GROUP TACIT KNOWLEDGE AND GLOBALLY DISTRIBUTED VIRTUAL TEAMS

Lessons learned from using games and social media in the classroom

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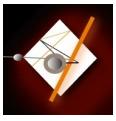
Until recently, communication over long distances was limited to one of three technologically-mediated choices: phone, fax, and post. However, new technologies have revolutionized cross-cultural communication by offering a myriad of platforms for rapid, asynchronous, and multimedia messaging, including Twitter and Skype. Thus, globally distributed virtual teams now demand new kinds of interpersonal competencies, such as the ability to empathize, lead, deliberate, and negotiate in channels mediated by novel technologies. Existing literature establishes the role of *tacit knowledge*, or contextual knowledge gained thorough experience, in creating more effective teams that collaborate in more traditional ways. However, there is a lack of understanding of the role tacit knowledge plays in teams collaborating digitally. In this article, we present a teaching case involving virtual collaborations between students in the U.S. and Uganda via a Twitter-based game. We observe that players who develop tacit knowledge during the game display increased interpersonal capacities. This teaching case yields important insights for developing pedagogical practices that facilitate tacit knowledge development as it relates to improving interpersonal skills for globally distributed virtual teams.



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Successful business, government, military, and/or academic team collaborations require effective communication among team members. For traditional teams working in close physical proximity, the role of tacit knowledge, or contextual knowledge gained through experience, in creating effective and collaborative teams is well established. However, cultivating effective communication among global virtual teams (GVTs) remains a challenge, and the impact of tacit knowledge among GVTs remains unexplored.

In this paper, we explore the relationship between tacit knowledge, information and communication technology (ICT), and teams to inform improved training methods for GVTs. We first discuss how technology has transformed teamwork, including the challenges that GVTs face for successful collaboration. We then define tacit knowledge and summarize its importance for teams as discussed in the literature. Next, we present a teaching case involving an educational game where students attending Arizona State University and Rochester Institute of Technology in the U.S. as well as Mountains of the Moon University in Uganda communicate via Twitter. The game demonstrates experiences of a newly formed GVT that we can use to inform strategies for overcoming challenges to digital collaboration. Observations of the game suggest that tacit knowledge can augment the interpersonal capacities of diverse individuals interacting through social media, ultimately leading to more effective virtual teams. Based on our findings, recommendations are provided for improving training methods for future members of GVTs.

ICT Challenges for GVTs

Substantial research exists in the realm of collaboration among teams, particularly on the role of verbal communication in coordinating joint activities among groups. For example, collaborative discourse theory identifies the role of dialogue

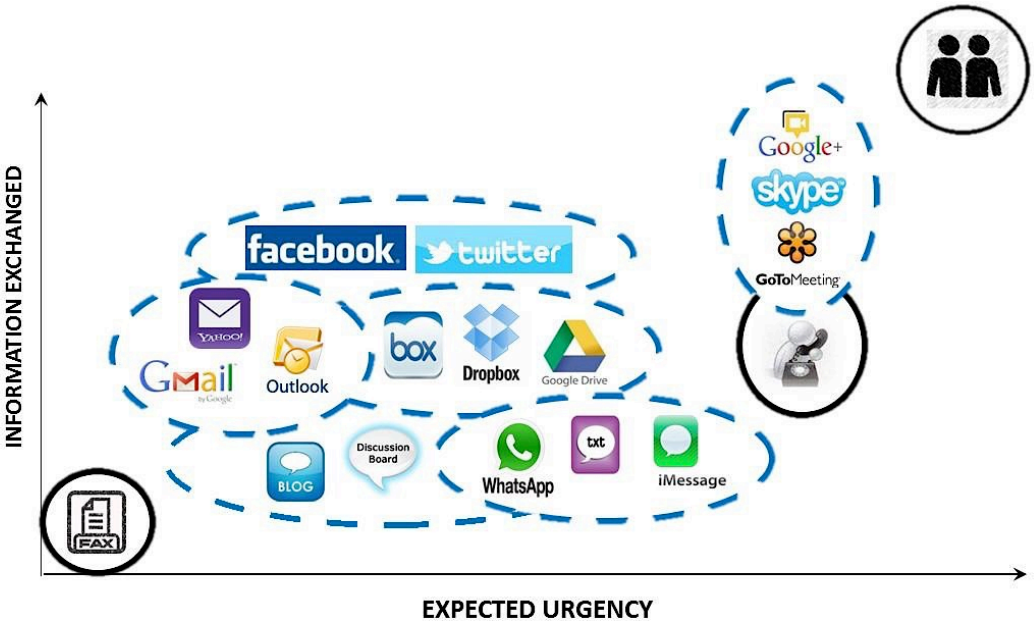
in the formulation and implementation of plans to achieve a shared goal (Hardy, Lawrence, & Gant, 2005). Joint intention theory suggests that successful collaboration in dynamic and uncertain conditions demands an open channel of communication to coordinate teamwork where heterogeneous beliefs and fallible actions among group members are the norm (Cohen & Levesque, 1991). Prior to the digital revolution, communication among teams was limited to face-to-face dialogue or one of three technologically mediated choices: fax, phone, or post. Today, ICTs, such as email, video chat, and social media, have introduced a suite of technological choices that facilitate the formation of GVTs, which enable faster and easier communication over large geographical distances.

Despite the increase in speed and efficiency, the growing reliance on ICTs creates challenges for GVTs. Whereas the norms of using nondigital forms of communication (i.e., face-to-face, fax, phone, and post) are well recognized and understood, communicating via ICTs often involves unestablished behavioral norms of a myriad of new technologies (see Figure 1 on page 116). For example, it is often unknown what the expected urgency is for replying to an email, as this is left out of most guides on email etiquette (Agnew & Hill, 2009); depending on the situation, an email may go untouched for weeks or it may be replied to immediately. Also, many ICTs quicken the pace of team member interaction (Gere, 2008) and thus speed up cross-cultural encounters on GVTs. Although faster communication capabilities yield many benefits, digital forms of communication may be vulnerable to misinterpretation. That is, condensed written forms, such as those found in text messaging, can lack the context required for accurate interpretations, especially when used across cultures (Zorn, 2005). Figure 1 displays a portfolio of ICTs and arranges them according to their expected urgency and the amount of information exchanged between team members.

Sending a fax, making a phone call, or talking to another person are distinct pathways for communication, where the information shared and the expected urgency are well understood (shown in black and white in Figure 1). In contrast, many ICT platforms overlap in their ability to transmit information and have relatively unclear expectations for response (shown in blue dotted lines

Figure 1

ICTs are arranged by the expected urgency of response (increasing from left to right) and the amount of information exchanged (increasing from bottom to top)



in Figure 1). Furthermore, the use of ICTs introduces communication problems related to the varying capacities of technologies to connect people in different parts of the world, especially those located in technologically disadvantaged nations.

Unfortunately, the technologies that offer the broadest participation and accessibility are ones that generally exchange the least amount of information. For example, analog mobile phones, which are capable of sending short text messages (160 characters or less at a time), are used by 7 billion people today, in comparison to the 4 billion with Internet access, and 1.2 billion with fixed telephone lines (International Telecommunication Union, 2010). GVTs functioning in areas with limited bandwidth for ICTs need individuals who can decipher meaning from short messages between digital devices. This presents a tradeoff between the

international reach of a particular ICT and the quality and/or quantity of information exchanged.

Contributing effectively to GVTs therefore requires team members who can communicate using a range of ICTs, adapt to changing virtual environments, and have the ability to appropriately communicate with people from different cultures, given current technical limitations. These challenges will no doubt be partially alleviated by team members who have strong interpersonal competencies.

