Optimizing linguistic diversity in highly multicultural engineering design teams

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Engineering design is a process that frequently takes place in teams. Teams function best when they are cohesive and draw on each individual's strengths, whereas teams in which members feel excluded or silenced are less conducive to positive outcomes. We examine team behavior in an extremely diverse undergraduate engineering design course. In previous iterations of the class we are studying, language-based exclusion and other language-based communication issues were the greatest sources of dysfunction on student teams. We manipulated team formation on the basis of linguistic diversity to reduce the likelihood of language clique formation. Our findings confirm that student teams in which there is no one dominant language group seem to have fewer problems with language-based exclusion or disengagement.

Language diversity and team formation

In this study, we chose to focus on and manipulate language diversity in team formation because, while there are still many visible minorities, religious minorities, sexual minorities, etc., in the undergraduate engineering design class under study, these types of diversity do not present communication barriers as stark and immediate as does the lack of comfort in a common language. In addition, language competency is far easier to quantify than the degree to which a person feels or acts as if he or she belongs to a given culture.

Previous studies on the effects of high linguistic diversity in the workplace confirm that people of low relative proficiency in a common language often feel vulnerable, frustrated, ignored and misunderstood, but when people in these situations seek clarification or refuge in their native language, others may see them as rude, unreliable and

untrustworthy [1-5]. Anecdotal reports of student behaviour in previous iterations of the engineering design course under study support these findings.

Team formation in this course in previous years was done by self-selection – students chose their own team members, forming teams of 4 or, less commonly, 5 students. Every year, the patterns of team formation were similar: while there were a few highly cohesive teams, there were also a number of highly dysfunctional teams. Many cohesive teams consisted entirely or mostly of speakers of a shared language and, often, culture. Conversely, dysfunctional teams tended to be made up of students hesitant to form their own teams, mixed with students who showed up late on team selection day. Students on these teams often had markedly different approaches to course work, only some of which stemmed from language or culture (more broadly speaking).

These patterns of team formation led to certain general patterns of team outcomes. Two types of teams in particular caused concern: teams that communicated almost entirely in a language other than English, and language-based exclusion of team members in mixed-language teams. When team members shared a common language other than English, team members communicated exclusively or almost exclusively in that language. This led to strong communication among team members, but made between-team communication in English– e.g. in class presentations – more difficult. Linguistically uniform teams experienced less dysfunction than other teams, but did not benefit from the diversity of the class as a whole or experience what working in today's global workforce is really like. Furthermore, the exclusive use of non-English languages in these teams reduced team members' exposure to and participation in conversations in casual spoken English. Students with low English proficiency levels were therefore deprived of an opportunity to practice their listening and speaking skills in English, as evidenced by the common phenomenon of students acting as translators for other students on these teams. While native-language communication among teammates is helpful for clarifying points, ongoing translation of class material by students for other students may also introduce distortions to the material being communicated because the student translators may not be proficient at understanding the material themselves. Students relying on peer translators may also lead to a distorted power dynamic within the class, in which the peer translators act as gatekeepers between the students relying on them and the TAs and instructor. These issues with peer translation are also known to be problematic in multilingual situations in industry [1-3].

Conversely, when a team contained several students who spoke the same language and who communicated in that language, excluding one or more members who did not speak that language, linguistic/cultural conflicts resulted. This situation includes teams where most people were proficient in English but a few were not; the people with lower English proficiency often felt excluded and talked-over.

These two specific types of teams were the subjects of complaints by students in past iterations of the undergraduate engineering design course, specifically, 1. some students in groups that spoke a common non-English language complained about their lack of exposure to English because of peer pressure to speak the other language, and 2. students who felt talked over and excluded by either teammates speaking in a language they did not understand at all or by teammates speaking English too rapidly for them to understand.

In this study, we aim to reduce the occurrence of these two types of problematic teams by using a team formation algorithm in which (among other things), no more than 50% of any team consists of members with the same native language, and no more than 50% of any given team speaks only English. The output of this process was expected to be teams roughly equal in terms of language ability and linguistic diversity, such that all students get exposed to teammates from language groups different from their own, and such that English is the only common language in the group, encouraging the use of English within teams and reducing language-based social exclusion. We also anticipated a reduction in students translating for other students. Forming heterogeneous groups to increase harmony in multicultural classrooms has been suggested before (e.g. [6]), though the methods that we employ here are unique in that we focus on language skills and not, e.g., nationality [7] or subject preferences [8]. We hope that our intervention will not only lead to an improvement in student experience, but also to cultural enrichment at this critical point in students' lives [9].Making friends with and developing trust in students from other cultures is important for students who plan on spending the rest of their undergraduate years in Canada – being able to bridge cultural divides will help students cope with culture shock and get them accustomed to dealing with people different from themselves, both in terms of their experiences at university and, we hope, in their lives as autonomous adults [10].

