one team used the Student Lounge, and only in the first week of the project.

Most teams used the Chat room for scheduled, synchronous discussions during class times. Three teams did not use the Wiki tool and two used it only a few times. By contrast, one team used the Wiki tool to collaborate on all deliverables. Another team only began to use the Wiki collaboratively in the last week of the project.

While for some teams, use of the Resources area was limited to uploading CVs prior to submitting their proposals, others used this area extensively to share files. In one
team, one member uploaded all 16 resources. Another team only uploaded their completed web site to the Resources area, choosing instead to share resources in a Discussion Forum.

*Team Preferences for Using Certain Tools:* We did not make any recommendations to students about how to use the tools; we only requested that they limit their communication as much as possible to Sakai. They were free to experiment and use tools that suited their communication strategies best. Although Sakai has an extensive range of collaboration tools, some teams still chose to use some external tools for various reasons (some of these will be discussed in the next section).

Because Sakai offers several collaboration options, it is not surprising that different groups used some tools more than others. Table II summarizes their usage of Sakai tools, as well as external tools. For example, whilst most teams only used the Announcements tool occasionally, one team (team 7) posted 20 announcements. There is also considerable variation in the number of Chat room postings per team. All of the teams relied heavily on email in addition to the other tools they chose to use.

*Table II: Summary of Tools Usage by Team*

<table>
<thead>
<tr>
<th></th>
<th>Announcements</th>
<th>Discussion Forum Postings</th>
<th>Chat Postings</th>
<th>Wiki Postings</th>
<th>Resources</th>
<th>External Tools (Non-Sakai)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team 1</td>
<td>5</td>
<td>58</td>
<td>100</td>
<td>Not used</td>
<td>2</td>
<td>Email and Mobile Phones</td>
</tr>
<tr>
<td>Team 2</td>
<td>3</td>
<td>21</td>
<td>594</td>
<td>11</td>
<td>8</td>
<td>PB Wiki, Email, and Skype</td>
</tr>
<tr>
<td>Team 3</td>
<td>6</td>
<td>114</td>
<td>398</td>
<td>10</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>
This finding is consistent with previous research, particularly Grosse’s survey of global executives [37]. However, unlike previous studies [38], [39], the reason for the students’ preference may not be related to the need to have more time to edit messages or to second language issues (since English was the native language of all the students), but rather to the students’ familiarity with email and to the problems that occurred with some of the other tools discussed in Section 4.2.3.

**Issues/ Problems Associated with Certain Tools:** Many team members commented on problems with Sakai Chat, in their Post-Surveys. In particular, they complained about the poor refresh rate, which meant that messages became delayed and disjointed. This hindered some discussions and raised doubts regarding the interest, attention, or enthusiasm of other team mates. In addition, they were unable to use other Sakai tools whilst in Chat, although some teams eventually found a way around this by opening another Sakai browser window.

Team members also encountered problems with the Sakai Discussion Forums, as Sakai did not email them notifications whenever new messages or replies to messages were posted. There were also problems with the Sakai Wiki; one student (2b) said in his Post-Survey "the text editing space is restricted, the mark-up language is not

<table>
<thead>
<tr>
<th>Team 4</th>
<th>3</th>
<th>31</th>
<th>638</th>
<th>Not used</th>
<th>46</th>
<th>Skype and Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team 5</td>
<td>0</td>
<td>32</td>
<td>266</td>
<td>Not used</td>
<td>20</td>
<td>Email</td>
</tr>
<tr>
<td>Team 6</td>
<td>4</td>
<td>13</td>
<td>622</td>
<td>79</td>
<td>16</td>
<td>PB Wiki and <a href="http://delicio.us">http://delicio.us</a></td>
</tr>
<tr>
<td>Team 7</td>
<td>20</td>
<td>26</td>
<td>840</td>
<td>14</td>
<td>28</td>
<td>Email and Microsoft Word</td>
</tr>
</tbody>
</table>
intuitive and it is difficult to track changes and to create and link new pages”. As a result, team 2 used an external Wiki (pbwiki) for collaborating on documents.

