

Bridging the Gap: Discovering Mental Models in Globally Collaborative Contexts

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ABSTRACT

The engineering and construction sectors have experienced a large surge in global projects. A common complaint is that American engineers are not ready to work globally because of their insensitivity to cultural differences. In this paper, we report two case studies of undergraduate engineering students in the U.S. collaborating with fellow students in Brazil, Israel or Turkey. We used survey, interview and observational methods to understand how cultural differences affected the quality of team interaction. We focus specifically on how culturally based differences in mental models of the work process (e.g., team structure, task processes, social conventions, knowledge/expertise) can account for problems that arise during engineering collaborations. The results can be used to design training software and materials to better prepare engineering students to work in a global context.

ACM Classification Keywords

K.4.3 Computers and Society: Organizational Impacts: Computer-supported collaborative work.

General Terms

Human Factors.

Author Keywords

CSCW, computer-mediated communication, mental models, cross-cultural collaboration.

INTRODUCTION

Advances in technology and new communication tools have led to the globalization of the economy. Corporations are outsourcing jobs, creating multi-national teams, and bidding for work in foreign countries. These international work efforts bring with them all the challenges of working at a distance, including coordination problems, lack of trust and

reduced common ground (e.g., [9], [21]) as well as some new challenges that arise from working with people from different cultural, geographic, linguistic, and other backgrounds (e.g., [10], [17], [23]). By understanding these special challenges of cross-cultural teamwork, HCI researchers can help inform the design of collaborative tools that make global work easier to accomplish.

In this paper, we focus on international teamwork in construction and civil engineering. Engineering companies often collaborate on highways, buildings, bridges and other infrastructure that are located in other countries and thus require employees to work closely with colleagues from other cultural backgrounds. The need for extensive information about the foreign site (e.g., materials, geography) and about the logistics of coordinating the various construction-related crews heightens the complexity of these collaborations. In addition, engineering educators have identified a lack of skill in cross-cultural collaboration as a specific deficit that needs to be addressed through the curriculum [28].

The underlying premise of the research is that team members from different national, ethnic or cultural backgrounds often have different *mental models* of the work process—how tasks should be assigned, how often and by what modality communication should occur, how much effort each member should put forth, and even what constitutes team success [5]. We explore these differences in mental models within the context of an international construction management course, in which undergraduate and graduate engineering students are exposed to cross-cultural teamwork. U.S. students collaborating with students from Turkey, Brazil or Israel were interviewed throughout the 16 week course. From these interviews and observations of their teamwork, we identified a set of cultural differences in mental models of the work process that appeared to be interfering with smooth collaboration. In this paper, we first describe the background research that motivated our study. Then, we describe the class, our methods of data collection, and our findings. We conclude with some implications of the work for designing new tools for cross-cultural collaboration and for training engineers how to be better global collaborators.

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BACKGROUND

In this section, we first describe the process of construction management in more detail, as well as the problems that can arise in cross-cultural construction management. Then, we describe how mental models of work processes may account for some of these problems. Finally, we describe how we implement the mental model theory to define the goals and purpose of the current study.

Cross-Cultural Collaboration in Construction Management

Civil engineering is a branch of engineering that deals with the design, planning, construction, operations, maintenance, and decommission of private and public infrastructure such as roads and bridges. It includes such subcategories of engineering such as structural, geotechnical, transportation, construction materials, hydraulic engineering, and construction management. Preparing for projects involves an integration of research into materials, sites, and other factors, risk and cost assessments, as well as the end design. Construction management deals with the construction process, including project planning, cost and time management, quality control, safety, and management of contracts.

In 2005, global construction spending reached around 4.4 trillion U.S. dollars, a 5.25% increase from 2004, an amount that is expected to increase in years to come [8]. A 2005 global construction survey by KPMG [25] reveals that 59 percent of surveyed construction companies worldwide have a portion of their work that is in countries other than their own.

