

Investigating the Impact and Pedagogical Implications of Extroversion on Team Dynamics in Post-Secondary Student Teams

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Abstract—This research paper presents insights obtained from an online team support tool in an undergraduate setting. In this research, the authors examined patterns of self- and peer-reporting regarding preferences for speaking in groups, as well as downstream effects such as perceived voice safety and voice enactment. In both course contexts, the data show that students who initially identified as more extroverted did speak up more in groups, felt a higher sense of belonging, and had their ideas enacted more often. Importantly, by the end of the semester, women and international students reported less extroversion compared to other groups, which may indicate that these students have experiences on their teams that affects their perception of extroversion. These patterns were consistent in both the introductory engineering and business courses, and suggest that instructors should pay attention to team conversational dynamics to promote equity in team conversations.

Index Terms—Extroversion, Pedagogy, Students, Engineering, Business, Education, Teams

I. INTRODUCTION

Project-based learning on diverse teams is critical for engineering students' success in the global economy following their education [1]. There is a large body of research furthering knowledge in pedagogical strategies to maximize student learning in team-based environments [2], [3], [4], [5], [6], [7].

However, teamwork is not a universally positive and equitable pedagogy. Research has shown that gendered behaviors are often exacerbated in various team settings based on team composition. Women are often tasked with non-technical and project management work; they often do not have their voice heard in team conversations; and they do not always have equitable evaluations compared to male counterparts [8], [9], [10], [11], [12].

Surprisingly, then, research also shows that team and project-based learning can increase self efficacy and retention of underrepresented student minority groups [13]. Significant attitude differences for first year engineering students can be present across various ethnic groups and between genders, which can impact the way students learn [14].

Team-based instruction and active learning techniques contribute to student success for all demographic groups [15], but perhaps not equally so. These techniques also require a significant investment from course faculty and staff. Additionally,

when imposed without careful consideration of equity issues, these pedagogical techniques can actually worsen demographic gaps in outcomes [16].

At our large research university in the United States, a team of instructors for a first year team-based design-build-test-communicate engineering course designed an online team support tool, with the assistance of a university development team, in order to assist instructors with facilitating student teams. The tool, called Tandem, provides automatic, tailored guidance to teams based on weekly short survey check-ins from the student teams, longer peer and self assessments, and responses to short teamwork lessons. Offloading the general support and teamwork instruction to an automated system allows for more instructor time to address individual problems.

Tandem was designed to assist students in navigating conflict and understanding team dynamics, as well as to teach leadership concepts [17]. The web-based tool is optimized for use via smartphone or computer and includes surveys at the start, middle, and end of the project asking questions such as individual motivation, self assessment of team dynamic attributes, and individual preferences for group-work. At the middle and end of the semester the students also provide peer and self assessments of contributions to the team project as well as on pro-teamwork behaviors.

In both a pre-project survey and a project-reflection survey, students are asked to self-rate their perceived level of extroversion, by asking if students tend to listen more than speak, or if they often speak up in groups. Students responded using a sliding seven point scale.

The system automatically selects short lessons for student teams to complete based on the feedback the teams have given. The instructor team is provided with a dashboard to monitor teams in areas such as working together, team confidence, sharing ideas, logistics, and equal workloads among team members. The dashboard allows instructional staff to quickly assess if a team is having trouble on a week-by-week basis, or if a team is trending downward so that potential problems can be mitigated before they happen.

Tandem was piloted in the Fall of 2019 with three courses at the university, including the introduction to engineering course

taught by the tool creators, an introduction to business course for business major students, and a graduate level architecture course, which was not included in this study because of low response rates to some surveys.

In this research, the authors hypothesized that an individual students' extroversion would impact their team dynamics, perception of voice safety (how easily one can communicate even an unpopular idea), and voice enactment (whether one's ideas are incorporated into the group plan). Recent research has focused on marginalization on student teams, considering especially demographic groups and communication patterns, both in engineering [8], [18] and in other contexts [19]. This body of research extends that prior work by investigating whether extroversion may serve as a protective factor. Additionally, by virtue of the large group using the survey tool, this research allows for a fairly large sample size (N=683) of processes that have primarily been studied qualitatively.

The specific research questions are: 1) Is there a relationship between students' demographic characteristics and their perceived extroversion? 2) Does their perception of their extroversion change over the semester? and 3) Is a students' perceived extroversion related to their team experience, such as their likelihood of having their ideas enacted?