Interpersonal competency is recognized as the ability to motivate, enable, and facilitate collaborative and participatory research and problem solving. This ability includes strong skills in communication, deliberation and negotiation, collaboration, leadership, empathy, as well as pluralistic or transcultural thinking (Wiek, Withycombe, & Redman, 2011). However, strong interpersonal skills may be insufficient for effectively contributing to GVTs, where ICTs are changing faster than social or behavioral norms and protocols. The authors contend that tacit knowledge, or contextual knowledge gained through experience, may augment an individual's interpersonal skills, enabling more effective communication in less familiar virtual environments. We believe this to be the case because additional tacit knowledge enhances comprehension of effective methods for leadership and fosters empathy among colleagues, both of which facilitate productive dialogue.

Review of Tacit Knowledge and Teams

Whereas explicit knowledge, or easily expressed or codified knowledge, is simple to aggregate and store and can be gained through logical deduction, tacit knowledge is difficult to transfer through communication because it is intuitive and dependent on context (Nonaka, 1994; Polanyi, 1966). *Tacit knowledge* is the know-how acquired through informal learning of behaviors and procedures, is embodied in the individual, and is tied to physical experience and intuition gained through shared group experiences and socialization (Erden, von Krogh, & Nonaka, 2008). For example, the crew of a ship with a broken navigation system was able to make it to safe harbor because each crew member intuitively knew

what to do and how to function without the system guiding them because of a high level of group tacit knowledge (Erden et al., 2008).

Moreover, tacit knowledge can only be acquired through immersion in the society of those who already possess it (Collins, 2011). In the workplace, tacit knowledge is considered key to managerial success as well as a way for workers to augment academic learning and experience (Smith, 2001). For example, managers benefit from tacit knowledge about teams of employees that possess different types of expertise than their own, as is the case with managers of large scientific projects (Collins & Sanders, 2007). Tacit knowledge is also considered a competitive advantage because it enables adaptability to changing conditions, which can improve organizational effectiveness in a way that is difficult to replicate (Berman, Down, & Hill, 2002; Erden et al., 2008; Jackson, 2012; Johannessen, Olaisen, & Olsen, 2001). For our purposes, we summarize these definitions and define tacit knowledge as contextual knowledge gained through experience. Thus, tacit knowledge is essential to working effectively in GVTs because advanced group tacit knowledge allows the team to more effectively respond to rapid change and provides for better teamwork and understanding.

Most research on tacit knowledge and teams focuses on the individual level and how it can facilitate interactions between teammates, such as leadership, negotiation, and conflict resolution (Berardy, Seager, Selinger, & Uhl, 2013; Collins, Evans, Gorman, 2007; Collins & Sanders, 2007; Johannessen, et al., 2001; Panahi, Watson & Partridge, 2012; Smith, 2001). Alternatively, Erden et al. (2008) consider the importance of *group tacit knowledge* for successful teams. Group tacit knowledge is the degree of implicit understanding present in a group, which enhances coordination and collective action. Erden et al. claim that group tacit knowledge at its best quality allows a group to function as a collective unit in diverse and complex situations in the absence of explicit rules or directions, making the team more efficient at achieving its goals. Such tacit knowledge allows groups to function in this way because it allows groups to address complex tasks with integrated knowledge through coordinated actions between group members that are implemented without the need for explicit rules or communication (Erden et al., 2008).

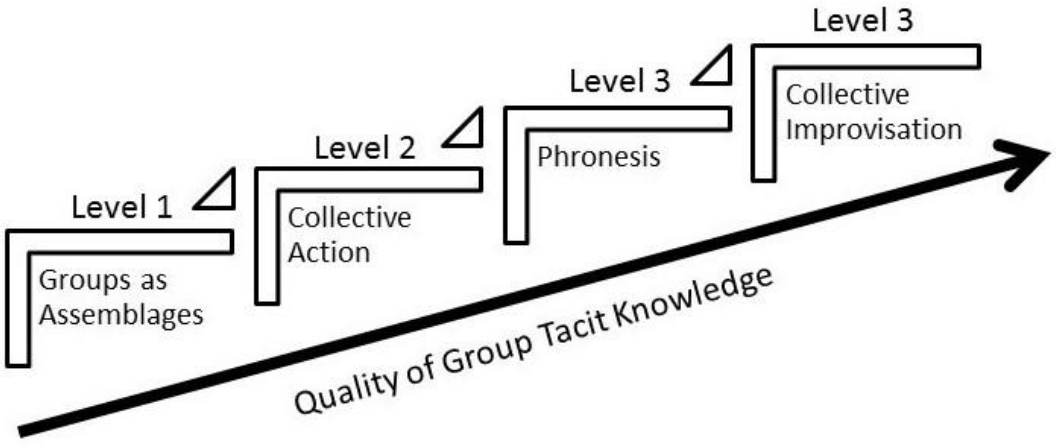
As shown in Figure 2, the development of group tacit knowledge is a progression of group behavior that begins with an assemblage of individuals (level 1) that, through shared experiences, work their way through stages of collective action (level 2), phronesis, or the wisdom to take action for the common good, (level 3), and eventually collective improvisation (level 4).

Level 1 represents a newly formed team that acts as a collection of people with no shared experience and weak group ties, providing no basis for group tacit knowledge. An example would be a newly formed soccer team with players from around the world with different age groups, experiences, motivations and understandings about soccer. At this level, players will be difficult to coach, they won't be able to coordinate team strategies, and individual players will not want to or know how to pass to other players.

Level 2 is achieved after some shared experiences help the group understand how to act collectively, and it develops routines and group culture so that there is a sense of belonging, and familiar obstacles are overcome by repeating past successes. An example would be a soccer team that has practiced a few times

Figure 2

Adapted from Erden et al. (2008) – Quality of group tacit knowledge in teams



and knows a couple of plays very well, but requires a coach to tell them which ones to use.

At *level 3*, the team is advanced to the point that they can manage themselves and determine the best action for the common good of the group. A soccer team at level 3 would not require a coach because they are able to collectively identify the best actions in new situations based on previous experiences.

Finally, *level 4* is the highest quality of group tacit knowledge, where group improvisation is possible because each member is a trusted expert. The group now has a collective mind and intuition guiding actions, and the team becomes more than the sum of its parts. At level 4, the soccer team can quickly adapt to change (such as a player injury) and develop new and appropriate tactics during a match without discussion.

It is worth noting that there are significant opportunity costs for developing group tacit knowledge, as tacit knowledge development requires time, attention and investment, such as money directed at team building exercises, which could be used elsewhere, or keeping an existing team in place even if more qualified employees become available. Additionally, not all situations require the highest level for a successful outcome, but increasing this characteristic will help groups deal with uncertainty and increase loyalty among group members (Erden et al., 2008).

To date, researchers have focused on the importance of tacit knowledge among teams working together in close physical proximity (Collins & Sanders, 2007; Erden et al., 2008; Johannessen, Olaisen, & Olsen, 2001; Smith, 2001), but there is a paucity of research on the importance of tacit knowledge for teams communicating digitally. A 2001 study recognized the changing conditions for companies as digital forms of IT, such as email and text messaging, first became popular, but the focus was not on tacit knowledge in digital communication (Johannessen et al., 2001). This research explained the influence of IT on tacit knowledge, and argued that as companies invest in IT, the speed of explicit knowledge transfer increases, shifting priority away from developing shared tacit knowledge. As a remedy, the authors suggested that companies need to balance

explicit and tacit knowledge promotion as both are needed together to bring about innovation and sustainable competitive advantage. Our teaching case builds on the 2001 study by observing how the development of group tacit knowledge augments interpersonal capacities among digital teams to improve their ability to work collectively. The goal is to inform methods for training that will enhance students' capacity to contribute effectively to GVTs.