Problems in Cross Cultural Construction Management

Today's construction companies report that their engineers and project managers are not prepared to deal with the requirements of increasing globalization. Their knowledge of materials, equipment, construction techniques, management techniques and methods is frequently cutting-edge, but their social skills are culturally-bound and therefore limiting. Much research has already revealed cross-cultural difficulties in some sectors, such as business, management, and software development (e.g., [14][18][32][20]). Many of the studies have compared Western cultures to those of East Asia, including China and Japan (e.g., [24][**Error! Reference source not found.**][34][**Error! Reference source not found.**]).

In the global market, cross-cultural interactions can easily go awry. Conflicts and misunderstandings arise from a number of sources, including differences in values (e.g., the need to work hard or to please a supervisor) [33], local norms [10], and language use, particularly when some members of a global team are using a second language. Brislin [4] describes clashes as "well-meaning," because all persons involved in an interaction are behaving appropriately according to their own culture's norms and values. However, there is evidence that if teams can work

through their cultural differences, global collaborations are more likely to succeed [32].

Cultural conflicts manifest themselves internally (at the individual level) and externally (to the organization as a whole). The most common internal conflict is culture shock, or the complex mixture of both cognitive and affective overload from vastly different cultural environments, manifested in a sense of loss and helplessness. These feelings are common in expatriates [27][33][4], but the likelihood, the nature, and the extent of this effect in remote collaborations is unknown. Culture shock might be put into simpler terms by equating it to a lack of adaptation to the new environment. Its effects may lead expatriates to return home early or may lead to bad experiences in collaborations, which may in turn lead to animosity, dissolution of collaborations, or reduced chances of future collaborations [26][27].

One approach to educating engineering students about their foreign teammates is to familiarize them with the broad dimensions along which cultures differ, such as individualism-collectivism (e.g., [22], [35]) and high vs. low context of communication [19]. Members of individualistic cultures, for example, are more likely to work toward their own success, whereas members of collectivistic cultures are more concerned with the success of the group as a whole. Studies have shown that these differences impacts manager behavior [14], beliefs about education [22], and trust across cultures [23], among other aspects of work life. Similarly, Hall [19] proposed that low-context cultures such as the United States communicated primarily through words, whereas for high-context cultures such as China and Korea, communication is implicit, with verbal content interpreted through the situational context. These differences in communication styles can lead to misunderstandings when high-context and low-context workers meet [19][33], as for instance when a refusal is conveyed through silence (high context) versus an explicit statement (low context).

Mental Models as a Barrier to Cross-Cultural Collaboration

Mental models are cognitive representations of the world—in this case, representations of the world in which the work takes place as well as its work processes. Team mental models are shared understandings and mental representations of the team's environment [30]. In a work setting, these mental models encompass such elements as role assignments, power and status hierarchies, team procedures, and the external working environment. Cannon-Bowers and Salas [6] state that to perform optimally, "team members must be familiar with the knowledge, skills, attitudes, preferences, and other task-relevant attributes of their teammates" and that "shared mental models allow team members to predict the needs of the task and anticipate the actions of other team member in order to adjust their behavior accordingly." When mental models are shared, team members understand one another's work

processes and are able to adapt their communication and behavior appropriately (e.g., [2], [16], [30]) because of the overlap in methods, processes, goals, and ideas.

A great deal of research suggests that cultural differences play a role in computer supported collaborative work (e.g., [31]). Members of international engineering collaborations may come to the project with very different mental models of team structures and processes, including communication styles, task assignments, pacing of tasks, and authority structures (e.g., [10]). Geographical distance further compounds the problems by making it impossible for collaborators to actually observe each other at work [11][9]. Even within a single culture, distributed work leads to misattributions of the causes of remote teammates' behaviors—for example, attributing a delay in responding to laziness or disinterest rather than technical problems. In cross-cultural collaborations, the impact of technological mediation can be greater due to cultural differences in attributional styles, or ways of explaining team dynamics or outcomes ([11][13]).