In the remainder of this paper, the authors will discuss how initial data from Tandem is used to determine how extroversion impacts student behaviors, and how demographics can have an impact on the extroversion of individual students. Results will be presented and potential pedagogical implications will be discussed.

II. METHODOLOGY

The data for this research study was collected in Fall 2019 from survey questions administered to all students in the target courses. Specifically, this data focuses on the students in an introduction to engineering course at the first-year level (N=61), and students in an introduction to business course at the second-year level (N=622). The unequal sample sizes in our analyses are an artifact of the real situation, that the business course using the tool was a much larger course than the engineering course using the tool. Of the total 683 students in the subject pool, 608 (89%) students responded to both the beginning of term and end of term survey. This research has been reviewed and approved by our university institutional review board for human subject research.

Students answered questions using sliding numerical scales. Most questions were out of seven points; others were out of nine points, to gain additional fidelity in those question areas. This allowed for students to be more specific in their ratings for how they felt. Each peer assessment included students rating teammates on contributing ideas, having their ideas enacted, and putting forth effort; only the term-final peer assessments were used for this project since there were no beginning of term peer assessments (students did not know each other yet), and since this project focused on the semester growth as a whole and did not examine the mid-term ratings.

Peer ratings were then averaged into a single "received-from-peers" score for each individual on each item.

Demographic data for each student participant was gathered from university records.

All survey data were collected via Tandem online, via the start and end of term surveys, and then anonymized for analysis once the semester was concluded. In order to determine statistical significance of the data, Kruskal-Wallis H-Tests [20] were performed using IBM SPSS Statistics version 26.

The Kruskal-Wallis H-Test was used because it is a non-parametric, rank-based method for determining if there are significant differences between groups, similar to a one-way analysis of variance (ANOVA). A one-way ANOVA was not used in this case because several key assumptions of the one-way ANOVA are violated in this dataset, including that there are significant outliers in the data, sample sizes were unequal, the dependent variable is not approximately normally distributed for each category, and there is not always homogeneity of variances.

It should be noted that the outliers in the data were not removed from our analysis for several reasons. If we believed the outliers to represent errors in the data, such as students who clicked the wrong button, we would have removed them. However, our "outliers" just represent students who are dissimilar to their peers, and we don't want to exclude their information from our analysis. In fact, we are particularly interested in those minority students' experiences. Since Kruskal-Wallis allows us to investigate the same question without removing these students from analysis, it felt more appropriate to leave them included in the analysis.

For each test case, the Kruskal-Wallis H-Test was performed making all pairwise comparisons. Survey non-responses were ignored, which generally corresponded to a student dropping the course before completion or joining the course late causing them to not take the beginning of term or end of term survey. For each test case a box plot was generated in order to compare the distributions for each category of the independent variable. The descriptive statistics of each independent variable category were also calculated.

In order to determine if each variable's distribution was of similar shape, the box plot was examined. If the median was in approximately the same place within the distribution, with similar tails on the distributions, the distributions were considered to be of similar shape. Note, the medians did not have to be equivalent; they could be offset and the shapes would still be similar.

For statistically significant results, a post-hoc test was run using Dunn's (1964) procedure [21] with a Bonferroni adjustment to further determine which pairwise comparisons were significant while controlling the false positive rate.

III. RESULTS

The first group of results examines the relationship between demographics and extroversion. The second group of results examines how extroversion-reporting changed over the course of the semester. Finally, the third group of results examines

the downstream effects of extroversion on student voice. For all of these results, “extroversion” indicates that students rated themselves towards the “likely to speak up a lot” in groups rather than “likely to stay quiet in groups.”

A. Extroversion by Demographic

Overall, students in both the business course (BA 200) and the engineering course (ENGR 100) considered themselves moderately to highly extroverted, and their assessment increased over the course of the semester. The mean self-perceived extroversion at the beginning of the term was 4.63 on a 7 point scale, with a median rank of 5. At the end of the term, the mean was 5.29 with a median score of 6 out of 7.

The relationships between student course (business versus engineering), gender, ethnicity, and minority status (including underrepresented minorities [URM] separately) were compared for both the beginning of term self rating and the end of term self rating.

In order to classify a student’s minority status or underrepresented minority status, the authors used the definition used by our institution. Our institution defines URM students as those who identify, at least in part, as African-American/Black, Hispanic, Hawaiian, or Native American. Students identifying as Asian are considered a minority student but not URM. All other students are considered non-URM and non-minority students. There were some students who chose not to disclose their ethnicity (“not indicated” in the data).

