Impact of Team Formation Method on Student Performance, Attitudes, and Behaviors

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Abstract: This project examined the effects of two team selection methods (self-selected and instructor-formed based on matched academic performance) on team and individual student performance and on self-reported attitudes and team behaviors in a freshman-level core-required introductory course. The data included mid and end-of-semester self-reports. Matched-performance groups had significantly higher grades on several performance measures, with a larger effect on the team grades than on the individual grades; however, overall the effect sizes were small. Although there were no group differences for most self-reported items, a key finding was that self-selected teams were significantly more likely to already have friends on their team, and a significant correlation showed that already having friends on a team was negatively correlated with many of the performance measures. In contrast, members of both types of teams reported equally high likelihood to make new friends, which was positively correlated with performance. Understanding the impact of different approaches to team formation may guide instructors and lead to more well-functioning teams, higher student learning, and greater student satisfaction.
Keywords: teams, team formation methods, team dynamics, student teams

Overview

Teams can make organizations more responsive, and they often become the primary unit of performance. In a military environment, the ability to work efficiently and effectively within a team can sometimes mean the difference between life and death. The importance of teamwork in the Air Force is reflected in one of the three broad categories of the United States Air Force Academy's (USAFA) institutional competencies, "Leading People and Teams" (USAFA, 2015). The pedagogical advantages of teamwork in an educational setting are also valuable. Team experiences can enhance student learning. For example, Oakley, Brent, Felder, and Elhajj (2004) found that "students taught in a manner that incorporates small-group learning achieve higher grades, [and] learn at a deeper level". Further, working in teams allows students to receive additional help and support from their peers (Feichtner & Davis, 1984) and share ideas holistically, increasing the performance of the entire class (Hernandez Nanclares, Rienties, & Van den Bossche, 2012).

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While there seems to be broad agreement that teamwork has its advantages, these benefits are not automatic. Social factors such as communication, conflict resolution, and group time management are often required for high functioning teamwork, and in turn, these factors may be impacted by the particular combination of individuals on a team. Thus, how the teams are initially formed could impact the team's performance and overall experience. The objective of this investigation was to assess the impact of two different team formation methods (self-selected and instructor-formed based on grouping by student predicted performance) on team performance, individual student performance, and self-reported student attitudes, behaviors, and outcomes. The investigation was conducted within a freshmen-level introductory course required for all students as part of the core curriculum. This research focuses solely on the initial manner by which teams were formed, and not on any intentional efforts by instructors to develop the teams or teamwork skills after they were formed. The large sample size of this investigation (845 students across Fall and Spring semester offerings of the course), and the combination of academic performance as well as self-report items offer a meaningful contribution to the literature.

Background

To better understand why teams might provide benefits both academically and beyond, we need to understand what characteristics transform a group into a team, and what factors may impact team cohesiveness. The school of thought about teams summarized and extended by Katzenbach and Smith (1993) is that "a team is more than the sum of its parts" because teams produce discrete teamwork products that are better than individual products due to the joint contributions of their members. They suggest that a team is "a small number of people with complementary skills who are committed to a common purpose, set of performance goals, and approach for which they hold themselves mutually accountable" (Katzenback & Smith, 1993, 2). Therefore, teamwork is about common commitment. Without it, groups perform as individuals. With it, well-functioning teams can become a powerful unit of performance.

The positive relationship between team function and performance (Kozlowski and Ilgen, 2006; Katzenback & Smith, 1993), as well as the fact that many academic, government, and industry projects utilize teams, has led to considerable research to better understand the characteristics of well-functioning teams. Some identifiers of a well-functioning team include effective communication, constructive conflict, and shared commitment (Katzenback & Smith, 1993). Additional indicators include team members' positive attitudes, values, enjoyment, and high ratings of effectiveness of the team experience (Chapman, Meuter, Toy, & Wright, 2006). One factor that could influence the characteristics for team functionality is team composition, including team size, and myriad individual member characteristics: member academic experience, expertise and abilities, cultural background, gender, life experiences, and interpersonal skills (Connerley & Mael, 2001).

Given the known increased learning potential when students work in teams (e.g., Hernandez Nanclares et al., 2012; Oakley et al., 2004), some prior researchers (e.g., Chapman et al., 2006; Connerley & Mael, 2001) questioned to what extent the process of team formation may contribute to student satisfaction. Team formation methods in educational settings are divided in two main categories: self-selected and instructor-formed teams. Self-selected team formation allows students to choose their own teams. Instructor-formed teams can be formed in many ways, such as through randomization (Mahenthiran and Rouse 2000; Chapman et al., 2006) or by using known student characteristics such as prior academic achievement (the basis of the current study; Matta, Luce, and Ciavarro, 2010), gender, attitudes revealed by questionnaire results (McClough and Rogelberg, 2003), or student personality (Pociask, Gross, and Shih, 2017; Shen, Prior, White, and Karamanoglu, 2007).