The Current Studies

The current studies seek to examine how mental models of work influence the success of intercultural collaborations on civil engineering tasks. We examined the mental models of a small sample of engineering students in a U.S. course on international construction management, as they interacted with teammates in Brazil, Israel or Turkey in two separate years of a course designed to promote international experience. In both cases, observations began at the onset of the course, before students had any interaction with their partners from other cultures. We then observed their teamwork and interviewed them weekly about their collaborations, focusing on misunderstandings and problems that arose. Although we had no explicit hypotheses, we expected that the Americans' mental models would be highly inaccurate at the outset of the class and that the subsequent performance of the team would be dependent on whether or not the Americans and their partners were able to identify and work through these differences in mental models.

A secondary goal of the studies is to help inform the design of new tools to train engineers to be better global collaborators. One of the most successful training techniques is to physically immerse someone in a foreign environment. However, the cost of an immersion program renders it an impractical solution for an entire undergraduate engineering population. We are exploring virtual immersion as an alternative. An understanding of the differences between cultural groups' mental models and the problems that arise from these differences will help us design new and better training tools.

STUDY 1

Study 1 was undertaken during the first year the course was taught. Each team was comprised of individuals from two

countries: the United States and either Brazil, Israel or Turkey. Interviews, observations of teamwork and written materials were used to understand individual team members' mental models and how they shaped the collaborative process.

METHOD

Participants

Participants consisted of 9 students at Carnegie Mellon University, who were enrolled in a course intended to provide engineering students with the skills necessary for working in a global market. Participants were grouped into three-person teams, and each team was then assigned one of three collaborating countries: Brazil, Israel, or Turkey. The multinational students consisted of 2 Israelis, 3 Brazilians, and 2 Turks. These collaborating countries were selected based on existing relationships between the third and fourth author and faculty at the foreign universities.

Class Projects

Students were expected to work on a set of selected projects, developing deliverables such as risk plans, bid plans, cost analyses, schedules, product models, production plans, project contracting clauses, and project organization plans. These were actual projects either in progress or already completed by international engineering teams in the home country of their foreign teammates (i.e., Brazil, Israel or Turkey, depending on the team). The students had access to the original design documents and specifications and decided on how to execute their projects in foreign countries. Throughout the course, students interacted with clients (remote professors) and students located in the assigned participating countries. During the 2007 course offering the projects were as follows: the US-Brazil team had to design and construct low-income housing for the city of Canoas, the US-Israel team had to design and construct a given stretch of the Carmel tunnels in Haifa, and the US-Turkey team had to design and construct part of the Eskisehir Light Rail.

Each group met once a week, during which they either worked with their remote and collocated partners or presented work to the class. Students also set meetings which were held outside of class. The "clients" determined which deliverables were due from week to week.

Collaboration Tools

Students interacted over the Internet. They had access to tablet laptops, webcams, and headsets. Students used Microsoft Netmeeting for desktop sharing and Skype for video conferencing and voice meetings. Course information and assignments were managed through Blackboard. A locally developed collaboration extranet was used for scheduling meetings, for threaded discussions, and for exchanging documents and information. Teams also had access to other tools, such as an electronic whiteboard, as needed.

Measures and Data Collection

We were interested in observing how the American students' mental models of their own and their partner country's work processes affected the dynamics of their collaboration. Our primary method of data collection was detailed observations of group meetings held during the weekly class period. We interviewed the American students, exploring with them incidents that had been noted in the observations as well as soliciting general information about successes and hurdles in the collaboration. In addition, we had access to the American students' weekly journals, in which they relate some of their experiences. (IRB restrictions prevented interviewing or journal access for students from outside the U.S.).

In addition to these qualitative measures, we attempted to gather survey responses at several times during the class. The survey asked each person about work life in his/her own country as well as in that of the other countries. Due to small sample size and because the American students often refused to answer the questions about other cultures, we do not discuss the survey data in this paper.

Analysis

Notes from the observations, interviews and journal entries were compiled and grouped into categories reflecting the type of problem an individual or team encountered. We then explored the notes from each problem category in order to examine how cultural differences in mental models might have contributed. In the next section, we describe some of the emerging themes from this analysis.