Methods

An online language proficiency survey developed by S. Scharf for this study (see Appendix) was administered to the 259 students in the Fall term prerequisite course to the Winter term engineering design course being studied. The language proficiency survey measures students' self-reported proficiency at various language skills, including listening comprehension as well as communication, including self-expression, in speech and in writing in both formal and informal contexts. The component of the survey used in team formation was a student's reported proficiency in chatting with friends, since informal speech and/or text messages are the main forms of communication that students use with each other. (Determining the meaning of "chatting" was left up to the students filling out the survey).

Students were given credit for participating, regardless of whether they consented to allow their data to be used in this research study. Due to a glitch in the implementation of the language proficiency survey in the Fall term, only high-level information about proficiency could be gathered. Nevertheless, this information was used in the team formation algorithm in the prerequisite course to the course being studied. Team formation in the Fall term course was considered to be a trial run for the class under study, the Winter term engineering design project course.

A debugged language proficiency survey was administered at the beginning of the class in the Winter term. Again, the language survey was mandatory but student consent to participate in this research project was optional. Initial enrolment in the Winter term class was 247; 245 students completed the survey and 30 opted not to consent to share their data. Three students later dropped the course, leaving a total of 213 out of 242 students whose language data were available for analysis – an 88.0% participation rate.

The language survey was set up not to measure English proficiency in the round of questions used in team formation so that students would not be led to believe that English proficiency was being taken into account in team formation at the expense of other information; we believe that students were more likely to answer questions honestly about their proficiency in languages other than English than about their English proficiency. (We are aware, however, that relative English proficiency would be very helpful to measure for team formation [3] and hope to capture this data in future studies).

Preliminary results

There was a very high student buy-in with the language proficiency survey both times it was run. When the survey was run on a test basis in the prerequisite course in the Fall term, 251 out of 259 students (96.9%) consented to participate. Of the 251students who consented to participate, 48% speak various dialects of Chinese, and a further 25% of the students speak a variety of other languages (28 other languages in total). One quarter of the students in the class are unilingual in English.

There was an error in survey implementation in the Fall term such that the "not possible" option boxes did not appear. Interestingly, student feedback about the questions included two independent requests for a "not possible" option for each of the tasks associated with each language. As well, despite being informed that the results of the language proficiency survey would be used to help form linguistically diverse teams, some students wrote that they did not want to be grouped with other people who spoke the same native language that they spoke (in this case, Mandarin Chinese). This indicates that at least some students want to maximize their multicultural experience in this course independently of knowing that that was what we intended to do when forming teams. The high rate of participation and the nature of the feedback request indicate strong student

support for language competencies to be taken into account in team formation in this undergraduate engineering design course.

In the Winter term, as detailed above, 93 (43.3%) of the participating students use Chinese, 64 students (29.8%) are unilingual English speakers, and the rest of the class (58 students, 27.0% of the class), regularly use other language. Twenty-six languages were represented in the class, if all dialects of Chinese are counted as one language; 82 of the Chinese-speaking students (88% of Chinese speakers) speak at least some Mandarin, though a total of 9 dialects were represented in the class. The most highly-represented languages other than English and Chinese were French (32 students), Korean (9 students), Farsi (6 students), Arabic and Spanish (5 students each), though most of the students who indicated some proficiency in French were not fully fluent in that language; it is likely that many of these students were exposed to French in elementary school and high school in Canada, where French is compulsory until grade 10. Other languages used by students in the class include Bangla, Belarusian, Filipino (Tagalog), Finnish, German, Hebrew, Hindi, Japanese, Malay, Polish, Punjabi, Romanian, Russian, Serbo-Croatian, Sinhala, Tamil, Telugu, Tibetan, Turkish, and Urdu. Only 18 students (8.4% of participants) spoke two or more non-English languages; the most common combination of languages was Mandarin Chinese and French (5 students, 2.3% of participants).

The teams formed by the algorithm in the trial run in the Fall term appeared to be internally diverse but externally relatively equally matched. For instance, unlike in previous years, all teams seemed to be hesitant to start making decisions about their first-term projects. In past years, more linguistically uniform teams seemed to start working together as a unit right away (they "hit the ground running"), whereas more linguistically heterogeneous teams took longer to become engaged in the subject material. Also unlike in previous years, there were no teams comprised exclusively of shy students and/or students with poor English skills and/or latecomers and relatively apathetic students. In the past, teams made up of people who were not self-selected to be on other teams tended to start work slowly, have relatively low cohesion, and relatively poorer outcomes in comparison with teams made up of students who actively chose to work with each other.