Many team members commented on the lack of tools for audio- and/or video-conferencing. Every student was required to participate in two videoconferences, one at the start and one at the end of the project; this afforded them opportunities to see and hear each other synchronously. Throughout the duration of the project, students were also encouraged to use online telephone software (such as Skype) to interact with one another, but unfortunately UL was unable to provide access to Skype in the lab. Nonetheless, some UL students (only those who had broadband) installed Skype on their personal computers at home.

**Team Roles** While leaders emerged in all seven teams, some teams actively chose leaders and others did not. Some teams chose their leaders based on their knowledge and experience; other leaders seemed to emerge by default. In some of the teams, leadership was deliberately rotated among team members. For example, team 3 assigned a different project manager for each project deliverable.

Team Leaders: In all the teams, the leaders were those individuals who took the initiative to establish communication and to keep their team mates on task. For example, in team 6, 6b posted the first discussion message wherein he introduced himself to the team. He also began the first Chat session and frequently made comments recapping decisions the team had made and suggesting the direction for further work to be done. Similarly, in team 1, 1b took a proactive role at the beginning of the project by posting a message containing his contact details and a statement that the other team members could contact him at any time.

Leaders also made efforts to praise their team mates' efforts, to offer encouragement throughout the course of the project, and to thank team members for their contributions. Leaders in teams with only one member located in Florida also made a special effort to prevent that team member from feeling isolated. The Limerick-based leader of team 3, 3a, sought to counterpoint 3d's geographic isolation through communication. As 3d commented in her Post-Survey: "By reaching out to me via
email and Sakai, I felt as though I really got to know [3a], and I grew to trust him without a doubt.

Technology Leaders: One strategy used by most of the teams with great success was assigning team members leadership roles within their areas of greatest strength. For example, most of the teams had one member designated as the "technology leader". In team 6, 6c became the team's technology leader, probably because of his work experience and expertise in that area. In team 7, 7c took the lead in regard to technology and the creation of the web site. In team 1, 1b took on the role; in team 2, 2a was in charge of the web site design and while the group initially discussed not having a team leader, they eventually agreed that 2a should assume this role as well.

Editors: Several teams also had one member designated as the team's editor. In team 6, 6d emerged as the team's primary editor as well as one of the team's two leaders. This team, like many of the teams, had one team leader based in Limerick (6b) and one based in Florida (6d). Similarly, in team 7, 7c was the Limerick team leader and 7a was the Florida team leader; in fact, her Florida-based team mate, 7d, described her in exactly that way in her Post-Survey. In team 4, 4d became the unofficial editor. In some cases, as in teams 1 and 2, the overall team leader also fulfilled the role of team editor.

Other Roles: Team 6 was particularly successful in that all team members were satisfied with the learning experience and said they would gladly participate in a similar project again. This team did an impressive job of playing to each member's strengths. They also handed off responsibility to one another seamlessly and picked up the slack when one member was temporarily unable to participate fully due to illness, work commitments, or technology problems.

Team 7 also considered the team experience very rewarding, at least in part due to their team management strategies. According to 7b in her Post-Survey, they successfully delegated team roles: "Another successful strategy adopted by the team was assigning roles to each team member at a very early stage". Similarly, 7a stated in her Post-Survey: "What worked well for our team was to have clear distinctions on what exactly each team member was doing…".
Likewise, in team 2, each team member had a specific role and was responsible for areas they were particularly strong in. Both teams 1 and 5 were very open and democratic in their decision making processes; while these teams had a less formal leadership structure than the other teams, they too benefited from having a direct, task-oriented approach to the completion of the project. Team 4 had four members, but after non-participation of one member during the proposal phase, they ended by dividing the project among the remaining three members. This team divided the web development into two strands: web design and content production, with two team members, one from Limerick and one from Florida, responsible for each strand.