We were unable to get permission to collect data from the multinational students. The results, therefore, are written from an American perspective.

RESULTS

Our coding of field notes and journals suggested several instances in which mental models of team processes differed between cultures, having a negative impact on collaboration: models of team structure, task process, social conventions, and knowledge/expertise. We discuss each of these in more detail in this section.

Mental models of team structure

Team members have mental models of how work groups should be structured, how roles should be assigned within the group, and who is responsible for ensuring that tasks were completed competently and on time. We observed that when members of different cultures disagreed in how teamwork should be structure, problems arose in the collaboration.

Structure. Group organizational structures vary across cultures, affecting roles, expertise, and divisions of labor, as well as the proper channels through which one achieves goals (e.g., [22]). When groups fail to share the same mental model of group structures, they may disagree when trying to form a team or some members of the team may

feel uncomfortable in their team. We saw several cases in which teams had difficulty organizing their work across the U.S. and remote sites. For example, the Brazilian group and their American counterparts initially had problems coordinating because they could not agree on the hierarchy of their work groups. Brazilian students felt that the proper way to structure their group was in accordance with an egalitarian system. The American students preferred a more hierarchical structure. One American student insisted on this kind of structure, causing a bit of discord at the beginning. After several weeks, however, they were able to compromise and agree to a structure, though by this point, the disagreement probably started the collaboration on the wrong foot.

Roles. Expectancies of the roles group members should fulfill varied, often a result of hierarchies and specific job roles, but also relating to gender or age. Each of the teams had to negotiate roles both among the U.S. team members and across the American and foreign sites. Some teams did this fairly effortlessly. For example, the American and Israeli students were able to come up with roles for team members by separating tasks into three teams of two (one American and one Israeli student per task). Other teams had significant difficulty, for example the American and Brazilian team, and disagreed vigorously over role assignment. This disagreement culminated in a compromise where members of both teams rotated the roles each week.

Task responsibility. In addition, team members have mental models of what individuals holding specific roles are responsible for achieving. Disagreement with respect to task responsibilities was most evident in the Brazilian-American team. The Brazilian students did not agree with their American counterparts over the locus of responsibility. While American students desired a clause in their contract concerning the punishments for individuals who were unable to complete their work, Brazilian students preferred to spread responsibility across all members, thereby avoiding punishing any specific members but instead accepting blame collectively. Because this would have to be written into their joint "contract," it was a point of contention.

Mental Models of Task Processes

Team mental models research suggests that shared representations of the task process help teams to interact better because they will be able to understand the way their partners work, allowing them to form reasonable expectations [5][6][9][10][11]. Team processes, however, turn out to be complex. The process is affected by available technology, the distribution of materials and information, and communication.

Communication. All groups had problems communicating due to different accents, varying levels of English proficiency, and local terminology, which led to misunderstandings and lost time spent establishing common ground. In addition, necessary documents were often not

translated into English, a problem that occurred with all three teams. This required collaborators to either verbally translate relevant sections of the document, which may lead to omission of other relevant information or to spend precious work time doing translation.

Rules. Some scenarios may involve preset standards and rules for how teams are supposed to work, which become ritualistic in nature. Hofstede covers rules under the umbrella of concepts that forms *uncertainty avoidance*, the tendency to avoid uncertain situations [22]. While rules may be unstated, they may be internalized and acted out. It was evident shortly into the projects that the Israeli students had a very efficient approach to working, where timeliness was expected and social chat was discouraged. American students seemed to catch on to this rule early on, allocating this information into a mental model of the process by which their counterparts worked.

Mental Models of Social Conventions

Perception of time. Cushner and Brislin [12] pose that time differences (time zones) and differences in the perception of time cause culture clashes. *Punctuality and Tardiness* are problematic and the level of acceptability across cultures can lead to conflicts. *Deadlines* also are problematic when the expectations of what is to be presented at a deadline differ among members.

