Group Formation and Performance of International Students in Capstone Groups

Bridget M. Smyser and Gregory J. Kowalski
Northeastern University

As the number of international undergraduate students in U.S. universities grows, more students will be required to work on multicultural Capstone teams. A total of 175 previous Capstone design project teams were studied to determine relationships between the proportion of international students on a team and various outcomes such as prototype completeness and writing grade. This database provides objective information to investigate the accuracy of anecdotal observations and to develop strategies to improve student outcomes. Other factors such as previous experience with group members, language proficiency, and whether or not a team was student formed were also investigated. Results show that international students tend to perform better on student formed teams, and that their ability to create a student formed team tended to correlate highly with English language proficiency. The results of this investigation provide insight in mentoring actions to improve student outcomes and to provide positive experiences for international students.

Keywords: International students, team formation

Corresponding Author: Bridget Smyser, b.smyser@neu.edu

Introduction

Team work, particularly in Capstone design, is an essential skill for engineers.[1] The literature contains a number of team formation schemes that have been used over the years, including teams based on GPA, project interest, and self-selected teams.[2] Other studies have used Meyers-Briggs personality testing[3] or web based tools such as CATME[4] to form teams. While some authors have found that student formed teams perform less well[5], other researchers have found that instructor formed teams have no particular advantage[6]. Many tools have been developed for dealing with difficult students[7], but these often focus on mental health issues and work ethic, without a large amount of detail on international student issues. Work relating to international students notes differences in competitiveness and reluctance to ask questions between students of different nationalities, although it does not specifically address group work.[8] In addition, many international team initiatives in Capstone design involve two teams in separate countries collaborating on a project[9], and thus much of the work on these initiatives focuses heavily on the logistics of working across time zones and with disparate academic calendars[10]. The Capstone design literature does not seem to address the integration of multiple nationalities on a Capstone design team to a great extent.

Work on managing multicultural teams in the literature focuses heavily on the corporate setting. One such study found that regardless of ethnicity, individuals who can tolerate uncertainty do well in the early stages of team formation, while those who value relationships do better later in the team process.[11] Another author observed that while some cultures value succinct style more than others, country of origin and native language cannot explain all communication style preferences.[12] Yet another study showed that surface level diversity issues such as gender and ethnicity can be overcome by individuals with a strong preference for team work, whereas issues such as individuals' sense of time urgency and degree of extraversion require more active intervention, often from outside the team.[13]

A common denominator in both corporate and educational settings is the need for, and problems caused by, communication. Project work has been shown to help international students both with their English skills, and also their socialization to the majority culture[14]. These studies recognize the language and cultural barriers to speaking in public, which must be specifically addressed in order to allow international students to reach their potential. Native speakers can assist in the socialization process by scaffolding team assignments for the non-native speakers and taking time to work past language barriers. The role of native speakers in incorporating non-native speakers into active participation in their teams may prove to be a key factor in the ultimate success of a multicultural team.

Capstone in MIE at Northeastern University

The Mechanical and Industrial Engineering department at Northeastern University has a required two semester

Capstone design sequence. Students work in teams of 4-5 members with the goal to produce a functional prototype at the end of the second term. Prototypes are assessed at a point 2 weeks prior to the end of term on a 10 point scale; 5 points for completeness of the prototype at that point, and 5 points for completeness of verification testing. Students are also assessed on written and oral communication, and how well the delivered product meets the initially developed specifications.

Group formation happens at the beginning of the first term. Students are asked to form teams of 4-5 people and submit a preference form in which they rank all of the projects from most to least desirable. Students who are unable to form groups may submit preference forms as individuals, pairs, or groups of three. The instructor forms these students into teams based on project preference. An effort is made not to isolate female or international students on teams, however this is not always possible.