Instructor-formed teams may lead to more diverse teams than self-selected teams, because students may have the opportunity to work with others with whom they would not typically work.

In the literature, there are strong advocates for each approach. For example, Bacon, Stewart, and Silver (1999) advocate "giving students a say in team assignments." In contrast, in their "profile for failure," Feichtner and Davis (1984) include "allowing students to form their own groups" on their list of procedures that are likely to lead to failure. A potential drawback to self-selected teams is that this process may lead to unselected team members, requiring that the instructor assign them to a team, and potentially reducing the positive dynamics of a self-selected team. Depending on the specific method the instructor uses to form the teams or add members, students could feel that the teams were not fairly formed based on perceptions of favoritism or prejudices.

While there are many discussions of findings in the literature, there is less empirical evidence to guide choice of team formation (McClough et al., 2003) and that evidence is mixed. Matta et al., (2010) found that the act of selecting their own teammates led to only a very small impact on students' level of satisfaction with the team. Likewise, Pociask et al., (2017) found student performance was similar regardless of team formation method, and therefore suggested that student self-selected teams can be a reasonable option for instructors to consider. Chapman et al. (2006) provide one of the few larger-scale empirical comparisons of self-selected and instructor-formed (using randomization) teams. Their end-of-semester, self-report questionnaire asked about team dynamics, participant attitudes about their teams, and team outcomes for semester-long project teams in upper-level business courses. The vast majority of questions for which there were significant differences favored the self-selected teams over the randomly-formed teams (e.g., better communication, more enthusiasm, more interest in teammates, better conflict resolution, higher confidence in teammates, greater perceived value, usefulness and effectiveness, higher likelihood of making new friends, greater enjoyment, greater pride in work). There were exceptions within their study, however, which showed randomly-formed teams benefited by being more task-oriented and more likely to get straight to work with less socializing.

Mahenthiran and Rouse (2000) compared the impact of a fully randomized team-formation method with a hybrid team-formation method that allowed students partial control over the process. The hybrid approach involved randomly combining self-selected pairs of friends. Student satisfaction was measured using a questionnaire. Mahenthiran and Rouse noted significantly higher performance on project grades by the hybrid teams, and this result was true regardless of their incoming grade point averages. They concluded that the best team formation method is to pair friends and then randomly combine pairs to form the team rather than using complete random assignment.

An important factor related to team formation is the diversity of the team members. Within academia, students often select teammates who are similar to themselves when given the opportunity (e.g., Pociask et al., 2017; Rienties, Alcott, & Jindal-Snape, 2014). Nonetheless, Scott and Pollock (2006) found that a diverse range of skills can be found in self-selected teams. Some of that discrepancy could be due to the two researchers using different characteristics to define diversity, since there will always be some diversity between members who are otherwise highly similar in many ways. If student academic ability is the characteristic of focus for diversity, research suggests that stronger students often seek out one another in self-selected teams, leaving the weaker ones to form their own teams (e.g., Oakley et al., 2004). Although such groupings reduce academic diversity in the teams, they can decrease the likelihood of weaker students "riding on the coattails of stronger students," allow teammates to be surrounded by others with similar levels of motivation, and prevent anyone within a team from feeling like they were falling behind (Bronson & Merryman, 2013; Carrell, Fullerton, & West, 2009). However, there are also benefits of having academic performance diversity enforced through instructor formation of teams. For example, in well-functioning academically diverse teams,

weaker students can benefit from observing how stronger students set-up, approach, and solve problems and can even gain from being tutored by the stronger students. Stronger students benefit with increased understanding from having to explain the problem to another person.

The mix of support for the various ways to form teams suggests that additional research is needed to help guide the choice of team formation method. This study compares large sample sizes of self-selected teams with instructor-formed teams based on previous academic performance (heretofore referred to in this study as Matched-performance teams). We gathered self-reported attitudes, team dynamics, and outcomes via a questionnaire and several performance measures: two individual work averages, two team work averages, and the final course average. The questionnaires were administered at the mid-semester as well as at the end of the semester, which allowed us to investigate how team formation method might impact our measures over time. With these data, we were able to conduct group and time correlations to determine the effect of team formation on student performance and attitudes.