Collaborations between students in the U.S. and Uganda via Twitter

The Externalities Game

Students at Arizona State University (ASU), and Rochester Institute of Technology (RIT) in the U.S., as well as Mountains of the Moon University (MMU) in Uganda participated in a two-week educational experience called *The Externalities Game* (TEG). TEG uses Twitter for asynchronous communication between players in different locations during game-play and requires that participants communicate, strategize, and negotiate with other players to coordinate actions for group success. Thus, TEG is an example of a GVT playing a noncooperative game, which means that players make decisions independently and any cooperation is self-enforcing. The nature of the game places a tension between individual incentives and positive group outcomes because each player can only advance their grade at the expense of others. That is, students must work together to achieve outcomes that are beneficial for all players.

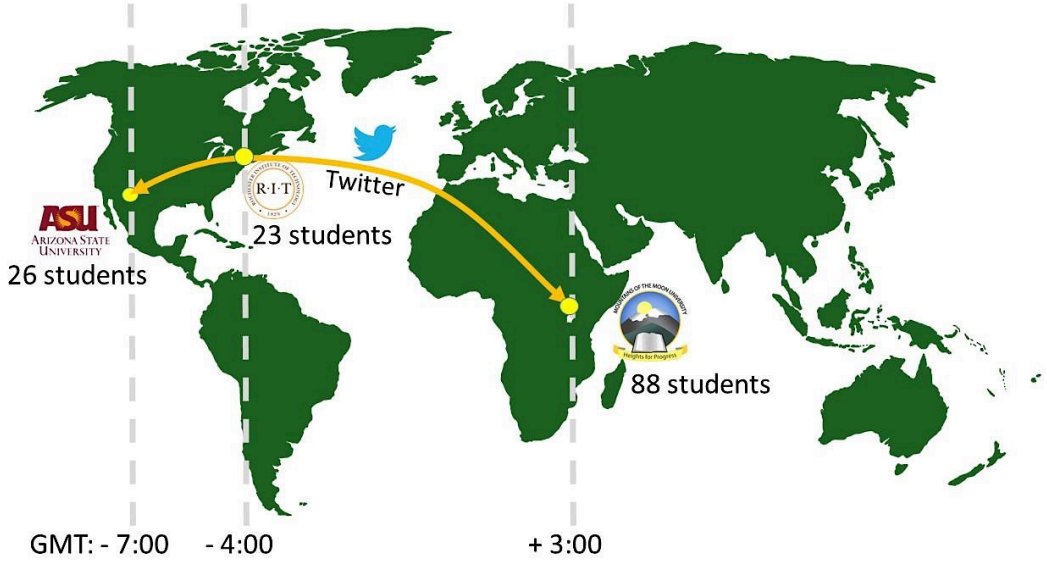
TEG has been used in a variety of contexts, including several multiple-university situations. The primary objective of TEG is to experientially educate students about environmental externalities. Although TEG was not specifically designed for research on GVTs, we think that the ASU-RIT-MMU experience is particularly relevant for informing training methods for GVTs because it allows us to examine how a GVT of students developed group tacit knowledge, illustrated by their ability to act collectively towards limiting externalities.

Participants in this game were college students attending ASU, RIT, or MMU. Figure 3 shows the locations of the institutions, the number of players and the differences in time zones (e.g., MMU was 7 and 10 hours ahead of RIT and ASU, respectively). Students at ASU and RIT were a mix of undergraduate and graduate students taking a Sustainability Ethics class designed to experientially teach students about ethics related to sustainability issues. The students at MMU were taking a class on business development, which included aspects of business ethics. All students communicated in English (English was not the first language of the students attending MMU but classes are taught in English at the University).

Data was collected through pre and post surveys, submitted decisions by individual players, digital communication records from Twitter and an online discussion board, as well as observations by instructors. This study was exempt from IRB review and all students were aware of the study and consented to participation (see information letter to students in Appendix C). At each institution, the instructor of each class introduced the game to students and oversaw

Figure 3

Map showing details of the ASU-RIT-MMU case study



their participation. TEG was integrated into each class as a graded assignment (the value of the game varied by class). Game instructions provided to the students are included in Appendix A.

The logistical challenges for the TEG players were high. Limitations for online communication in Uganda (e.g., unreliable electricity access and poor Internet service) meant that the SMS capabilities of Twitter offered a way for MMU students (all of whom had mobile phones) to communicate with other students during game-play. Calling cards were purchased for the MMU students in advance, and all students were provided with instructions on how to access Twitter using SMS on their mobile phones, thus ensuring students had the explicit instructions and access to resources necessary to participate in the game (see Appendix B). The American students could also use other forms of ICT to communicate across classes that were less available to the Ugandan students (e.g., an online discussion board), and each individual player could communicate in person with their classmates during class time. Figure 4 on page 124 shows the envisioned communication pathways for the game.

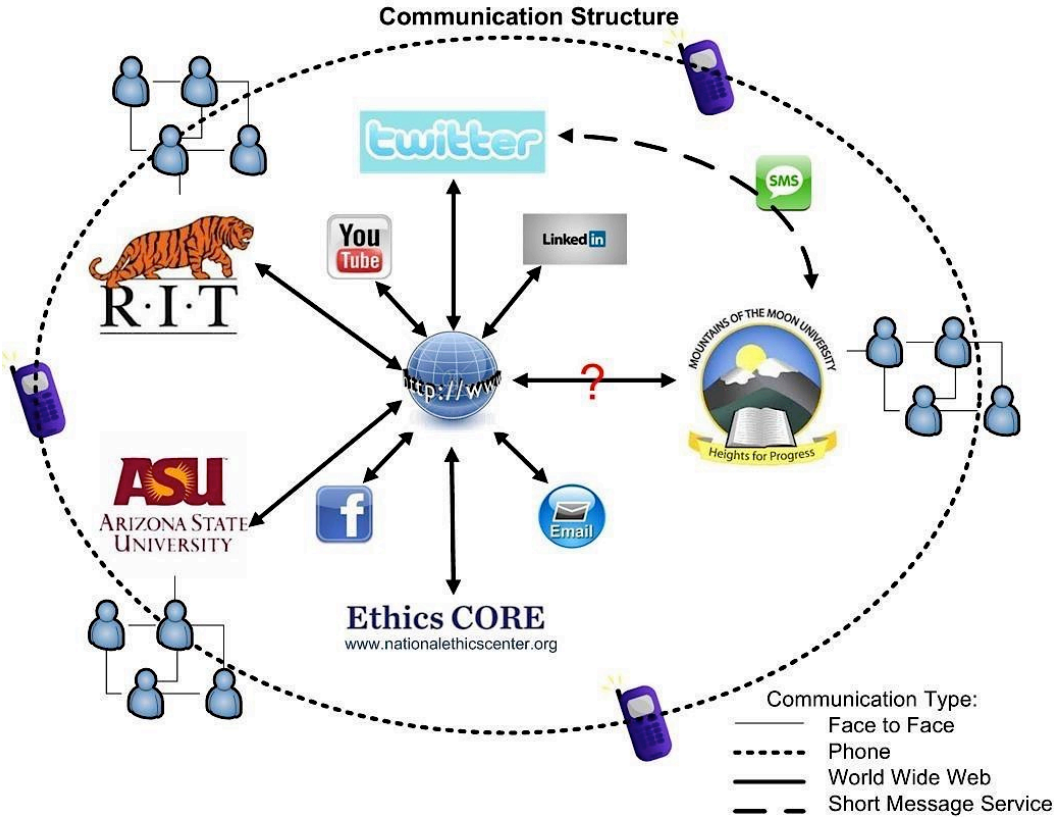
While a detailed description of TEG is beyond the scope of this paper, we provide a brief discussion of the game as it relates to virtual interactions between players (for more information on TEG, see Hannah, Berardy, Spierre, & Seager, 2013). Players in each class are randomly divided into three different levels of goods producers: luxury, intermediate, or subsistence. Note that all three types of producers were present in each class and generate varying levels of profits (in terms of grade points for the individual) and externalities (which subtract from all students' grades) as follows:

- Luxury players gain the most points per unit of production, but emit the greatest amount of externalities. The instructors assigned 10% of students in each class a luxury role.