Northeastern University has a 5 year program, in order to accommodate up to three six month long co-op experiences. Students are split into two cohorts, and one cohort is on co-op at any given time. The majority of students remain with their cohort throughout their college experience. However, some students end up taking Capstone 'out of sequence' due to various reasons. Because of this, these out of sequence students are often less familiar with their classmates, which may lead to difficulty in forming teams.

A laboratory course in Measurements and Analysis is typically taken one year prior to Capstone. This course requires extensive group work and an independent experimental design project. This provides students with an opportunity to work closely with some of their classmates. The ability to learn other students' skills, strengths, and weaknesses may have an influence on future group work and Capstone team member choices. Although in theory students should take Measurements before Capstone, some students take Measurements concurrently with Capstone, and some take it after Capstone.

Research Questions

A previous study by one of the authors[15] found that student formed teams seem to perform better on measures of passion and commitment to the project, particularly when students choose teams based on skills and with an eye toward complementary work styles. Students who formed their own teams also tended to demonstrate more ownership of the project, which leads to more complete projects in the time allotted.

The current work investigates the performance of groups containing international students. Casual observation by the instructors seems to indicate that groups with a higher percentage of international students seem to perform less well. However, no data had previously been collected to validate these observations. Specific questions include:

- Do student formed teams produce higher writing grades and higher prototype grades?
- Are international students more likely to be on instructor formed teams or student formed teams?
- For student formed groups containing international students, what factors are significant?
- What are the characteristics of groups containing only international students?

Methods

A total of 175 Capstone projects from 2007-2015 were examined. Of those groups, 42% of the groups had international students. Teams were assessed based on:

- Number of international students
- Number of different countries represented
- Number of students on team sharing a common language
- English language proficiency of students
- Team writing grade
- Team prototype grade
- Whether the team was formed by the student or the instructor

The language proficiency of the students was assessed based on instructor observation of oral presentation and written work and was rated as 'high', 'medium', or 'low'. Over the period of observation, the same instructor assessed the written grades, English proficiency and prototype grade using the same grading rubric.

In addition, the teams from both the previous Measurements and Analysis course and Capstone were analyzed to determine how many students were on Capstone teams with previous teammates. Additional data was gathered for individuals including:

- Whether the students were on a team with a previous Measurements partner
- Whether or not the students were out of sequence

These factors were examined using the Pearson Product-Moment Correlation Coefficient implemented with the Excel correlation analysis.

Results

A summary of the assessment tools in terms of the countries represented is shown in Figure 1. The information is a summary of the individuals in the 175 teams investigated.

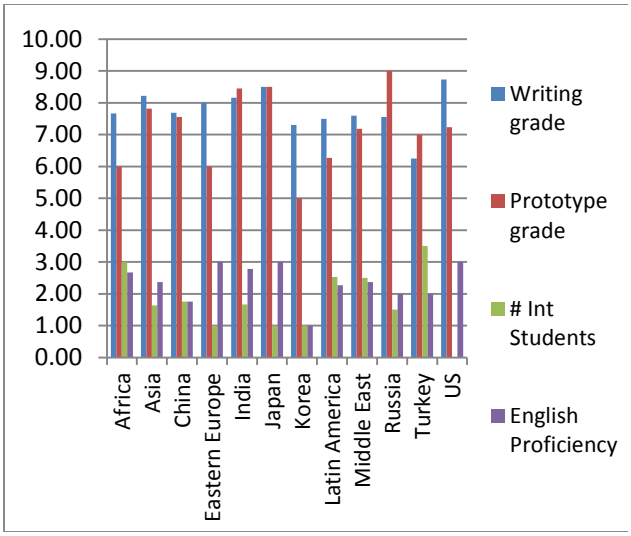

Figure 1 A summary of the data used in this investigation in terms of the international background of the students. The writing grade was scaled by a factor of 10.

An examination of all of the groups showed that student formed groups did perform better on their prototype and writing scores, although the correlations were not especially strong. Considered as groups, the writing grade/student formed group correlation was 0.49, and the prototype grade/student formed group correlation was 0.22. When students were considered as individuals, the writing grade/student formed group correlation was 0.35, and the prototype grade/student formed group correlation was 0.18.