Although team leaders tended to communicate more than other team members, most teams had fairly equal participation among all members. Many students specifically commented on their satisfaction with the shared responsibility and the democratic decision making of their teams, in their Post-Surveys. As one team member commented, "We all very much felt a part of the decision-making process…[and] it was a pleasure to work in the team…[because] we had a great work ethic" (6b). Similarly, most team members were satisfied with and appreciated the leadership of their team mates. One student commented: "I do feel that [1b] showed many good leadership qualities throughout the duration of the project" (1c).

Two teams faced the challenge of a non-participating team member. Team 3 had one participant who appeared to cut herself off from the others and who contributed little to the project. Interestingly, only one team member expressed her frustration over this problematic situation in the Post-Survey. The other team members did not comment on the situation at all, and the team received excellent grades on all group deliverables even without the participation of one member.

Team 4 had one team member who participated in chats and discussions, but did not produce any work. His non-participation caused conflict within the team when he failed to meet the first deadline. Following this incident, the team members discussed the situation, but they did not confront this team member directly. Instead, they "minimized their expectations" and completed the project without any input from him on subsequent deliverables.
<table>
<thead>
<tr>
<th>Team</th>
<th>Team Leader</th>
<th>Technology Leader</th>
<th>Editor</th>
<th>Team Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team 1</td>
<td>1b (UL)</td>
<td>1b (UL)</td>
<td>1b (UL)</td>
<td>One member assumed many roles.</td>
</tr>
<tr>
<td>Team 2</td>
<td>2a (UL)</td>
<td>2a (UL)</td>
<td>2a (UL)</td>
<td>Whilst one member seems to have assumed many important roles, she initially only assumed the technology leadership role. Her team mates later suggested she assume the other roles as well. Other members each had specific sub-roles.</td>
</tr>
<tr>
<td>Team 3</td>
<td>3a (UL)</td>
<td>No-one clearly emerged</td>
<td>No-one clearly emerged</td>
<td>One team member contributed little, which caused some tension. However, the other members still received high grades overall.</td>
</tr>
<tr>
<td>Team 4</td>
<td>4b (UL)</td>
<td>No-one clearly emerged</td>
<td>4d (UCF)</td>
<td>Team leaders were responsible for one &quot;strand&quot; each. One member contributed little, which caused some tension, but the rest of the team then split the remaining work amongst themselves.</td>
</tr>
<tr>
<td>Team 5</td>
<td>No-one clearly emerged</td>
<td>No-one clearly emerged</td>
<td>No-one clearly emerged</td>
<td>This team had a less formal team structure than other teams.</td>
</tr>
<tr>
<td>Team 6</td>
<td>6b (UL)</td>
<td>6c (UL)</td>
<td>6d (UCF)</td>
<td>This team was very successful and satisfied overall.</td>
</tr>
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<tr>
<td></td>
<td>6d (UCF)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team 7</td>
<td>7a (UCF)</td>
<td>7c (UL)</td>
<td>No-one completely emerged</td>
<td>This team was successful and satisfied overall.</td>
</tr>
<tr>
<td></td>
<td>7c (UL)</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Socio-Emotional Communication**  Three of the seven teams had very strong socio-emotional communication: teams 3, 6, and 7. The other four teams had some socio-emotional communication, but were less pro-active about team building. Post-Surveys show that those teams that worked on team-building activities and had strong socio-emotional communication enjoyed the project more than those that did not.

*How Socio-Emotional Communication Developed:* Socio-emotional communication developed in different ways in the seven teams, mainly through: humor, non-task communication, and conflict.

Two teams used humor extensively to build team morale. Team 6 used humor to lighten the mood when facing tight deadlines for the project deliverables. In this team, 6b took the lead in injecting humor into their communication: "Who is the project manager? Who wants to take on this role? Apparently your salary is increased by 10% if you volunteer for it". The other team members followed 6b's lead in this regard and began using humor in their communication. Throughout the project, members of team 7 shared information about themselves, discussed their cultural backgrounds and experiences, and used humor to connect with one another. One member, 7c began adding humor to his Chat messages, and joked with 7b about catching a flight from Ireland to attend 7d's party. Teams 2 and 4 also used humor occasionally in Chat conversations.