The definition of a deadline also varied. In the American-Brazilian team, Americans felt like Brazilians were not observing deadlines and to the Brazilians, deadlines seemed to be more flexible. Perhaps it could be that the deadline itself is not strict or it could be that it is better to submit finished work late than unfinished work on time. Without access to the Brazilian students, we unfortunately cannot explore why this occurred.

Teams had also problems coordinating around holidays which were not shared, such as Brazilian Carnival and American students' Spring Break. Also, the time differences mean that collaborators are not available at the same time.

Americans working with Turkish students found that their counterparts were often late to meetings, ranging from 5 minutes to half an hour late or longer. This meant that American students were often idle while waiting for their teammates to arrive. While the American students were bothered by the chronic tardiness, they accepted it as a quirk of their remote collaborators. The students noted that eventually they realized that this trait was not intended to spite them. Here, a mental model of promptness in arriving at meetings was definitely an issue, but the students were able to resolve it.

Norms. Attitudes, goals, interpersonal relations, and other aspects of life that are deemed important are often not the same across cultures. Cushner and Brislin [12] claim this concept as one of the areas where culture differs.

We expected to witness some differences in values like timeliness, and relationship building. Only the American-Turkish team engaged in relationship-building behaviors with any frequency, often spending fifteen or more minutes socializing at the beginning, the end, or at both points of their meetings devoted to talking about news and sports. A poignant example of this occurred when an earthquake happened in Turkey. At the next meeting, the American students were aware of the event, and asked if any of them or their families had been affected.

There was an initial attempt between one American student and one Brazilian from the Brazilian-American team, but from our observations, this was the only attempt and the team as a whole did not develop friendships. This may be due to the American students or to the multinational students not initiating social talk. As mentioned before, one student was particularly difficult to work with, which may have damaged the relationship early on. The problem may not have been cultural at all, but simply an issue of one dominant personality.

Space. The space domain connotes a physical closeness to cross-cultural counterparts [12]. It has been shown that, in collaborations, distance matters and that remote collaborations face difficulties that collocated collaborations do not [3][31]. Because of the lack of closeness and presence, remote collaborations are troublesome. This is not to say, however, that distant partners do not find other ways of becoming close. Continued effort to communicate, working at strengthening a relationship, and enthusiasm might be able to overcome space. A preexisting interest in cross-cultural encounters may make one more apt to be a better cross-cultural collaborator, further suggesting that acting on the intent of being a good collaborator would make one a better collaborator than one who doesn't.

The American-Israeli team was observed as having a relatively large psychological gap. The Israeli students, Americans noted, were "all business" noting that they "arrive at meetings and talking about work, but never talking about personal things." Understanding that a no-nonsense approach to work might be a part of Israeli work ethic rather than unfriendliness, Americans in this team were able to adjust their work modes accordingly.

By contrast, the American-Turkish team had a significantly smaller spatial gap. American students began their project with meetings where they got to know their Turkish counterparts. They began work later than the other two teams because of the initial time spent, but seemed to feel much better about their collaborators than the other American teams. The American side of this team also found news, using news sites such as Yahoo! in order to find conversation starters. The Turkish side also sought out conversation topics, usually by following American basketball as well as other sports, that being a topic that their American counterparts were interested in.

One American student on the Brazilian team attempted to build up a pre-projects relationship with a Brazilian partner. On the whole, however, the team was unable to recover from their early clashes. Given the problems experienced, it was not surprising that the psychological space remained large between the American side and the Brazilian side.

The vast difference between the Brazil-US team and the Turkey-US team is that the Americans working with the Turkish team attempted to understand their cross-cultural counterparts and change their model. There was an interest in building a mental model similar to their teammates and it was reciprocated. The Americans working with Brazilians, for the most part, did not make an attempt at developing a mental model. As such, both teams retained their original models, making closeness difficult to achieve.

Mental Models of Knowledge/Expertise

There is knowledge about the world that does not carry over from one culture to another. In construction management and engineering, examples of such kinds of knowledge could be building methods or materials. Universities might have different foci for their courses, and the knowledge is likely to be focused more on local building techniques.