International students were less likely to be on student formed teams, with a negative correlation of -0.37, whether considered as individuals or teams. When considered as individuals, international students were less likely to be on a team with a previous team member (-0.31), and less likely to have high writing grades (-0.41). Individual international students with a high language proficiency are slightly more likely to be on student formed groups (0.29) and are also more likely to be on groups with previous Measurements partners (0.26).

When considered as teams, international students were much less likely to be on a team with someone with whom they shared a common language (-0.68), were less likely to have a high English proficiency (-0.58) and were less likely to have a high writing grade (-0.58). However, international students were much more likely to be on a team with a high diversity of countries represented (0.72).

Student formed teams containing international students showed a number of interesting patterns. There were positive correlations between writing grade and English proficiency, as expected (0.53). Interestingly, there was also a positive correlation between prototype grade and diversity of countries represented (0.35). The prototype grade and the writing grade were also positively correlated for this subgroup (0.29), although there was a lower correlation (0.17) for all student groups considered together. A large diversity of countries represented correlated negatively with many students having a common language, as expected (-0.62). For this small group there was a correlation of -0.53 between the writing grade and the number of international students. There were also negative correlations between English proficiency/number of international students (-0.36) and prototype grade/number of students with a common language (-0.25).

Eight teams were studied which were composed only of international students. Five of these groups were student formed, 2 were instructor forms, and one group had an unknown method of group formation. The student formed groups had an average prototype score of 7.2, while the instructor formed groups had an average prototype score of 4. The average writing grade for all eight groups was 70.4, however the average writing grade for the instructor formed groups was 66.5. Although the sample size is too small for extensive analysis, it does seem that teams consisting of only international students perform better when student formed.

Discussion

There were a number of factors that seem to have very little effect on group performance. Writing grade was not strongly affected by whether or not students were out of sequence, nor by the order in which students took Measurements and Capstone. International students did not seem to be more likely to be out of sequence with their peers. The order in which students took the two related classes also did not seem to influence whether or not the teams were student formed.

Only 35% of the total number of groups with international students were student formed. Because there seems to be an advantage to being on student formed teams, especially for international students, it would be beneficial to encourage all students to form their own teams. However, the results seem to indicate that language proficiency can be a barrier to student team formation. Students with low language proficiency may have fewer strong bonds with other students, particularly without a common native language. When these students find at least one teammate with whom they share a common native language, they are more likely to be able to clearly communicate ideas and brainstorm. A diversity of viewpoints seems to make for better prototype scores.

Prototype scores may also be higher for students who can write more coherently about their ideas, as the instructor can better understand what the team has or hasn't done up until that point.

International students seem to perform well on diverse teams with at least one proficient English speaker. However, teams with only international students can also be successful, particularly if they are able to choose their own team. What is not known is what cultural factors might influence the ability of students to form their own teams. Initial observations of student origins showed that students from Asia, including China, were present in 31 groups, of which only 6 (19%) were student formed. However, students from Middle Eastern countries (present in 22 groups) were able to form student groups in 9 cases (41%), while students from Latin America (19 groups) were able to form student groups 7 times (37%). Additional research will be necessary to determine how cultural factors influence the ability of students to form their own groups.

Conclusions

It is clear that with the student population at Northeastern University, student formed groups lead to improved outcomes. As the number of international students grows among the undergraduate population, additional work must be done to integrate them into the student body more completely. In particular, improving English proficiency seems to be the key to international students being sought out by other students for Capstone teams. Adding in opportunities for discussion and socialization in earlier courses could improve the chances that international students will be included on student formed teams. When the instructor must form teams, he or she should endeavor to balance team diversity with the need for students to share a common language with someone on their team. These interventions would be relatively simple to implement, and could lead to improved student outcomes.

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