- Intermediate players gain a medium level of points per unit of production, and emit a medium level of externalities. The instructors assigned 30% of students in each class the role of intermediate.

Figure 4

Envisioned communication pathways for the ASU, RIT and MMU Game



- Subsistence players gain the least points per unit of production, and emit the least amount of externalities. The instructors assigned 60% of students in each class the role of subsistence.

There are two steps to the game:

1. First, players decide how much they want to produce and negotiate the allocation of grade points, knowing that their production results in negative externalities (negative points) affecting the entire class.

2. Second, players may transfer the points they earned in the first part of the game to other players.

In our case, players were required to submit their individual decisions to the game administrator using Twitter via public or private message and to do so before a preestablished deadline. The game administrator reported all player decisions to participants at each step using private identifier codes and an Excel spreadsheet that was published online and provided to each instructor.

During the game, students faced three key challenges to developing group tacit knowledge that are relevant to GVTs, including technological failure, digital culture shock, and individualistic vs. collectivistic approaches to the game. Each challenge is discussed in detail in the next parts of this section.

Technological Failure

The ASU and RIT students seamlessly accessed Twitter and initiated communication. However, when the 70 students at MMU simultaneously tried to create Twitter accounts using SMS on their mobile phones, the Uganda Twitter network failed. Eventually some MMU students were able to access Twitter, but it took persistence on their part. This factor positioned MMU students at an early disadvantage because students at ASU and RIT began strategizing before MMU students were even able to get on Twitter. Technological failure may also have influenced players at RIT to act less cooperatively than they would have otherwise. The RIT instructor reported that his students gave the impression that they were interested in working collaboratively early in the game, but their behavior changed once technology constrained their ability to do so.

The failure of Twitter represented the digital divide problem, or the unequal access to, use of, and/or knowledge of ICTs and the benefits that they enable. The digital divide is a real limitation for GVTs that engage colleagues in areas that lack the infrastructure necessary for reliable ICTs. The World Economic Forum's Global Information Technology Report (2014) indicates that the digital divide is problematic for many areas around the globe including Mexico, many countries in South America, Latin America, and parts of South

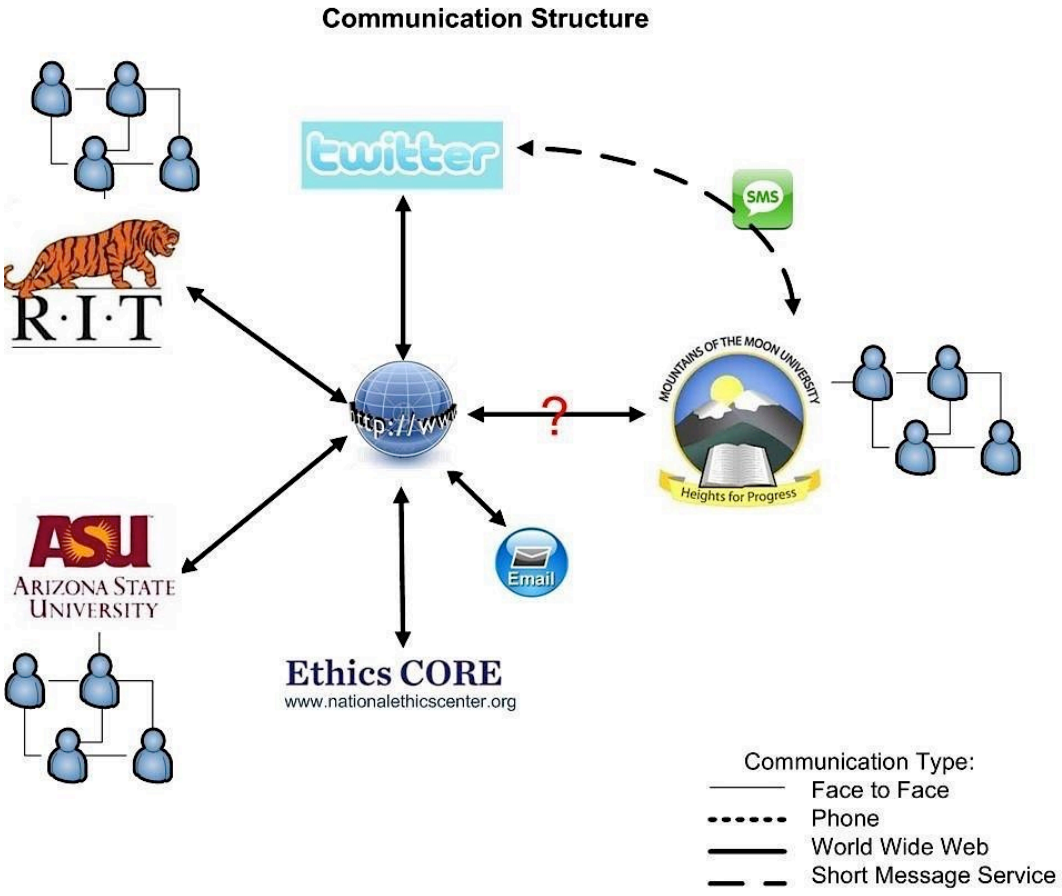
Asia, and is particularly severe for countries in Sub-Saharan Africa (Fuchs & Horak, 2008). Because TEG engaged students in Uganda, the divide was especially problematic, but the unforeseen complication provided an invaluable learning moment, allowing students to consider how to appropriately continue the game, given MMU's unequal access to ICTs and a diminished ability to communicate with other players. GVTs that have members in the areas listed here should be aware of the potential for technology to limit the participation of individuals. As observed in TEG, these technological failures will likely hamper the development of group tacit knowledge and may be especially limiting when the failure occurs during the early stages of team-building.

Furthermore, in GVTs it is especially important for all members to have the opportunity to shape a team's work. This requires team members to be attuned to whether and how all members have an opportunity to contribute. Of note in TEG, we observed an MMU student, in response to a power failure, seek to create an alternative way to participate in the early strategizing process by tweeting "have no power, can't visit discussion board. What else can we do to help?" The U.S. students failed to directly acknowledge this request and draw the MMU student into the work of strategizing. The U.S. students were not accommodating to their international team member's need and desire to participate in the important early strategy work. Ultimately, in not attending to the MMU student's request, the U.S. students reduced the capabilities of the communication structure shown in Figure 4 and communicated in a more limited manner as is shown in Figure 5 on page 127. Put another way, the U.S. students' actions lessened their ability to leverage all team members' expertise in formulating a strategy for playing TEG, inhibited collective teamwork, and ultimately reduced progression through levels of group tacit knowledge. Consequently, many students (especially at RIT) were unable to move past the assemblage stage of Erden et al. (2008) levels of group tacit knowledge.

Twitter failure in Uganda during TEG suggests that relying on ICTs can actually reduce communication capacity for GVTs, which is in opposition to the popular notion that ICTs broaden or enhance communication pathways. Unlike the newly formed group of students, GVTs that possess higher levels of group

Figure 5

Utilized communication pathways during the game



tacit knowledge would be more resilient to surprises like technological failures because they would have previous experiences to draw from on how to adapt to new operating conditions.

Digital Culture Shock

The second major challenge for students was what we describe as *digital culture shock*. Drawing from Furnham and Bochner (1986), "culture shock" is defined as

the psychological consequences of exposure to unfamiliar environments. In the game, we observed the impact of culture shock via Twitter, which can be described as quick, low doses of culture shock through short text messages that are surprising, unfamiliar, and lack context for interpretation.