Research Questions and Hypotheses

Based on the literature reviewed, we formulated three research questions and hypotheses to give us some insight as to whether team formation method impacts student performance, attitudes, and behaviors. First, how do the two team-formation methods impact our performance measures? Because prior research (Chapman et al., 2006) indicates that self-selected teams are more prone to socializing and being less task-oriented, we predicted matched-performance teams would perform better academically than self-selected teams, and that group differences would be greater for team grades than individual grades.

Second, how do the two team-formation methods impact the self-reported attitudes, team dynamics, and outcomes? We predict a mix of results, depending on the question and the comparison group. In most cases, matched-performance and self-selected teams are likely to be academically similar (Oakley et al., 2004), and therefore might have similar reported attitudes and behaviors. Self-selected teams are more likely to have prior friends on their team (Pociask et al., 2017; Rienties, Alcott, & Jindal-Snape, 2014; Chapman et al., 2006), and therefore, may show more positive ratings of social factors. Randomly-selected teams are likely to be less similar than our two types of teams; thus we predict that our group differences will be smaller than those found when comparing self-selected and randomly-selected teams (e.g., Chapman et al., 2006).

In this study, the investigation of the time factor (mid-semester versus end-of-semester) was more exploratory, although we predicted there might be an increase in differences across time between the groups due to an enhancement of team dynamics as the teams' amount of time working together increased. We also chose to investigate how the individual self-reported questionnaire items would correlate with the performance measures. Specifically, this part of our investigation considers to what extent, if at all, the self-reported attitudes and team dynamic items predict the performance measures.

Method

Participants

A total of 845 first-year students enrolled in a core-required introductory engineering course participated in this study during the Fall 2015 and Spring 2016 semesters. The students represented 75% of the entire first-year class and were chosen because their instructors (N=18) used one of the two team-formation methods of this study. They represented a pseudo-random subset of their entire

class because students do not choose their instructors or course sections at our institution. As is standard at our institution, student assignment to course sections was performed by the Registrar's Office, which used a random method with constraints (e.g., student intercollegiate athletes cannot enroll in late afternoon courses due to team practice schedules). Of the participating students, 617 were male (73%) and 228 were female (27%), an accurate reflection of the student population at the institution.

Design

The introductory engineering course used in this study was selected based on the large amount of teamwork, which comprised 40% of an individual's final grade in the course. Over the course of a semester, more than half of the contact hours during class time were spent working on team tasks, such as fabricating projects in a lab, field testing, working in a classroom environment on collaborative design, or presenting their team project results. In addition to the time working in groups during class, a considerable amount of out-of-class team work was expected as they completed the ten group-project deliverables required in the course.

Students in each section were organized in semester-long teams of four student members, a size that matched the tasks and scope of the course projects (Denton, 1996). There were two independent variables, team-formation method (Self-selected, Matched-performance) and time (Mid-semester, End-semester). Matched-performance teams used predicted performance to create teams with relatively similar prior semester GPA, when available, or Academic Composite scores[2] for first-semester students. Teams were formed by ranking students based on prior academic performance and then grouping the top four, then the next four, and so on.

To assess the impact of the two different team formation methods, this study used responses on a self-report questionnaire and five measures of student performance. The performance measures are summarized in Table 1 and include two team work averages, two individual averages, and the final course average.

Table 1. Academic Performance Measures

	Assignments & Exams included in Averages	Points
Mid-semester Team Average	4 team assignments	125 (14%)
Second-half Team Average	6 team assignments	230 (26%)
Mid-semester Individual Average	5 assignments & mid-term exam	235 (27%)
Second-half Individual Average	2 assignments & final exam	310 (33%)
Final Course Average	All of the above	900

[2]Academic composite scores are computed by USAFA's admissions office for each student prior to their arrival based on a number of factors, including high school coursework and activities and standardized test scores (ACT/SAT). The numerical value of the score ranges from zero to 4000, and is primarily used as an indicator of predicted academic performance, with higher Academic Composite scores predicting better student academic performance. For the participants in the study, the highest Academic Composite was 4000, the lowest score was 2411, and the average score was 3270 with a standard deviation of 332. These scores well represent the typical range found across our first-year students.

Materials

The self-report questionnaire contained 24 questions that assessed three categories: team attitudes (seven questions), team behaviors and dynamics (twelve questions), and team outcomes (five questions). Fifteen of the 24 questions were adapted from Chapman et al. (2006). Questions related to attitudes asked about overall attitude, fairness of team formation method, value of the teamwork, the scale to which the teamwork was enjoyable, and effectiveness of the team experience. Questions pertaining to team dynamics provided insight on enthusiasm, team communication, conflict resolution, work session dynamics, and methods teams used to share work responsibilities. Questions focused on team outcomes asked about friends on the team and quality of the work products. The full questions can be seen with data in Tables 5, 6, and 7.