In the pre-project survey, there were no significant relationships between perceived extroversion and any demographic characteristic.

At the end of the term, student self-reported extroversion had moved, and demographics were related to differences in extroversion. Specifically, for “likely to speak up in groups,” men rated themselves higher than women, and domestic students rated themselves higher than international students, following their project experience. This was true for both engineering and business students.

There was no statistically significant difference when examining the mean rank by course, and there was also no difference in mean rank by ethnicity, $\chi^2(5) = 7.744, p = 0.171$. For the case of gender on end of term extroversion, the mean rank was statistically significant between groups, $\chi^2(1) = 7.119, p = 0.008$. Here, the male mean was 5.43 on a 7 point scale, while the mean female score was 5.09. Recall that the difference at the beginning of the term was not significant. This shift is shown in Fig. 1.

To consider student minority status, we split students into three categories: minority-domestic, non-minority-domestic, or international. Minority-domestic students were further split into underrepresented minority (URM) and non-URM for some analyses. There were significant differences by minority status for end-of-term self-rating of likelihood of speaking up in groups, primarily driven by differences between domestic and international groups. For minority students, $\chi^2(2) = 8.446, p = 0.015$. Within the pairwise comparisons, the only significant differences were between international students

TABLE I: The mean and standard deviation (in parenthesis) of the self-rated extroversion for each demographic category are shown for the beginning of term (BOT) survey and the end of term (EOT) survey on a seven point scale, with 7 indicating “likely to speak up in groups.” Gender had a significant relationship at the end of the term. There was also a significant relationship at the end of the term between international and domestic students.

Category	Student Demographic	Extroversion Rating	
		BOT	EOT
Course	BA 200	4.65 (1.46)	5.31 (1.57)
	ENGR 100	4.45 (1.43)	5.20 (1.65)
Ethnicity	White	4.71 (1.42)	5.33 (1.54)
	Asian	4.58 (1.44)	5.30 (1.54)
	Black	4.47 (1.55)	5.25 (1.76)
	Not Indicated	4.48 (1.54)	5.00 (1.65)
	Hispanic	4.67 (1.52)	5.72 (1.54)
	Multi-Ethnic	4.20 (1.64)	4.65 (2.08)
Gender	Male	4.66 (1.42)	5.43 (1.52)
	Female	4.59 (1.50)	5.09 (1.63)
Minority Status	Non-Minority	4.66 (1.44)	5.28 (1.56)
	Minority	4.62 (1.48)	5.31 (1.59)
	International	4.21 (1.45)	4.66 (1.54)
URM Status	Non-URM	4.66 (1.45)	5.30 (1.56)
	URM	4.60 (1.49)	5.55 (1.67)
	International	4.21 (1.45)	4.66 (1.54)
Overall		4.63 (1.45)	5.29 (1.58)

and minority-domestic students ($p = 0.013$). The difference between international and non-minority-domestic students was almost significant ($p = 0.051$). The mean for minority students was 5.41, non-minority students 5.28, and international students mean was 4.66, suggesting that by the end of the semester, minority-domestic students saw themselves as most likely to speak up in groups, and international students reported being the least likely to speak up in groups. This pattern is shown in Fig. 2.

When examining underrepresented minority students, the relationship was also significant $\chi^2(2) = 9.566, p = 0.008$. The mean for non-URM-domestic students was 5.30, the URM-domestic student mean was 5.55, and the international student mean was 4.66. URM students most reported seeing themselves as being likely to speak up in groups.

The results for all demographic categories are summarized in Table I.

B. Extroversion over Time

The extroversion rating was a self-reported estimate of extroversion in a particular context on a scale of 1 to 7. Overall, students reported a higher average self-extroversion rating from the start of the semester (mean 4.63) to the end of the semester (mean 5.29), suggesting they saw themselves more likely to speak up in groups after a semester of working with a group.