One striking example that brought this domain open to all teams occurred during a presentation. The American-Israeli group's project was to build a tunnel and series of bridges through a mountainous region. At the end of the presentation, which all countries listened to, a professor brought up the fact that the project could be built more quickly by hiring five-hundred migrant Chinese workers, the solution that was chosen by the actual construction company who undertook this project. This was something that none of the students had thought of as a possibility.

Interviews with one US-based student from the US-Israel team revealed that she felt the team did not have knowledge that their counterparts might have had. This had an interesting outcome. The team realized that they could not divide into American and Israeli subgroups because the Americans were too far from Israel to make planning decisions. They decided to change their organizational structure subgroups consisting of one American and one Israeli student for each of the tasks/deliverables.

Interviews with Americans in the American-Turkish team revealed that Americans saw the Turkish students as doing most of the work. They expressed insecurity over their skills and thought their Turkish partners' opinions of them might be low, especially since they themselves thought they weren't contributing. They attributed their inaction to being too far from the site to make accurate or meaningful decisions. This might be true, but if false, would suggest that the stress associated with a perceived lack of knowledge is detrimental to the work experience.

Other occasions where lack of knowledge was an issue involved the use of documents in non-English languages, rendering the American students dependent. In addition to

being a communication problem, this is a knowledge problem because one group has information that could be vital to the other, yet they have no way to easily transfer this knowledge.

External Issues

Technology: Technical problems often provided unwanted frustration. VoIP (Voice over IP) connections were often dropped, the high incidence of which may increase the level of stress. Webcams may have improved overall feelings concerning partners, especially where bridging psychological space is concerned, but impact on the actual task is unknown. Cramton's study of geographically dispersed teams [9] suggests a similar problem, *difference in speed of access to information*. In her study, she finds that people in distributed groups have varying amounts of Internet and computer access. When email occurs infrequently, works slows down and negative attributions about partners' work effort or skills could be made. Time delays in chat, she finds, also lead to negative attributions.

An example that we found occurred during Brazilian Carnival. U.S. students expected their counterparts to remain connected during the holidays to do work, but most of the Brazilian students did not have Internet access at the beaches where they were spending their vacations. American students viewed this as laziness and complained about the lack of contact. Eventually an angry email was sent, getting the attention of the Brazilian partners, but raising tensions within the group.

Interestingly, because of the instability of Skype and Netmeeting to all students involved, we didn't observe any erroneous personal attributions when software was to blame.

Distribution of Information. Cramton [9] suggests that uneven distribution of information is one problem where misattributions occur. Likewise, as noted earlier, we found that problems arose when members from multinational teams had to refer to documentation that was not in English. All teams experienced problems calculating the pricing of materials and labor in other countries. While they *did* have the information available in American units, they did not have the information needed to gauge local pricing or availability. To simply convert prices from U.S. Dollars to other currency leads to an incorrect estimate, since the prices in the United States reflect national availability of resources, wage values, local productivity, local construction methods, and so forth, all of which may be higher or lower given circumstances in other countries. In all cases, the documents were available, but not in English. Given these circumstances, their cross-cultural counterparts would have to translate the documents or do the work and doing all the work would take as much effort as translating all documentation.

A theme that surfaces with uneven distribution of information is the allocation of work. While U.S. students

wanted to be helpful, they were often at a disadvantage because the projects take place in other countries. Without the experience of site visits, interactions, and documentation, they often relied heavily on their remote teammates. The American students in the U.S.-Turkey team often complained about their inexperience and of feeling unhelpful in situations where they felt unable to help their teams, many times admitting that their counterparts had to “do a lot of work to cover” for them. One member concludes that,

... in most multinational construction projects, at least one person would be in the other country.

But without the benefit of such a physically immersed person, when it is impractical or the cost to provide that person is too high, materials still need to be evenly distributed.

STUDY 2

We conducted a second case study that was very similar to the first with only a few differences, namely the students’ groupings and the task. The purpose of the second study was to collect more data, since the sample size for each year of the course was small.