Digital culture shock equates to unexpected behavior that weakens initial relationship building among GVTs. For example, one of the first and most surprising tweets from an MMU student was the following: "The world was to end in 2000 millennium and the dead were expected to join the living! Should we continue waiting?" Another student wrote, "The Woman was got from Man's rib becoz God knew how much knowledgeable the Woman was compared to the Man," and "if you were to make one wish before you go to bed, what would you ask God?" These statements of religion were unexpected and alarming, especially to the American students who are accustomed to a relatively secular society compared to Uganda. The U.S. students did not respond right away, as if they were taken back by these religious statements. The MMU students, having never used Twitter before, seemed to treat it as a microphone to declare their religious values to the world.

Digital culture shock in TEG revealed another dimension of the digital divide problem, which describes individuals who are less experienced in communicating through ICTs. Twitter has its own digital culture and behavioral norms that can seem unfamiliar and challenging to those with less ICT experience. For example, many of the MMU students who had never used Twitter before had to learn the norms of Twitter through experimentation with tweeting before they were able to communicate effectively. For some MMU students, the failure of Twitter in Uganda was enough to make them stop trying to connect, and those that did get on Twitter had to learn the rules of tweeting (using 140 characters or less, hash tagging, using the '@' symbol). The Twitter record reveals instances where students seemed to be experimenting with how to use Twitter, for example, tweeting nothing but their own twitter handle. Ultimately, digital culture shock is something that newly formed GVTs may experience as well, especially if members of the team represent distinct cultures and where individuals have little to no previous experience using the ICT

platforms required of them to communicate. Allowing for unjudged technological experimentation for novice team-members might alleviate some of the frustrations of this type of digital culture shock.

Individualism vs. Collectivism

The third and last major challenge in TEG also derives from cultural differences. We observed an individualistic approach towards the game by the American students compared to the more collective approach exhibited by the MMU students. While an individualist values personal freedom and achievement, collectivists emphasize conformity and discourage individuals from standing out (Gorodnichenko & Roland, 2011). The cultural distinction we observed is supported by comparing the Hofstede individualism scores (a measure of comparison for cultural differences among countries) for the U.S. with countries in Sub-Saharan Africa (Hofstede, 2001, 2011).

We saw this individualism versus collectivism distinction in the player decisions and grades, as well as their communication on Twitter. In the first part of the game, all but one of the MMU players followed an egalitarian strategy, whereas many more American students overproduced, going against the collective strategy. For example, the initial grades of the subsistence players at MMU was an average of 84.6% (with a standard deviation of 2.2 points) compared to an average grade of 110.5% among the American subsistence players (with a standard deviation of 49.5 points).

In reflecting upon these findings, a more collective approach may reduce barriers to group tacit knowledge among GVTs, whereas individualistic tendencies will likely increase the difficulty of coordinating actions. Such a perspective would seem to confirm Ardichvili's (2005) identification of individualism vs. collectivism as a potential knowledge sharing barrier for online international exchanges related to cultural differences. In TEG, the presence of individualistic tendencies hampered the progression of group tacit knowledge. Being aware of individualistic cultural tendencies among GVTs will help teams find ways to overcome this cultural challenge.

Overcoming Challenges to GVTs

Despite the challenges of technology, digital culture shock, and the clash of individualistic and collective approaches, the students playing TEG figured out strategies to overcome these challenges and showed signs of growing group tacit knowledge, which is promising for GVTs confronted with similar challenges. When TEG began, the students were unable to agree on a strategy, let alone coordinate actions. They were operating on what explicit knowledge they had of the rules of the game, previous perceptions and generalizations they had about individuals at the other institutions, and any previous experience they may have had using Twitter and other ICTs. They were behaving as an assemblage, just as Erden et al. (2008) describes level 1 of the group tacit knowledge (see Figure 2 on page 123), and were unable to function tacitly as a group.

We did observe some ability of the individual classes to organize themselves in productive debates and discussions (among students with whom they had previous face-to-face experience). For example, students at ASU rearranged their desks to form a circle that would facilitate a more collaborative environment and students took turns speaking during class. However, as soon as the digital communication commenced across classes with people they didn't know and had no prior shared experiences, the group was incapable of collective action. For example, in the ASU class, students were accustomed to raising their hand when they had something to add to the conversation, where digital etiquette for communicating across classes was unknown. In a similar way for GVTs, it will also be easier for team members that are in close proximity to one another (or even in the same time zone) to communicate more effectively because communication protocols are likely to be either previously established or easier to organize. In other words, achieving successful collaboration will be more likely among GVTs that are relatively homogenous (geographically and/or culturally) compared to those that are not.

The fact that most of the players were able to earn grades above an 85% (out of 100%) indicates that students were generally successful in coordinating actions, and an indication of the students moving up Erden et al.'s levels of group

tacit knowledge (see Figure 2 on page 119). Particularly relevant for GVTs are the interpersonal skills we observed being implemented among the students to coordinate actions and develop group tacit knowledge, including leadership, empathy, and cross-cultural thinking. Additionally, the individual capacities of the students to lead, empathize, and think pluralistically were not only ways for the class to organize and act collectively, but are also evidence that the growing group tacit knowledge enabled these interpersonal skills to be influential, as summarized in Table 1 and discussed next.

Interpersonal Competency and Group Tacit Knowledge

Perhaps the most influential interpersonal competency among students was leadership—defined here as someone who exhibits influence on others to accomplish a common task. In general, the student leaders weren't chosen or elected,

Table 1

Observations of students developing group tacit knowledge by class

Levels of group tacit knowledge	ASU Arizona State University	Mountains of the Moon University	R·I·T
1. Groups as assemblages No cooperation or shared goals	Individualistic actions	Religious declarations via Twitter	Lack of Twitter communication
2. Collective action Work towards common goals	Student leadership on Twitter as game progressed	Collectivist strategy	Not observed
3. Phronesis Actions in the interest of the common good	Point transfer to MMU at game end	Plea for more communication on Twitter	Not observed
4. Collective improvisation Deals with uncertainty or disruption easily	Not observed	Not observed	Not observed

but organically emerged when students communicated to their class ways that they should behave and by transferring knowledge from one class to another on Twitter. Within this context, the characteristics that marked students as "leaders" were those that went above the requirements of the game to organize, coordinate, and/or communicate strategies for group success. In the case of the MMU students, the few that were able to access Twitter and communicate were obligated by the situation to represent their classmates, as if they were Twitter ambassadors. These student leaders provided a sense of stability in an otherwise complicated and uncertain circumstance.

Evidence of this leadership is exhibited when we plot the number of tweets contributed by each student in TEG (Figure 6 on page 133). A few active students (mostly from ASU & MMU) made most of the contributions to the group. The observed power-law relationship of contributions is indicative of student leadership, at least in terms of participating in online discussions. Despite the overall low participation on Twitter by MMU students, several tweets show great enthusiasm for communication across classes. For example, one MMU student was pleading with the American students to communicate with them by tweeting "Hi, everybody is quiet!! Not made up ur mind?"

In general, the online contributions by the most active players seemed to greatly influence the strategies that led to the collective solution between ASU and MMU. That is, they influenced the disparate groups to cooperate with each other instead of taking the more individualistic approach to the game. Such influence could be seen in behaviors like explaining the reasons behind strategies of the game and referring to moral principles of justice and fairness that helped persuade others to follow the egalitarian strategy.