Teams 3, 6, and 7 took many opportunities to build their teams through social, non-task interaction. Team 6 discussed events going on in their lives, ranging from travel plans and work responsibilities to health issues and home repairs. In each substantial Chat conversation, members of team 3 used posts at the start and end to discuss non-
project topics such as their hobbies, work, or how they planned to spend the weekend. One comment in 3a's Post-Survey highlights a deliberate use of socio-emotional communication to reduce any geographical barriers and increase trust: "I attempted to include what, I have since learned, … [is] socio-emotional communication in most of my emails, Chat and Discussions with 3d. Questions about the drinking habits of people from Florida, and the usage of [the term] 'awesome' … would be categorized as examples of 'improving cultural understanding' and 'confirming understanding'" (3a, Post-Survey). Team 7 began developing personal relationships from the start of the project, discussing holidays, work, and study from an early stage.

In teams 1 and 2, Florida members attempted to introduce more non-task communication but their Irish team mates did not always respond. In team 5, 5c mentioned his children in one post and discussed his interest in soccer in another: "P.S. Did you catch the Celtic FC match? They only show Man Ut'd here, so I watch what I can get, but I saw they won 2-0. Are you all Celtic fans? They look like they're making a good run for it. Not many people over here to talk football with". Conversations in teams 1, 2, 4, and 5 were good humored but largely task-oriented. Members used several emoticons and informal, friendly language, but there was very little non-task discussion.

Two teams had a problem of non-participation by one member in each team, which created conflict. This lack of participation may, however, have brought the other team members closer. For example, the three active members of team 4 praised each other's work frequently—"Excellent job. Very well written. I'm glad I'm on your team!" (4a, Chat)—and all three noted in their Post-Surveys the mutual respect generated through working together. Likewise, in team 3, the active team members seemed to make a stronger effort to communicate: "I really felt that 3a and 3b strove to include me in every decision made for the group…It is obvious to me that [3a] went out of his way to include me in every aspect of this collaboration" (3d, Post-Survey).

Tools used for Socio-Emotional Communication: Socio-emotional communication was initiated and nurtured through Chat (rather than Discussion or other collaboration
tools): teams used the Chat tool more than any other for non-task communication. Even though each team had access to a Student Lounge Discussion Forum for non-task communication, only two teams used this forum and only at the start of the project. In team 7, for example, Chat was the preferred means of communication because it allowed them to have real-time interaction, which fostered their development of trust. In this team, 7c attributed the team's ability to bond to their use of Chat. He stated: "TRUST has developed and ...the Chat room tool in Sakai has encouraged this new relationship". Likewise, 7b commented in his Post-Survey: "The use of the online Chat function in Sakai, contributed the most in the development of the project".

*How Socio-Emotional Communication Contributed to the Project:* Where a strong bond developed among team members, it led to a cohesive team: for example, as 7a reflected in her Post-Survey, "We were able to build a cohesive team because we stressed the personal relationship as well as the academic relationship". Clearly these team members had developed a shared understanding of the project and their identity as a team.

One noteworthy aspect of communication in team 6 is that they frequently volunteered to take on tasks and to help one another with the work. The members of this team were especially supportive of one another.

All teams took the trouble to thank each other for work done and to praise each other's work. Appendix 1 provides further examples of messages relating to socio-emotional communication, team roles, and technology use.

*Balancing Socio-Emotional and Task-Based Communication:* The members of team 6 managed to balance socio-emotional and task-oriented communication effectively to develop swift trust and to maintain trust throughout the course of the project. They kept on task all the time even when using humor and when sharing personal information.