Participants

Participants consisted of a different set of 9 students at a U.S. university, 4 Brazilian students, 2 Israeli students, and 4 Turkish students. All were enrolled in the same engineering course mentioned in the previous study. This time, each team consisted of at least one student from three of the four participating countries. The purpose for this was to broaden the students’ exposure to other cultures. The previous year, students had focused on the interactions with the single country they worked with and did not learn about the other countries. This method allows students to see one more side of the problems that surround multinational remote work.

Class Projects

There were also changes to the nature of the project. This time, each team had to research the building of commercial buildings in each country and then choose one of their represented countries in which they were to build the commercial structure. In order to do this, students had to research costs, materials, risk assessment, methods, etc. for each of the three countries before deciding which country would be most efficient. This change was made in order to be able to compare progress and end results between groups, as well as to promote a sense of competition for the best proposal in the class. Also, the professors specified team roles at the beginning of the course (e.g., team leader, risk assessor, pricing assessor) and students assigned themselves into those roles.

As in Study 1, students had to submit journal entries as well as read book chapters and papers on international collaboration. The students met once a week to discuss the

readings and talk about the course. Group meetings were scheduled outside of class time.

Collaboration Tools

In addition to the tools available to students in the previous study, students in the second study had a video conferencing system that allowed them to see and talk to all of their partners simultaneously. This system also allowed desktop sharing.

RESULTS

General Assessments

The change in team structure, member composition, and task changed the project, probably for the better. In the previous setup, American students only had to research one country, the one that their multinational counterparts were already familiar with. This time, because there were three countries and three potential projects, all students were able to learn about engineering practices in other countries.

Also, the team structure change meant that students did not have to go through the exercise where they try to coordinate and form a team structure. While this saved students from some early frustration, it is not clear that this was necessarily a good experience to miss.

Mental models of team structure

Because the structure and roles were defined at the beginning, students’ initial mental models were more similar at the outset than was the case for Study 1. In terms of benefits, this aided the students in the sense that they did not have to fumble through the process of organizing a multinational team. The tradeoff, though, is that in real world situations, group structure and roles are not likely to be given from the start. If those students were to come across the situation where they must organize a multinational team, they will not have had the experience.

Mental Models of Task Processes

Communication. Again, teams had difficulty understanding each other because of accents and varying levels of fluency in English. Because Americans had not been trained in any of the other languages (and the difficulty of instating that requirement on the course), English remained the language for all communication. One student said:

Language is probably a number one thing. People interpreted things about what was important and others didn’t. It caused a lot of problems.

Mental Models of Social Conventions

Perception of time. Perception of time was an issue again, possibly more so than in the previous study because teams were comprised of three cultures. The addition of a third culture adds another possible opening for differences.

Teams started working even if some partners were missing or late, because of the difficulty in scheduling a good meeting time for all groups. To wait for someone might

mean that there will be much less time to work once all parties are present.

Norms. As with the time-related issues, cultural norms were a larger issue than in Study 1 because of the addition of another group of students with established cultural norms.

We again found clashes with cultural norms during holidays, during which students from some countries did not think they should be working. Other members of the team expected that their partners would still be working, even though they did not have to go to school.

...when they say 'I'm not going to be in Ankara for a week, they don't bring their computer with them or I guess they don't have internet...

It is interesting to note that in this example, the student doesn't seem to know the real reason why his/her partner(s) would be gone and makes attributions to the technology rather than to cultural norms with respect to holidays.

Mental Models of Knowledge/Expertise

As previously mentioned, differences in the state of the world and knowledge varies between regions. Processes, what they entail, and which factors or concepts are important or relevant to those processes can vary greatly. One group faced misunderstandings when members differed on value management, a project management technique that measures the project's process, such as scheduling, budget, etc.

In Turkey we mainly defined value in terms of the income of the owner after the construction completed. However, in US value adding activities indicates the ones that decrease cost and duration of construction phase."