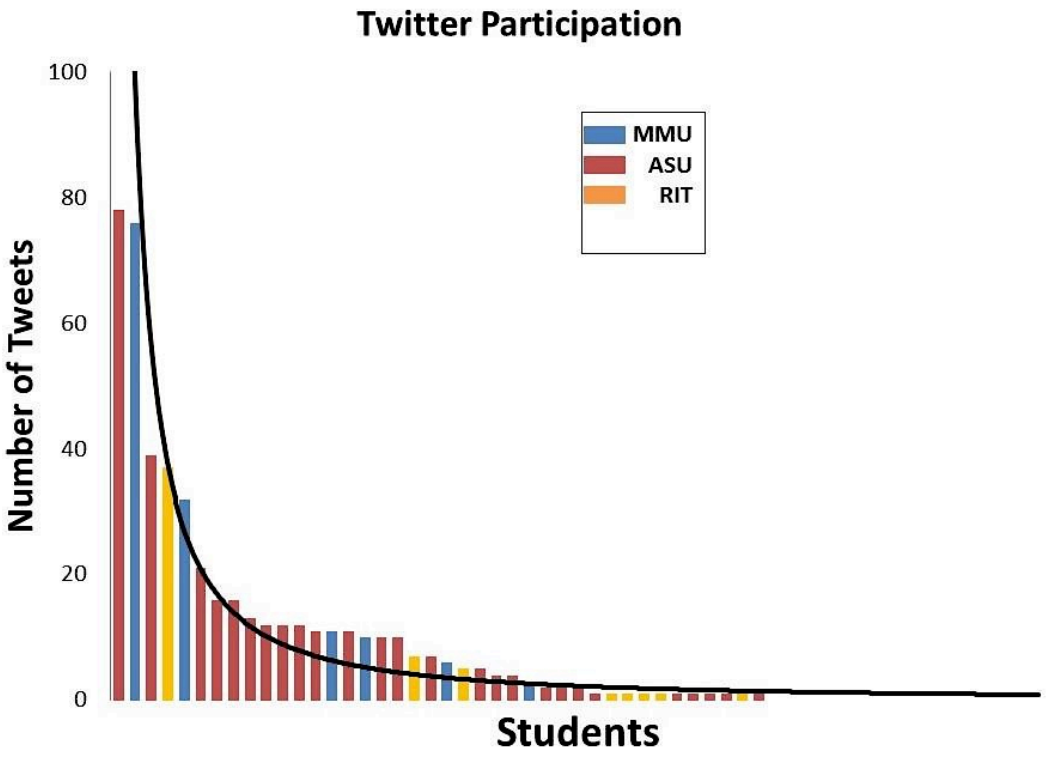
The influence of student leaders in TEG suggests the criticality of strong leadership among GVTs and offers evidence of group tacit knowledge. An individual with great leadership skills will be unable to lead if a newly formed GVT is unwilling to listen to instructions or, in the case of TEG, when that leader is struggling to even communicate with many players in the game. The same leader will have more success influencing the group after the group has time to establish some basic behavioral norms, such as listening while another person is

speaking, which is also characteristic of group tacit knowledge. By recognizing behavioral norms, the students were able to overcome some of the communication problems and provided the group with shared experiences that resulted in the development of group tacit knowledge. Consequently, the increased group tacit knowledge reduced further barriers to communication and collective action, as well as augmented the existing interpersonal leadership capacities of players.

In a similar fashion, the recognition of behavioral norms enabled students to better navigate cultural differences, another example of group tacit knowledge.

Figure 6

The total number of tweets contributed by each student playing TEG



The black line represents a power-law function, showing that a few students dominated the conversation on Twitter (left side of graph), while most students contributed minimally or not at all (middle to right side of graph).

Specifically, as time passed the tweets from the increasing number of MMU students on Twitter changed from religious declarations to questions about the game. When the digital culture shock subsided and the character of the communication on Twitter changed, the digital leaders at ASU emerged as they became active on Twitter and engaged with players at MMU. It was as if the American students overcame their initial feelings of unfamiliarity and discomfort with responding to the religious statements and moved forward with the game at the same time that the MMU students began to understand that their religious statements were not helping them play the game. Thus, our observations indicate that tacit knowledge and leadership may be strategies for overcoming, or at least alleviating, digital culture shock among GVTs.

The ability of the students to move past the initial digital culture shock experience may have been influenced by an in-class discussion at ASU about the role that religion played in the everyday lives of the Ugandan people. ASU had the benefit of an instructor that had visited Uganda in the past year. The instructor possessed tacit knowledge of the importance of Christianity to the people living there, which enabled her to codify her experience into explicit knowledge for the students. The explicit knowledge from the instructor enabled the ASU students to better understand their experience with the MMU students communicating their religious values, and may have facilitated further group tacit knowledge among the ASU and MMU students.

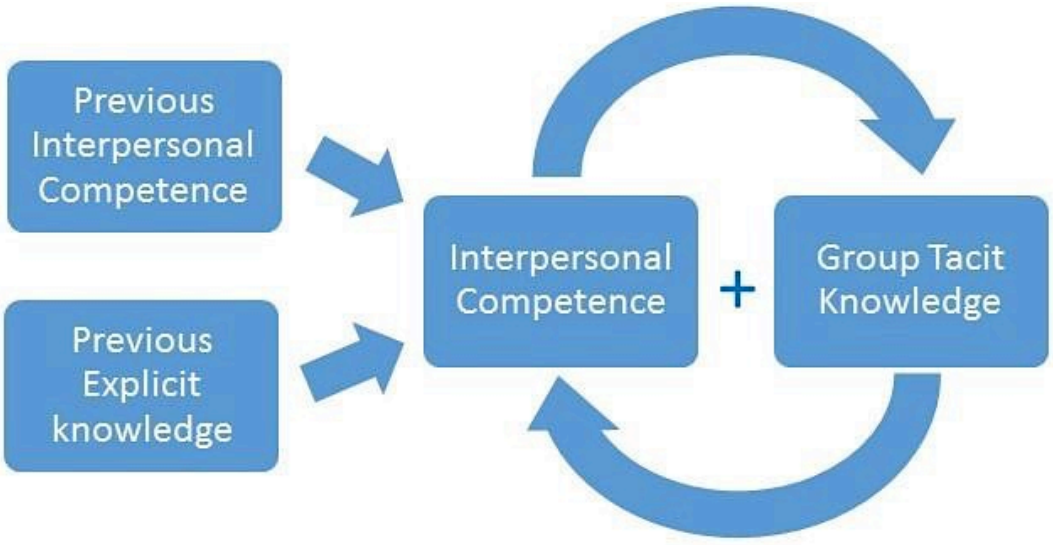
The instructor also gave the students insights on the limited access that MMU students had to the Internet and how power-outages were a common occurrence in Uganda. This information inspired some American students who, after hearing about some of the everyday hardships of the MMU students, had a greater sense of empathy for the MMU students and began to reconsider how to more ethically approach TEG in a way that benefited the MMU students. Possessing empathy can be thought of as an example of group tacit knowledge because it is defined as an ability to understand and share the feelings of another. In this way, we observed students developing their capacity for cross-cultural thinking and empathy, while simultaneously developing their group tacit knowledge.

The implication for GVTs is that obtaining explicit knowledge about the people you are engaging with virtually may increase the likelihood, and perhaps the speed, at which they are able to develop group tacit knowledge. The improved group tacit knowledge then enables individual interpersonal skills, such as empathy and cross-cultural thinking, to be more effective at guiding the group toward cooperative outcomes. Thus, we envision group tacit knowledge and interpersonal competence as a positive feedback loop, driven by individuals' previous interpersonal competencies and explicit knowledge (Figure 7). The initial development of group tacit knowledge in newly formed GVTs provides an environment for interpersonal skills (both obtained before and during the GVT experience) to become increasingly influential and effective in aligning group interests and ultimately shaping and allowing for success.

An example of the positive feedback between explicit knowledge, group tacit knowledge and interpersonal competencies in TEG occurred at the very end of the game, when the ASU students chose to pool points to send to the MMU class

Figure 7

Positive feedback loop between interpersonal competence and group tacit knowledge observed during the ASU-RIT-MMU case study



for distribution. Doing so conveyed a greater understanding of the technological limitations, showed an acceptance of MMU's more collective approach to the game (as opposed to the more individualistic approach of most American students), and was an act of kindness and altruism from ASU to MMU, given the disadvantages experienced by the MMU class during the game. This transfer allowed the MMU students to all earn final game grades of 89%, while the ASU students accepted a lower grade of 85% for all but one player, who gave a few less points. In this case, the information about the MMU students (previous explicit knowledge) encouraged the American students to empathize with and think more pluralistically about the game from another point-of-view (interpersonal competencies), which created a greater understanding and atmosphere for group cohesion (group tacit knowledge).