Of the 608 students to respond to both the beginning of term and end of term surveys, 345 students (57%) did not change their rating, 205 students (34%) reported an increase in extroversion, and 58 students (9%) reported a decrease in

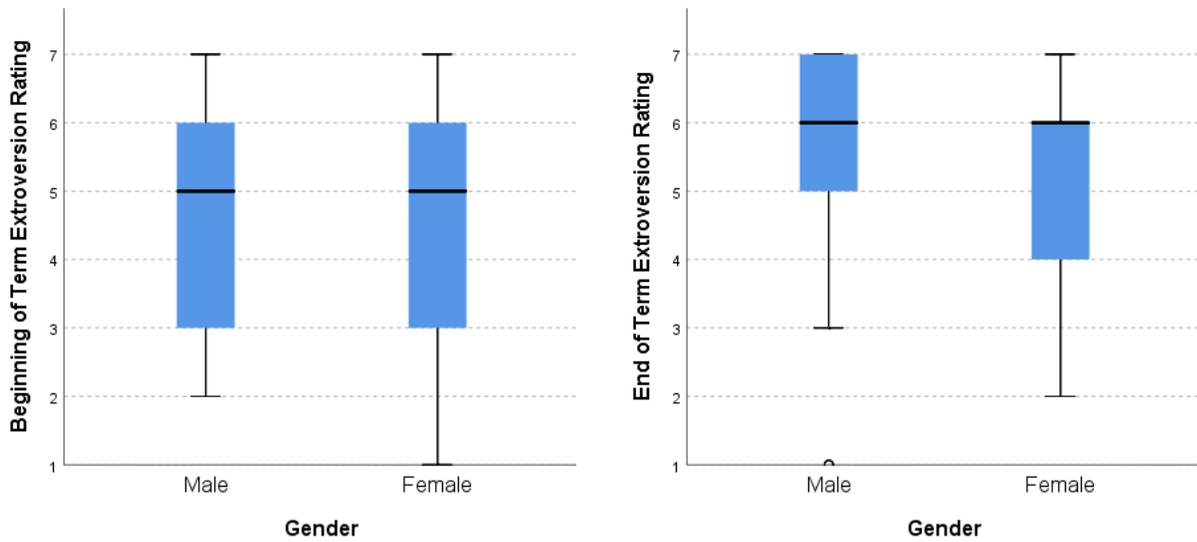


Fig. 1: The extroversion rating at the beginning of term and end of term are compared based on student gender for all students (since differences between the engineering and business students were insignificant, they are combined here). The beginning of term differences are not significant, but the end of term differences are, with men rating themselves higher on extroversion than women. Circles on the boxplot denote outliers.

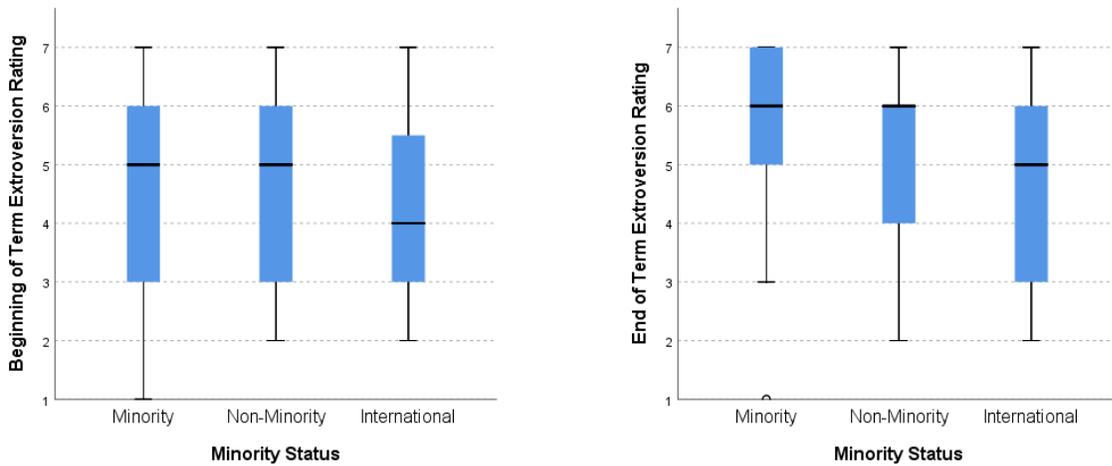


Fig. 2: The extroversion rating at the beginning of term and end of term are compared based on minority status for all students (since differences between the engineering and business students were insignificant, they are combined here). The beginning of term shows no differences, but the end of term differences are significant. Circles on the boxplot denote outliers.

extroversion. We note that students are responding on both surveys to how they speak up in groups, and intervening experiences (both the team experiences in this class as well as other events during the semester) likely affect their perception of how they engage in group conversations.