External Issues

Technology. Again, technology was an issue. Dropped calls and dropped video conferences made meetings more difficult. The video conferencing system was well-received by most of the groups. Only one group did not use that tool. In interviews, one of the students said "I just don't think we need to see each other," though in a closing interview, the same student claimed that "it might have been nice to be able to see the other peoples' gestures and faces."

Availability of technology was a problem, since not everyone has the same degree of access to computers and/or software. In the context of the course, this was manifested in the use of the video conferencing system. Because the system is not portable and the rooms where it is located are either offices or classrooms, combined with the added complexity or scheduling times to that system, other types of technology become more convenient. This is the reason why email, IM, and VoIP are used much more often than video conferencing. One of the non-US students stated that,

Except the limited usage of Polycom, I didn't face any difficulty related with technology.

Distribution of Information. Again, the distribution of information provided some difficulties. Some of this was alleviated by the fact that students were able to search for the information from their own countries to share with their partners. Because students were all working on the same tasks for all of the countries, they all began with the same disadvantage. This understanding might have alleviated some of the inner conflict with that the American students felt in the previous study. Likewise, this mutual disadvantage might have decreased the extent to which other students felt the American students were unprepared.

The solution to this problem was to rely on partners when the information wasn't available. One student stated,

If you couldn't find it online, we would email the people in the country and they would respond.

Because all group members eventually had to do this, there were probably fewer feelings of inadequacy. Also, some students used other resources to inform their projects, such as asking experienced practitioners.

Rules. Again, promptness to meetings was a clear difference in rules. One student stated:

I feel here in the USA, we were getting stuff done pretty regularly on time, but maybe the guy from Israel, maybe a little late

It is interesting to note, however, that in the previous study, tardiness from the Israeli team was not an issue. This reinforces the fact that individual differences may trump culture. It would be difficult to say which study more accurately reflects Israeli perceptions of timeliness with such a small sample.

CONCLUSION

In this paper we use observational and interview techniques to understand the experiences of American civil engineering students engaged in a cross-cultural learning experience with other students in Brazil, Israel or Turkey. By examining how the Americans talked about their difficulties in cross-cultural collaboration, we have begun to identify critical differences in their own and their foreign partners' mental models of the work. Americans and their foreign counterparts differed in their mental models of team structure, team process, time management, social conventions, and the distribution of knowledge and expertise.

The results of these problems were numerous. There was wasted time, when students faced obstacles, resolved them, and continued. Groups also had to devote time to reorganizing themselves when the solution to a problem was hierarchical or related to work distribution. Hostilities arose due to perceptions of lateness, laziness, and mutual misunderstandings. In some cases, team members could not attain goals properly and failed to present work of the desired caliber. In these cases, the collaborations came close to collapse. It was not evident from the American

students, however, that they would seek to avoid cross-cultural collaborations in the future.

One important concern deals with the duality between personality and culture. While culture can play a large role in the success or failure of work relationships, personality is also a key factor. This was evident as one particular American student proved to be difficult to work with, which caused many of the problems that the team experienced.

The things that are most interesting to this research team and other researchers who might undertake the building of a training tool is the identification of specific aspects of mental models of work that lead to problems in collaboration. Our next step will be to devise training tools and group training techniques that familiarize students in advance with the ways their foreign collaborators might conceptualize work. Although we have examined only three teams and three cultures in the current study, our longer term goal is to develop training methods that are culture-independent and thus will prepare students to engage in international collaborations with individuals from any culture.

There are of course weaknesses in the research. Most notably, the sample size is small. A much larger sample would be needed to fully explore these theories. However, we still feel that observing small groups can give some valuable insight into what the mental models *might be* and how they influence the process of collaboration.

Additionally, the studied suffered from the lack of survey data, our inability to interview the foreign students in the first study and the difficulty with obtaining interviews in the second study. In the future, we intend to expand the course, both in terms of enrollment and in terms of the number of cultures involved. In addition, we plan to run controlled field studies in which we can evaluate the training tools we are developing. In the long run, we hope this line of research will lead to engineers better prepared to work in the global market.

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