Recommendations

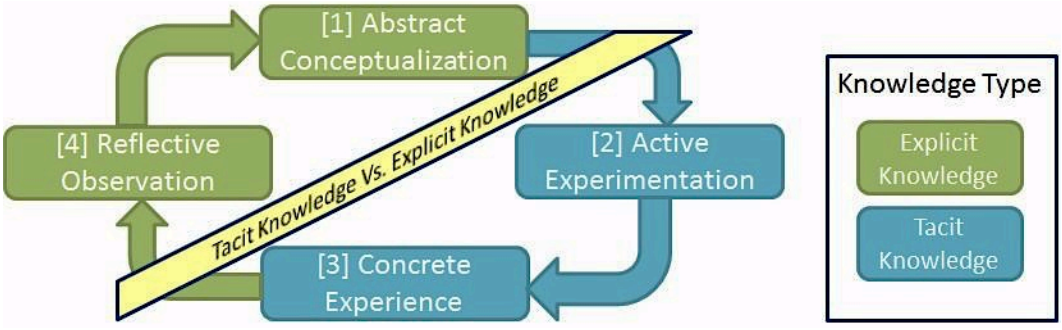
In the game, we observed a feedback loop between the advancement of interpersonal competence and group tacit knowledge, fed by group members' initial levels of interpersonal competence and explicit knowledge gained prior to and during the game. This feedback was observed in the ability of the ASU and MMU students to move up to higher group tacit knowledge levels, despite the challenges to communication and collaboration due to leadership, empathy, and cross-cultural thinking among students. These interpersonal competencies logically support group tacit knowledge, as they foster better communication and trust, and likely accelerate the process of moving up the different group tacit knowledge levels. Therefore, we recommend that training for GVTs should involve activities that transfer both explicit and tacit knowledge related to international cultures, ICT, and interpersonal skills. The explicit knowledge will help reduce some of the digital culture shock, and the interplay between tacit knowledge and maturing interpersonal skills will help teams navigate the quickened pace of communication and the potential technological limitations as well as reduce the likelihood of misinterpretation.

Explicit and tacit learning outcomes can be achieved by designing course activities to bring students around the entire Kolb Learning Cycle (Kolb & Kolb, 2005). The Kolb Learning Cycle is a widely used approach to learning that employs both active and passive components, including abstract conceptualization (i.e., thinking), active experimentation (i.e., doing), concrete experience (i.e., feeling), and reflective observation (i.e., watching), as shown in Figure 8.

The passive stages of the cycle (1 & 4 in Figure 8) involve reading, listening, watching lectures, and thinking about cultural concepts. These passive learning stages are useful for transferring explicit knowledge about another culture or technology. The active stages of the cycle (2 & 3 in Figure 8) involve real-world problem solving, active experimentation, interacting with other students, and even emotional experiences that students will instinctively and tacitly draw from later in their career. These active learning stages are useful for gaining tacit knowledge about another culture or technology, but also provide opportunities for students to practice their interpersonal skills. Particularly for GVTs, these activities should include real exchanges with people from other cultures using ICT, as our students did in TEG. Over time and through repeated international interactions, students will become more comfortable with the pace and forms of communication as well as develop a sense of what is appropriate given the context of the collaborating team.

Figure 8

Mapping tacit and explicit knowledge onto the Kolb Learning Cycle



Based on the ASU-RIT-MMU game experience and the above discussion of the Kolb Learning cycle, we recommend the following actions for implementing tacit knowledge development into educational activities:

- Design courses with experiential and active learning activities involving collaborative work through ICTs, which will help students develop interpersonal skills and provide an opportunity to practice strategies for group tacit knowledge development.

- Provide explicit knowledge to students about cultural differences that will lessen digital culture shock and enhance individual capacities for empathy.

- Inform students about various digital platforms for collaboration and provide opportunities for students to practice and develop tacit knowledge of ICTs. Practice with ICTs will reduce the experiential dimension of the digital divide.

- Discuss limitations of ICTs relevant for collaborating with individuals located in areas with technological disadvantages. This will help alleviate technical complications of the digital divide.

- Focus on learning outcomes related to interpersonal competencies that will build skills for effective communication and leadership. Doing so will accelerate the feedback between interpersonal competencies and group tacit knowledge.

Conclusion

This paper explored the role of group tacit knowledge for GVTs using a teaching case study involving students in the U.S. and Uganda playing an educational game via Twitter. We discussed the key challenges that students faced in the game, including technological failure, digital culture shock, and reconciling individualistic vs. collective approaches. Then, we discussed how small increases in quality of group tacit knowledge complemented the interpersonal capacities of leadership, empathy, and cross cultural thinking, making them more effective at

overcoming these challenges, and, ultimately, allowing for further progression of group tacit knowledge. Thus, we observed a positive feedback loop between group tacit knowledge and individual interpersonal skills. Based on the discussed teaching case, we recommend that training for GVTs involve experiential opportunities for gaining tacit knowledge about ICTs and developing interpersonal skills, in addition to providing explicit knowledge focused on cultural differences and the digital divide. ■

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Appendices

Appendix A: The Externalities Game Instructions for Students

In TEG you and your classmates will confront a non-cooperative game theory problem. Non-cooperative game-theory problems are characterized by conflicting tensions between personal interests and what is best for the entire group. You will be deciding how to allocate a limited number of grade points with your classmates and students at two other universities. You may choose to produce as many points as you can to earn yourself a good grade, but you will only be able to do so at the expense of the grades of other students. Thus your decisions will directly affect the grades of every other student playing the game. Will all the players in the game be able to find a way to solve the collective action problem like the Coase Theorem suggests?

In the game, you will be randomly assigned one of three producer roles: luxury, intermediate or subsistence. Each role produces individual grade points and externalities (or social costs) differently, according to the descriptions below:

- *Luxury players:* gain the most points per unit of production, but also emit the greatest amount of externalities. *Luxury players can produce between 0 and 10 production units.* There are about 15 Luxury players in the game, 9 at MMU, and 3 at ASU & RIT.
- *Intermediate players:* gain the second most points per unit of production, and emit the second highest amount of externalities. *Intermediate players may produce between 0 and 50 production units.* There are about 40 Intermediate players in the game, 26 at MMU, and 7 at ASU & RIT.
- *Subsistence players:* gain the least amount of points per unit of production but emit the least amount of externalities. *Subsistence players may produce between 0 and 240 production units.* There are about 82 Subsistence players in the game, 53 at MMU, 16 at ASU, and 13 at RIT.

  ***Note that players can only produce whole units up to their maximum production capacity and not less than 0. (No negative production).

Figure 1 illustrates how your grade will be determined. For every player, individual production points accumulate at a diminishing rate, whereas the shared externality points increase exponentially. Your grades will be calculated by subtracting your share of social costs (generated by the entire class) from your total production points earned individually.

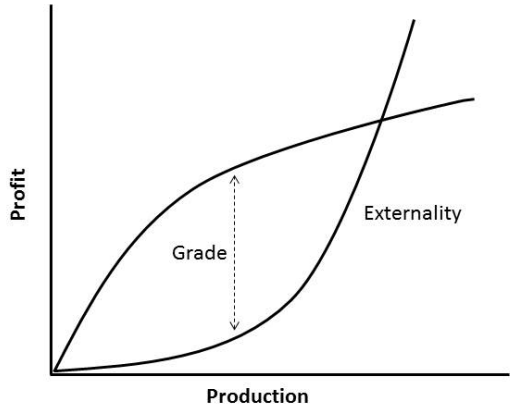

Figure 12. Individual points accumulate at a diminishing rate, whereas the shared externality points (or social costs) accumulated exponentially.