Comments in team 3 Post-Surveys reflect how a blend of socio-emotional and task-oriented communication fostered the strong cohesion that developed among the active
group members. "I found team members capable, cooperative, and amicable. There was excellent cohesion in the team" (3b, Post-Survey). "We communicate[d] effectively while maintaining an easy cordial relationship with one another" (3a, Post-Survey).

Members of team 4 expressed their disappointment at the lack of socio-emotional communication. As 4d noted in his Post-Survey: "Our infrequent meetings did not give us much time to focus on any sort of team-building activities, which is unfortunate". One member’s lack of participation in this team undoubtedly caused a sour note to develop: "There were issues of trust which arose in respect to one team member… because we failed to deal with this, the situation did deteriorate" (4b, Post-Survey). "This incident generated some trust issues for us, and drove a wedge into our team dynamic" (4d, Post-Survey). In this team, in contrast to the subjective satisfaction with virtual teamwork acknowledged by most or all members of every other team, only two of the four members said they would participate in a similar project. In her Post-Survey, 4a noted: "My overall impression of this project is negative and I would not care to repeat the experience". This is the most overtly negative comment of any student in any of the Post-Surveys.

Likewise, in team 5, the lack of socio-emotional communication was noted. In his Post-Survey, 5b said that "activity in the chat room was concerned only with project work, there was never any interaction of a social nature, or what might be considered as 'idle chatter'" and he went on to say that social chat "is a means of reducing stress and helps to improve bonds between individuals. Although, this is more difficult in virtual teams, … an opportunity was missed on this occasion".

**Analysis of Results**  This section presents an analysis of the results under the following headings: technology, leadership and team roles, and socio-emotional communication.

**Technology:** While teams had many synchronous and asynchronous communication tools at their disposal, they showed a strong preference for using email. This finding is consistent with previous research, particularly Grosse’s survey of global executives [37]. However, unlike previous studies [38], [39], the reason for the students’
preference may not be related to the need to have more time to edit messages or to second language issues (since English was the native language of all the students), but rather to the students’ familiarity with email and to the problems that occurred with some of the other tools discussed in the Issues / Problems Associated with Certain Tools section.

For the most part, teams relied on asynchronous, lean media to do their work. While the teams did use the Chat room feature in Sakai, they did not exhibit a strong preference for it because of the slow refresh rate. As Sole and Edmondson have argued, rich media are not necessary for teams to develop social relationships. However, they suggest that teams using lean media will need more time to develop these relationships than they would using rich media [24]. Given the short time period (eight weeks) that students had to work on the project, their ability to develop rewarding personal relationships and to engage in socio-emotional communication is remarkable. Clearly, the use of rich media is not always essential for teams to form bonds, to work productively, and to have a positive team experience. Although the students expressed the desire for more access to rich media in their Post-Surveys (particularly tools for audio- and video-conferencing), they demonstrated the ability to function quite well without rich media.

Leadership and Team Roles: We did not assign team leaders or prescribe team roles. We enabled teams to select a single team leader, or to rotate the position for different deliverables. Proactive emergent team leaders demonstrated the ability to establish positive team processes; this ability has been identified by Lurey and Raisinghani as a best practice in virtual teaming [6].

The importance of clear, task-oriented communication has been emphasized repeatedly in the literature on virtual teams [4]. In our study, the teams that were most satisfied with the team process and with the overall experience of participating in a virtual team were those teams that divided up the project roles and responsibilities based upon the team members' individual strengths. The efforts of the leaders to establish trust and respect among team members bear out Bell and Kozlowski’s charge that leaders are responsible for building a team’s culture [5]. Although the research suggests that virtual teams require some managerial guidance, examples of
self-managing virtual teams do exist [8]. Some of the teams in our study demonstrated the ability to work very successfully and harmoniously while sharing the leadership role equally among team members.