The distributions of extroversion for the beginning of term and end of term are shown in Fig. 3.

C. Student Voice Relations to Extroversion

The relation between student voice (peer ratings of their engagement in group conversation) and their self-reported extroversion were considered by using extroversion as the independent variable. For this analysis, extroversion ratings of 1-7 were condensed to three categories. Ratings of 1-2 were considered “Low” extroversion, ratings of 3-5 were considered “Moderate”, and ratings of 6-7 were considered “High” extroversion.

At the beginning of the term, there were two survey questions examined, asking if students felt concern about fitting in to the course or not, referred to hereafter as their “belongingness”, and if they felt it was easy to speak up in groups.

Beginning of term extroversion was related with belongingness (1-7 scale, with higher values meaning higher expectation of “fitting in easily”), and in a direction we found surprising, $\chi^2(2) = 98.901, p < 0.0005$. Students in the “low” extroversion group had a mean belongingness of 4.27, students in the “moderate” extroversion group had a mean belongingness of 3.46, and students in the “high” extroversion group had a mean belongingness of 2.59. All pairwise interactions were highly significant with $p < 0.0005$.

Even more interestingly, at the end of the term the relationship was also statistically significant, but in the opposite direction $\chi^2(2) = 22.854, p < 0.0005$. End of term belongingness was on a 9-point rating scale, with 9 indicating “I fit in well with my whole group”. The “Low” extroversion students had a mean belongingness rating of 7.89 on a 9 point scale, “Moderate” extroversion students had a mean rating of 7.74, and “High” extroversion students had a mean rating of 8.18. The significant pairwise interaction was between “Moderate” and “High” extroversion with $p < 0.0005$. These interactions are shown in Fig. 4.

For students’ perceived voice safety, differences between groups were statistically significant, $\chi^2(2) = 126.965, p < 0.0005$. Students who rated “low” extroversion at the beginning of the semester had a mean rating of 3.49, “moderate” extroversion had a mean rating of 4.16, and those with “high” extroversion had a mean rating of 5.19. All pairwise comparisons were highly significant with $p < 0.0005$.

At the end of the semester, the mean ranks were still significant, $\chi^2(2) = 186.987, p < 0.0005$. Of the pairwise comparisons, the significance lay between “Low” and “High” as well as “Moderate” and “High”, both having $p < 0.0005$. These comparisons are shown in Fig. 5.

Additional questions at the end of the term related to a student’s voice safety and voice enactment were also found

to be related to the student’s self rated extroversion at the beginning of the term. These questions were on a nine point scale. For these analyses, students’ scores were calculated as the average value they received from teammates. The mean of each group is shown in Table II.

Idea sharing (self: $\chi^2(2) = 78.311, p < 0.0005$, peer: $\chi^2(2) = 55.896, p < 0.0005$) focused on asking if a student offered most of the group’s creative solutions. Here, students rated themselves, and also their peers on their course project teams.

Teaching (self: $\chi^2(2) = 68.382, p < 0.0005$, peer: $\chi^2(2) = 25.3, p < 0.0005$) asked students if they explained work to others or shared their skills and knowledge.

Listening (self: $\chi^2(2) = 6.469, p = 0.039$, peer: $\chi^2(2) = 18.385, p < 0.0005$) asked students to rate if they were an excellent listener and encouraged other group members.

Finally, idea enactment (self: $\chi^2(2) = 68.193, p < 0.0005$, peer: $\chi^2(2) = 39.029, p < 0.0005$) asked about whether the students’ ideas were incorporated into the project.

TABLE II: End of Term Survey Question Mean Responses, Grouped by Beginning of Term Extroversion Rating. Responses were on a 9-point scale, with a rating of 9 being “High” for each category.

Survey Question	Beginning of Term (Self) Extroversion Rating			
	Low	Moderate	High	Total
Idea Sharing (Self)	6.53	7.08	7.69	7.39
Idea Sharing (Peer)	6.43	6.77	7.37	7.09
Teaching (Self)	6.98	6.95	7.67	7.37
Teaching (Peer)	6.93	6.95	7.33	7.17
Listening (Self)	7.89	7.20	7.21	7.26
Listening (Peer)	7.85	7.27	7.06	7.19
Enacted Idea (Self)	6.82	7.16	7.80	7.50
Enacted Idea (Peer)	6.67	6.93	7.39	7.18

IV. DISCUSSION

In team-based educational environments, it is important for all students to feel comfortable and safe in the group. Students are especially encouraged to have an active role in team discussions and decision making in order to receive the most educational benefit.