Registering with EthicsCORE (online discussion board):

Go to http://nationalethicscenter.org and click on the 'Register' link in the upper right hand corner of the page. You will be asked to input a username, password, and email address. EthicsCORE will send you a confirmation email to complete registration. Once registration is complete, you can join our group by navigating to "My Hub" and clicking on the "All Groups" link at the bottom of the "My Groups" box. Then you can search for our group in the "Find a Group" section by typing '**ASU_RIT_MMU Game-play**' in the search box. Then click on the group name to enter the group page. To join, click on the "Join Group" button in the upper right hand corner. All of the game materials can be accessed and downloaded by clicking on the "Resources" tab. You may use the "Discussion" and/or the "Chat" tabs to communicate with others in the group.

Game-play:

A round of play consists of two parts: 1) a period of across-university contract negotiations by students ending with production decisions by all players, and 2) a period of contract settlement.

1) As of **Saturday, September 15th** students at all three universities will be ready to start the first part of the round, by negotiating and strategizing about production

decisions. Feel free to contact and communicate with students in your class and students at other universities about strategies. You can communicate however you like. We have step-by-step instructions for you to use Twitter and short message services (SMS) with your phone. You can also follow the instructions above on how to register with EthicsCORE online to read and contribute to chats and discussions with other students. You may also call and email other students if you prefer. Ultimately, it is up to you and your classmates to figure out the best way to communicate during the game.

A copy of the spreadsheet that will be used to calculate your grades can be downloaded from EthicsCORE and may be available on a computer in the classroom. You may want to experiment with different game strategies by inputting various production decisions into the red columns. The resulting grades are calculated and displayed in the blue columns.

You will have about four days to negotiate about production decisions with other students before your final decisions are due. **All decisions are due by Sunday, September 23rd and must be submitted to the username 'TEG_submit' on Twitter (either online or via SMS).** To keep your production decision confidential, you can send a direct message to TEG_submit. See separate "Instructions for Twitter and SMS" for more details. Results will be available about 2 hours after submission and will be announced via Twitter and will be posted on EthicsCORE.

2) As of **Monday, September 24th**, the grades of students at all three universities will be revealed. At this time, the second step of the game begins and you are free to communicate with other students about contract settlements. Each player can transfer points to any other player. Note that negative scores earned in the first part of the round must be overcome by transferring points in this part; however, you cannot receive a final game grade less than zero. **The deadline for contract settlement is Sunday, September 30th**.

   If you choose to transfer points to other players you must indicate how many points you want to transfer with which particular player, identified by specific player roles. For example, if I am Luxury player 01 and I want to share 40 points with Subsistence player 42, I would send the following message to TEG_submit: 01_luxury share 40 points with 42_Subsistence. You can share points with multiple players as well by indicating how many points you want to give to each specific player. If the decisions are unclear, no points will be transferred. **Final grades will be revealed via Twitter and EthicsCORE by Monday, October 1st.**

Remember that all players can make deals during the game to limit production or share points for the greater good; however, **the Instructor cannot enforce agreements**. Players may lie to each other about their behaviors, and in many cases these lies may go undetected. Good luck!

Appendix B: Twitter via SMS Instructions

This document will guide you through playing TEG with your phone using only SMS. It is important to create a **new** account using your mobile phone for game-play if you want to keep your responses anonymous. You will deactivate this account once game-play is complete. If you are an MMU student and you cannot get Twitter SMS to work with your phone, you may submit your decisions by sending a regular text message to **0001 (602) 753-6539** (this is a U.S. number).

I. Sign up for a new twitter account via SMS

1. Send a text message with the word **START** to your Twitter shortcode (e.g. 40404 if you're in the US, 179 for MTN or 86444 for Orange and Vodafone carriers in Uganda).
2. Twitter will send you a reply and ask you to reply back with your **full name** to sign up.
3. Instead of your full name, reply with an **alias** to keep your identity anonymous.
4. Twitter will then send a message back to you and assign you a **username** based on the name you enter.
5. You're all set. Send a **text message** and it will post as your first Tweet! **Note that tweets are limited to 140 characters or less.**

II. Change Username to Assigned Role

Once you receive your role (in class), then change your username to reflect your role appropriately by typing:

SET USERNAME [new username]

Your new username should be in the following format: ['2 digit number_role']

Example: If assigned the role of 01 luxury then your new username would be '01_luxury'. If assigned 10 subsistence then your new username would be '10_subsistence'.

Once everyone has changed their username, players can follow other players by typing FOLLOW and new usernames. You must follow other players to see what they are saying:

Example: If I want to communicate with 01_luxury I would type in my phone:

FOLLOW 01_luxury.

III. Communicate!!!!

Feel free to experiment with twitter and communicate with one another about the game using SMS. **Remember you must follow other users to see what they are saying.**

How to Post a Tweet via SMS:

6. First, make sure you've created a Twitter account via SMS using directions above.
7. Simply send a text message containing your Tweet to your short code (40404 for the U.S., 179 for MTN or 86444 for Orange and Vodafone carriers in Uganda).
8. Your tweet will be sent to everyone that is following you.

IV. Follow TEG_submit

TEG_submit is the username of the administration account for our game.

To follow others type **FOLLOW [username]** which allows you to start following a specific user, as well as receive SMS notifications. Example: **FOLLOW TEG submit.**

You must follow TEG_submit so that you can submit your decisions before the deadline.

V. Deadline for production decision: Sunday, September 23rd at 9pm for ASU, 12am (midnight) for RIT, 7am for MMU.

> **You will send your production decision to the administrator, TEG_submit.**
>
> A direct message will keep your decision confidential from other players.
>
> **To Direct Message administrator** your production decision type **D TEG_submit [your production number].**

VI. Preliminary grades will be announced (via SMS and EthicsCORE) about two hours after decisions are sent to TEG_submit.

VII. Deadline for settling of sharing contracts is Sunday, September 30th at 9pm for ASU, 12am (midnight) for RIT, and 7am for MMU.

VIII. Final grades will be announced (via SMS and EthicsCORE) about two hours after decisions are sent to TEG_submit. They will also be announced in class.

IX. Deactivate account

> **STOP, QUIT, END, CANCEL or UNSUBSCRIBE:** will deactivate your account if you are an SMS-only user. If you completed the sign-up flow on the web, sending any of these commands to your Twitter short code will simply remove your phone number from your Twitter account.

Appendix C: Information Newsletter

Multi-University Game-Play for Sustainability Ethics Research

Dear Participant,

We are a team of researchers from Arizona State University and Rochester Institute of Technology. We are conducting research that examines how groups of diverse

participants organize and make decisions when confronted with a collective action problem.

As part of this course you will be playing one or more educational games that will encourage you to engage with other students in exercises where your grade will be influenced by the performance of others. These games will be played with students attending class at other Universities using digital technology (online discussion boards, SMS, and Twitter).

We are inviting your participation in providing data for our study that will be gathered during game-play and associated activities. These include pre-game and post-game surveys, writing exercises, class and online discussions, as well as observations of behaviors in class. Your participation in the game is a course assignment; however your participation in providing data for this study is voluntary. You have the right to not participate in surveys and the right to not have data collected from your actions, communication, or responses. If you choose not to take part in providing data for our study, we will exclude observations about your particular behavior and actions during game-play and disregard your responses. You will not be penalized for not participating and your grade will not be affected. You must be 18 or older to participate in this research.

There are no foreseeable risks or discomforts to your participation in the study. The data collected will be archived and studied in order to advance National Science Foundation project # 1037236, "An Experiential Pedagogy for Sustainability Ethics." Data collected from your participation may be used in dissemination material that discusses the project such as peer-reviewed scholarship, conference papers and presentations, and dissertation material. Should your responses be published, all information will be kept anonymous.

If you have any questions concerning the research study, please contact the research team:

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If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at (480) 965-6788.

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