**Socio-emotional Communication:** Socio-emotional communication led to strong participation and a sense of ownership of the project, and created a sense of subjective satisfaction with the virtual team experience. Members of teams, which lacked socio-emotional communication, regretted the lack of interaction and had overall less subjective satisfaction with the project. These students may have felt less satisfied in part because they did not share the same level of trust and sense of belonging with their teammates, as was evident in other teams.

Analysis of the communication strategies and Post-Surveys of all seven teams shows that if socio-emotional communication did not develop early in the project, it did not develop at all. This finding is consistent with Jarvenpaa, Knoll, and Leidner’s research on trust in virtual teams which shows that trust is related to initial impressions of the ability, integrity, and benevolence of teammates [17]. Jarvenpaa and Leidner found that the development of trust was facilitated when both social communication and task-oriented communication occurred early in the project [10].

Those teams in our study who engaged in both social and task-oriented communication reported feelings of trust in their teammates and a high level of satisfaction with the project. Dickey et al. argue that miscommunication among team members is more often caused by the lack of a shared understanding than it is by the use of lean communication channels [23].

The success of team 6, in particular, is consistent with the findings of Jarvenpaa and Leidner regarding the need for both social and task-oriented communication among team members [10]. Such communication enhances group cohesiveness and leads to the development of a shared culture.

**Conclusions**
This study examined research questions relating to the team roles, socio-emotional communication strategies, and technology use of Irish and US technical communication students collaborating in virtual teams. While the study did not include a large number of teams, some clear patterns emerged. For example, we found that the teams who divided up the project roles based upon the team members’ individual strengths had greater satisfaction with the team experience than those teams who did not. This finding should be of particular interest to online teachers and corporate managers charged with assigning team roles.

We also found that socio-emotional communication played a key role in the success of the team process. The most cohesive teams were the ones who made an effort to establish socio-emotional communication from the beginning of the project. This communication gave team members a strong sense of ownership of the project and created a subjective satisfaction with the team experience. Members of these teams were most positive about the overall experience and reported learning a great number of management and communication skills from the project. Therefore, online teachers and corporate managers should afford virtual team members some opportunities to establish socio-emotional connections with their team mates, particularly in the early stages of projects.

The teams varied in their technology use, but all the teams used some of the extensive range of collaborative tools available in the virtual learning environment. All the teams also used some external tools. However, those teams that built strong bonds through a mixture of socio-emotional and task-oriented communication tended to rely heavily on the Chat tool in the virtual learning environment. The students in these teams reported that they chose to use Chat (a lean medium) because it provided real-time feedback. They also reported using their personal email accounts extensively, but we were unable to capture any data from their email communication. Developers of virtual learning environments and lean media tools could use our technology findings to inform their design of more efficient tools. Also, our findings suggest that rich media are not always necessary for success in virtual teams.

Most of these findings support previous research done on virtual teaming. However, our study has demonstrated that a high degree of group cohesion, trust, and member
satisfaction can develop with the use of lean media, even during a project of short duration (eight weeks).

**Limitations**  This study involved a relatively small number of students collaborating over a short time period. Additionally, the student teams were not balanced with an equal number of students from each university. Two of the teams had three UL students and only one UCF student, and one team had two UL students and only one UCF student. Ideally, there would have been an equal number of UL and UCF students, and an equal number of males and females on each team.

Although we did expect culture to affect team performance, it proved not to be a significant variable for our Irish-US study, probably because the participants came from broadly similar cultural backgrounds and they were all native English speakers. However, as many virtual teams consist of members from many different cultures, we feel this is an area that warrants further study.

Students were encouraged to organize and hold structured meetings and to document the minutes of their meetings. However, as we did not give them detailed instructions on how to do this, some teams did not have very productive meetings and some team members did not always behave in a professional manner.

Whilst each team had to develop a web site about some aspect of intercultural communication, this was not a real-world project. In some ways, this may have affected some students' enthusiasm for, and commitment to, the project.

**Future Research**  In a future study, we would hope to address some of the limitations identified in the previous section. In this study, we found that teams that had defined leaders and structured meetings were both more successful in their product and more satisfied with the process. For this reason, we would like to designate team leaders and give students more instructions on how to organize and hold structured meetings. We would also like to award marks for professionalism.