It may also be interesting to note that team formation based on linguistic diversity did not split students along racial lines. There were some teams that were, for instance, 100% Asian, but they contained no two members who spoke the same language other than English.

Teams formed in the Winter term behaved in similar ways. Reports from teaching assistants confirmed that overall student participation in tutorials increased relative to previous years' classes. Unlike in previous years' classes, students did not chat during teamwork in languages other than English, no students acted as translators for other

students, and all the students seem to be engaged in their work to a higher degree, as evidenced by a lack of students texting or acting disengaged in class.

Discussion

All of the results so far suggest that student satisfaction in the course will increase relative to previous years; there are already fewer complaints about team dynamics than in previous years.

The slower start among heterogeneous teams this year, however, may be due to causes that were not examined in this study. For instance, the slower start could be due to the start-up costs associated with getting to know teammates from other cultures, and/or more reflection about what the project entailed – perhaps also stemming from a reduction in shared notions of what was important due to the linguistic/cultural heterogeneity of the groups. This could be an interesting area for future research.

Conclusions

Taking linguistic issues into account in team formation in highly multicultural classrooms has the potential to improve student engagement and reduce specific language-based problems that were known to occur when students were left to form their own teams. Given the increase in multiculturalism in Western countries in general (e.g. [11]), and the Canadian government's push to increase the number of international students in Canada to 450,000 by 2022 – up from 265,000 in 2012 – in particular [12], this research should be of broad interest to universities striving to increase the quality of students' experiences at their institutions across a variety of disciplines. We look forward to being able to contribute to this field of research even more when the rest of our data comes in.

Appendix

All of the following questions were administered online using LimeSurvey running on a secure internal server.

Language competency questions used in team formation

The following questionnaire about language competencies was developed by Sara Scharf in consultation with Dr. Penny Kinnear and several other colleagues. The survey was presented online in the form of clickable boxes, with the exception of the Chinese dialect box, and for the "Other" language boxes, which had to be filled in manually. The languages mentioned by name in the questionnaire are those spoken by the largest numbers of students in the Fall prerequisite course.

At the team formation stage (early in the Winter term), if the person filling out Question 1 indicates the ability to speak, read and/or write only English, the questionnaire will be over for that student.

All students who indicate the ability to use a non-English language will see Question 2.

Question 3 will appear for each language the student selects in Question 2. For every statement, the student will be able to select a box indicating his or her ability to perform the activity described. The three competency levels for each activity are "skilled," "passable," and "not possible."

Questions

1. Do you speak, read or write any language other than English? [Y/N]

2a. Here are some of the languages most commonly used among engineering design students at [University]. Please indicate which of the following languages you use.

If you use a language not listed here, please select "Other." You will be asked to specify the other language(s) you use in the next question.

Arabic	☐
Chinese (any dialect)	☐
Farsi	☐
French	☐
German	☐
Hindi	☐
Japanese	☐
Korean	☐
Malay	☐
Russian	☐
Serbo-Croatian	☐
Spanish	☐
Tamil	☐

Urdu	☐
Other	☐

2b. [Only appears if Chinese was selected in Question 2a].

Which of the following Chinese dialects do you use? If you use a dialect that is not shown below, please select "Other" and you will be asked to provide more information in the next question.

Guan / Mandarin	☐
Wu (includes Shanghaiese)	☐
Yue (includes Cantonese and Taishanese)	☐
Min (includes Hokkien, Taiwanese and Teochew)	☐
Xiang	☐
Hakka	☐
Gan	☐
Jin	☐
Other	☐

2c. [Only appears if "Other" was selected in Question 2b].

Which other dialect(s) of Chinese do you use?

[Spaces for up to 3 dialects were provided].

2d. [Only appears if "Other" was selected in Question 2a].

Which other language(s) do you use?

[Spaces for up to 4 other languages were provided].

3. [Appears for all languages selected, including those entered in "Other" categories in Questions 2c and 2d above].

In [language], what is your skill level at:

	Skilled	Passable	Not Possible
Giving a presentation	☐	☐	☐
Being yourself	☐	☐	☐
Chatting with friends	☐	☐	☐
Writing a university assignment	☐	☐	☐
Taking notes while listening to a lecture	☐	☐	☐
Reading academic texts	☐	☐	☐
Joking	☐	☐	☐
Understanding a radio news report	☐	☐	☐
Doing a job interview	☐	☐	☐

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