The goal of asking students before the project if they felt that they spoke up in groups (extroversion in this study) was to gauge students’ comfort in these activities. More extroverted students were expected to speak up more, contribute more ideas, and feel comfortable doing so. Instructors believed they might need to provide more support to students indicating less comfort in these activities.

A. Extroversion and Demographics

The relationship between demographics and students’ self-rated extroversion before the project began was examined. It is interesting to note that at the start of the semester, no differences were significant. That is, there was no difference between students in the engineering class and students in the business class, nor were there detectable differences by gender, by ethnicity, etc.

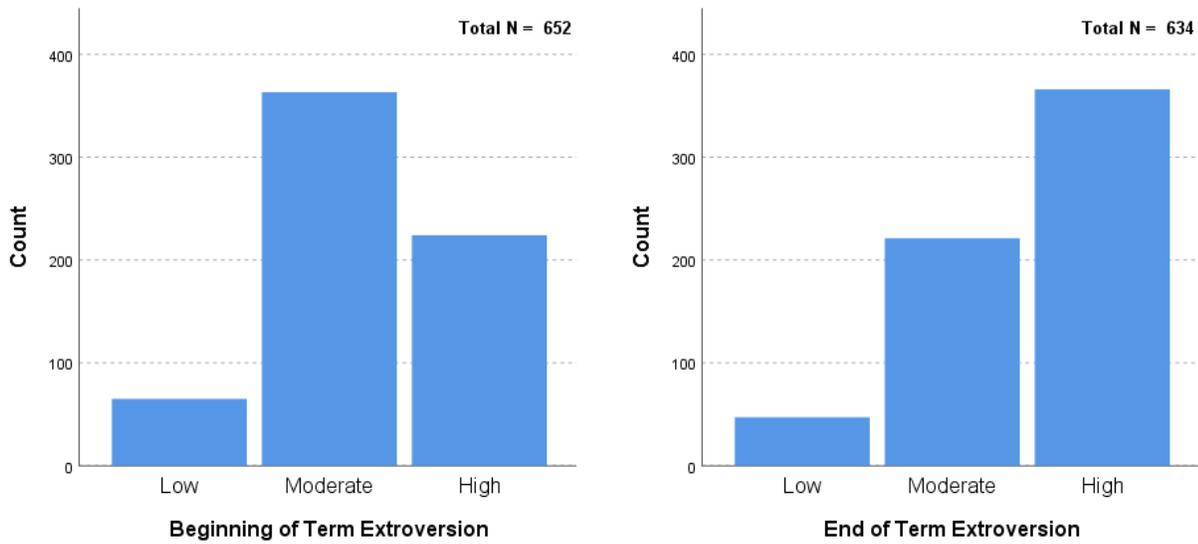


Fig. 3: The distribution of extroversion is shown over time. Overall, students reported a higher average self-extroversion rating from the start of the semester (mean 4.63) to the end of the semester (mean 5.29).