A study conducted with a larger number of students (and a larger number of teams) from Western and non-Western cultures could further investigate the correlation
between certain patterns of communication, collaboration, and technology use and the successful performance of virtual teams.

Finally, we believe that working on a real-world project with real clients would raise the stakes for students and lead to a higher level of engagement.
Appendix 1: Selection of Coded Messages

We coded the VLE postings and the Post-Survey comments, using an adaptation of Curtis and Lawson’s [45] behavior categories. The coding schema we used, however, was based on the research questions we wished to answer. Therefore, we coded postings and comments according to students’ references to team roles, socio-emotional communication strategies, and technology use.

Messages related to Team Roles:

Team 1 (1b, Post-Survey):
"My role in the team was as team leader. I was responsible for submitting and editing our work. I had to organize meetings and designate tasks for the group. I was responsible for the design and construction of the website in addition to researching information needed for the website".

Team 3 (3b, Post-Survey):
"It was satisfying to review the completed project with the knowledge that it was achieved through collaboration across a distance".

Team 5 (5b, VLE posting):
"Thanks very much for your contribution - most welcomed and very useful and informative…. what I had in mind was for me to draft one and for yourself, [5a] and myself to go over it and make improvements tomorrow, add [sic] so on to bring it more in line with what is needed. (-but certainly, feel free to do an entirely separate one if you wish".

Team 6 (6b, Post-Survey):
"We all very much felt a part of the decision-making process…[and] it was a pleasure to work in the team…[because] we had a great work ethic".

Team 7 (7b, Post-Survey):
"Another successful strategy adopted by the team was assigning roles to each team member at a very early stage".
Messages related to Socio-emotional Communication Strategies:

Team 1 (1b, VLE posting):
"We are fairly disappointed with the result but hopefully we can do better with the next project due".

Team 2 (2d, VLE posting):
"Sorry, sort of making fun a bit that you didn't have broadband and your [sic] a tech comm student".

Team 3 (3d, Post-Survey):
"I really felt that [3a] and [3b] strove to include me in every decision made for the group…[3a] is also very personable, which made me feel comfortable and flexible within the group. It is obvious to me that he went out of his way to include me in every aspect of this collaboration".

Team 5 (5c, VLE posting):
"P.S. Did you catch the Celtic FC match? They only show Man Ut'd here, so I watch what I can get, but I saw they won 2-0. Are you all Celtic fans? They look like they're making a good run for it. Not many people over here to talk football with".

Team 7 (7a, Post-Survey):
"We were able to build a cohesive team because we stressed the personal relationship as well as the academic relationship".

Messages related to Technology Use:

Team 1 (1a, Post-Survey):
Re difficulties with the Sakai Discussion Forum: "…hindrance was due to the fact that each team member had no way of knowing if a new topic or answer had been posted up in the discussion section unless they went through a few pages of information".
Team 2 (2b, Post-Survey):
Re difficulties with the Sakai Wiki: "…the text editing space is restricted, the mark-up language is not intuitive and it is difficult to track changes and to create and link new pages".

Team 3 (3a, VLE posting):
Re difficulties with Sakai Chat: "Not that I'm convinced that the online Chat feature … is going to work that well at this point in the project. Also, given … problems with SAKAI from home - my own home internet connection seems to crawl when in SAKAI - would our emails offer a better way to communicate?"

Team 4 (4d, Post-Survey):
Re difficulties with Sakai Chat: "…the user has to manually refresh the page … to see what he has written… resulting in some conversational backtracking. [N]ot being able to request [another online user’s] presence in Chat gets frustrating, as is your inability to chat and navigate the rest of Sakai at the same time".

Team 7 (7b, Post-Survey):
Re their decision to use chat rather than any other tool: The team settled on chat as it was the "medium which all team members felt most comfortable with".
References Cited