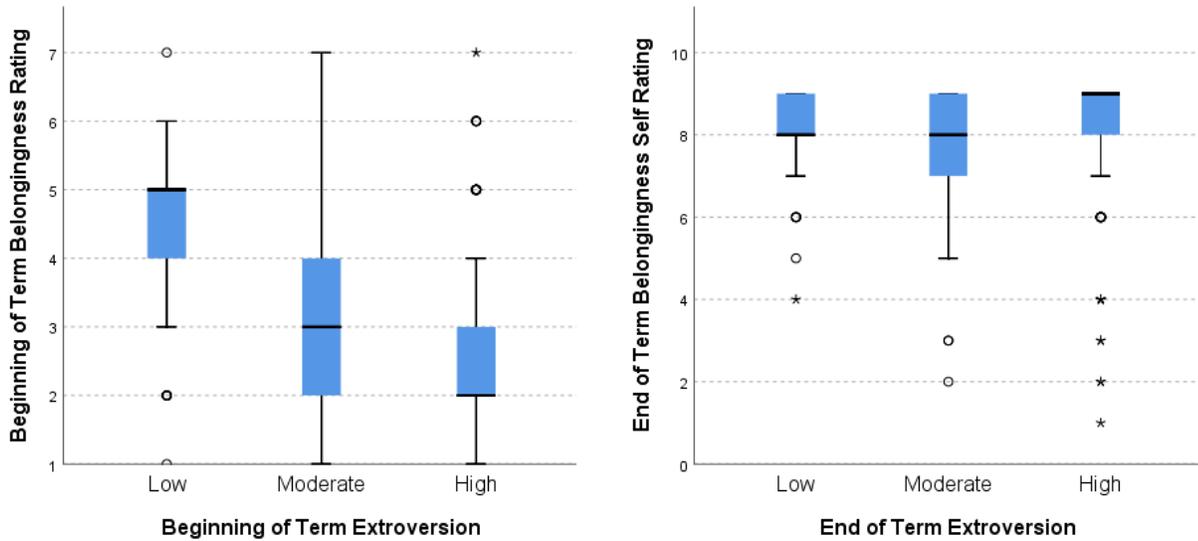


Fig. 4: The change in belongingness is shown between the beginning and end of the semester, based on extroversion. In both cases, all pairwise relationships were statistically significant. In the boxplots, circles denote outliers, while asterisks denote extreme outliers, greater than three times the interquartile range. It should be noted that the beginning of semester survey was on a seven point scale for Belongingness, while the end of term survey was on a nine point scale. While these scales do not align with one another directly, it should be noted that the overall distributions greatly narrow at the end of the semester, and are overall on the higher end of the scale more than the beginning of the semester. The outliers below on the end of the semester are also noteworthy and should be identified by instructors to ensure students are doing well.

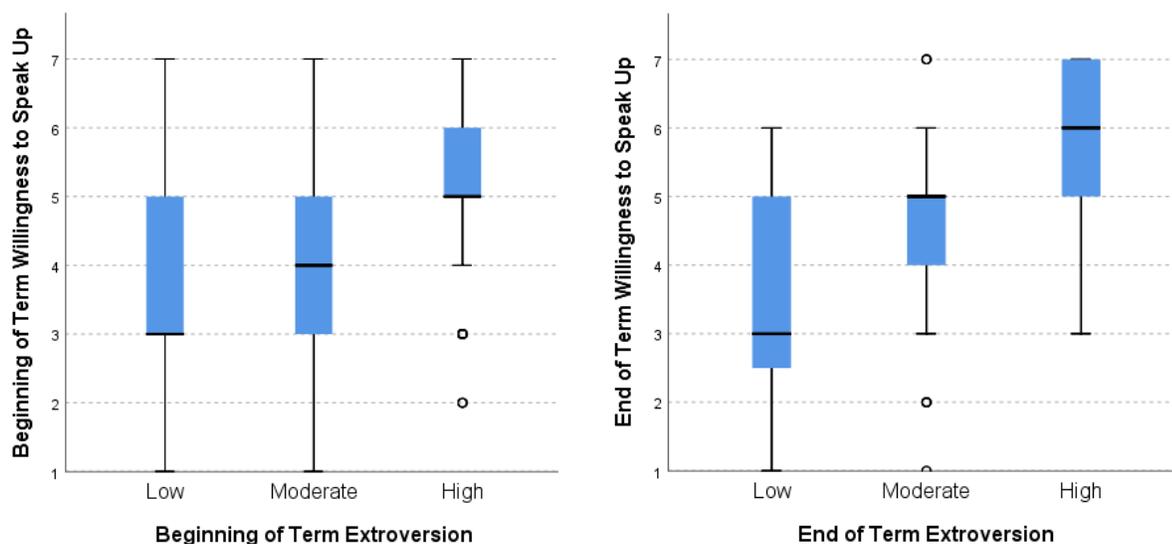


Fig. 5: The change in willingness to speak up over the course of the semester is shown based on extroversion. All pairwise comparisons at both the beginning of the term and at the end of the term were statistically significant. Circles in the boxplot denote outliers.

When students answered the same question after this project experiences, differences were significant: both gender and status (domestic vs international student) were related to response on the self-perceived extroversion measure. Importantly, the question asks students whether they speak up in groups, and all student groups on average increased in terms of their responses to the question. However, men increased more than women, and domestic students increased more than international students. We interpret this change as suggesting that some students' experiences in group conversations are more supportive than others. This finding is important because it shows that women and international students are having different experience from other students during the course of the semester. It is also interesting to note that while the authors expected that business students would be more extroverted than the engineering students, there was no significant difference in the self-reported ratings at either time point.

It should be noted that these extroversion ratings are self ratings, and we do not claim that actual extroversion has changed. Instead, we suggest that this change in student perception of their own extroversion may reflect differences in their experience in the team conversations they have experienced over the semester. Further work should capture actual discourse data to determine the validity of these perceptions.

B. Belongingness

Separate questions were asked related to sense of belongingness (do students fit in with their group/class) and willingness to speak up (is it easy to speak up with unpopular opinions

rather than acquiesce. Both at the start and end of the semester, extroversion was significantly related to students' feeling of belonging and their willingness to speak up. Interestingly, at the start of the semester, students who reported high levels of extroversion felt they fit in less but still felt more willing to speak up, which we found surprising. By the end of the semester, the trend for belongingness reversed, with more extroverted students reporting the highest level of belongingness, as we had expected. In both cases the most extroverted students reported being more willing to speak up, which was not surprising.

1) *Impact on initial team dynamics:* Regarding belongingness, it is interesting that students who felt *more* likely to speak in their groups felt they were *less* likely to fit in at the start of the semester. While this pattern had changed by the end of the semester, it is still a worthwhile note for instructors that even students who may appear comfortable in class may still have hesitations and preconceptions on not feeling that they will belong in course teams. It is also important to recognize that while students who reported less extroversion were also less likely to speak up, the overall scores were still above the midpoint on the scale, showing that most students were feeling comfortable at the end of the semester.

C. Extroversion and Student Engagement on Teams

Patterns of student engagement were queried on the self and peer assessment by asking students whether they and teammates taught others (rather than doing work in silos), whether their ideas were enacted, whether they actively listened, and whether they contributed ideas. More extroverted

students were rated as more likely to teach by sharing their own knowledge and also as less likely to be good listeners. Highly extroverted students were also more likely to share ideas and have their ideas enacted. These results were true for both self ratings but also for peer ratings, allowing some amount of triangulation amongst these perceptual data. These questions show that students' sense of voice safety will have further relationship with their voice enactment, meaning that students more willing to speak up are also more likely to have their ideas enacted. These students are also more likely to share their knowledge and experience, which will likely lead to a better educational experience for them [22].

D. Outliers: Guarding Against Generalizing Experiences

These results indicate the general importance of student extroversion to successful team experiences. However, instructors must be cognizant of individual student experiences on teams. Outliers in the data (e.g. Fig. 4) show that any given individual student may not follow the patterns suggested here, and therefore that student would need different types of resources and support so that they can have a successful team experience. Individualized support, especially for large classes, can be overwhelming, but there are tools such as Tandem that can assist instructors and managers in monitoring team interactions in order to quickly find outliers in the data and address concerns in real time.

V. CONCLUSION

In this research study, we examined the effects of student self-reported extroversion on team experiences in an introductory engineering course and an introductory business course. Our research provides new quantitative data for student perceptions and influences of extroversion on voice. The data revealed several interesting trends. On average, student self-rating of extroversion increased over the course of the semester, but women increased less than men, and international students increased less than domestic students. Extroversion has a significant relation on students' feeling of belonging and their willingness to speak up. Surprisingly, students who felt *more* likely to speak in their groups felt they were *less* likely to fit in at the start of the semester; however, by the end of the term, students who indicated they were more likely to speak up were back to feeling like they belonged in their group. Self and peer reported engagement on teams indicates there are unequal effects on voice safety and voice enactment for men vs. women and domestic vs. international students. These differences in engagement can adversely affect group-level outcomes. A better understanding of the relationship between student extroversion and engagement will allow for better team formation and support; software tools that embed items to capture extroversion in initial surveys and that collect outcomes information can assist with supporting all students.

A. Limitations of this Study and Future Work

In this paper, relationships were examined independently. In future work, it is the authors' goal to build a hierarchical

model to examine if the same demographic relationships on extroversion also have relationships with downstream questions. Further, our analysis was limited to only looking at main effects. We did not test for interactions, though it would be especially interesting to look at interactions by course (engineers and business) or by gender. While one group of students (the first-year engineers) was significantly smaller than the second group (second-year business students), the groups showed that there was no difference in their reported extroversion. In future work outlined above, the downstream effects of this difference will be examined. The authors do not believe there are significant differences between these student groups that would significantly alter the results. Finally, there is no comparison group in this research, so it is unknown to what extent the changes from beginning to end of the semester are related to the specific course and team experience and to what extent they are related to other salient changes happening in students' lives.

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