Response options for all questions were multiple-choice with two-to-five Likert-scale response options each. For 20 of the 24 questions, the five response options represented a bipolar spectrum of agreement with the statement in the question or the student's assessment of their experience or perceived quality of work (e.g., strongly disagree / disagree / neutral / agree / strongly agree or terrible / bad / average / good / fantastic). The remaining four questions had between two and four valid choices (yes / no; unfair / doesn't matter to me / fair; never / once / twice / three or more times). Four questions were reverse coded to minimize influence of response bias.

Procedure

At the beginning of each term, instructors for the core engineering course identified the team formation method they would use to form teams within their section(s). Although they were free to select their method of choice, they were informed of the study and requested to consider using one of the methods to stimulate ample representation of these two methods, Self-selected or Matched-performance. In all cases, teams were formed within the first three lessons of the semester-long course. A small number of instructors used other methods (e.g., random assignment/alphabetical, assignment by dorm location, predicted performance to form teams with a diverse mix of Academic Composite scores). Teams formed by these other methods were not included in this study. Table 2 shows the total number of students, teams, sections and instructors corresponding to the two team-formation methods evaluated in the study. Two instructors used different methods for the Fall and Spring semesters, hence, the total number of instructors is 18 rather than 20.

Table 2. Team Formation Method Metrics

	Self-Selected	Matched-Performance	Total
Number of Sections	13 (42%)	18 (58%)	31
Number of Teams	87 (42%)	121 (58%)	208
Number of Students	355 (42%)	490 (58%)	845
Number of Instructors	7 (39%)	13 (61%)	18

Students remained on the same teams while completing all ten graded team assignments throughout the semester. A small percentage of participants (7%) were on teams that had some change to their team's composition during the semester. A change in team composition is defined as when a

student moved to a new team or when a student was removed (change in section, disenrollment). These changes predominately occurred early in the semester, and any team transfers were initiated by the instructor to preserve 4-person team size (i.e., move one student to avoid having one 3-person team and one 5-person team). Neither the students nor the instructors were given any ancillary guidance on methods for developing higher functioning teams, and any team development encouraged by the instructor was informal and within what would normally be expected by educators at the institution. In a small number of situations, instructors intervened with dysfunctional teams to help them work better as a unit. No students transferred teams due to dysfunction.

The 24-item self-report questionnaire was administered to the students twice, once at mid-semester after they had completed four team assignments, and again at the end of the semester after they had completed nine (of the ten) team assignments. The questionnaires were administered in class using digital score sheets, and students were asked to provide identifying information to allow their responses to be linked for analyses. Once performance and questionnaire data were linked at the end of the semester, all identifying information was removed. Students were informed that the questionnaire was optional and that instructors could only have access to their responses after final grades were submitted.

Results and Discussion

At the completion of the two-semester study, all data were integrated for analysis, including attributing the following data to each individual participant: team identifier, section identifier, instructor identifier, team formation method, demographic information, all assignment scores and grade percentages, and questionnaire responses. After the data were integrated, all personally identifiable information was removed.

Prior to analyses being performed, participants who did not complete both mid-semester and end-of-semester questionnaires were removed from the data set. The missing questionnaire data were most often due to a class absence or the omission of a student identifier on the questionnaire response. It is worth noting that class attendance is mandatory at our institution; absences are typically due to illness, medical appointment or athletic team-related travel. Of the 845 participants in the study, 831 completed at least one of the two feedback forms (98%); however only 699 completed both feedback forms (83%). Using only those students with complete data sets, Self-selected teams accounted for 310 students (44%), while Matched-performance teams accounted for 389 students (56%).

Student Performance Analyses

Prior to conducting analyses of student performance measures, the Academic Composite score was investigated for use as a possible covariate. Academic Composite score significantly correlated with each of the five student performance measures at the $p < .01$ level for Mid-semester Team Average $[r(697)=.26]$, Second-half Team Average $[r(697)=.27]$, Mid-semester Individual Average $[r(697)=.49]$, Second-half Individual Average $[r(697)=.56]$, and Final Average $[r(699)=.57]$. Next, we investigated if there was a significant difference in Academic Composite between the two groups, which there was not, $t(1,697)= -0.28$, $p=.78$. Because of this, Academic Composite score was not used as a covariate in the subsequent analyses.

For each of the five performance measures, independent group t-tests and tests for effect sizes were completed. Table 3 presents mean and standard deviations for each group for each performance measure. For the team average measures, one group showed a significant difference, with the matched-performance teams having higher scores than the self-selected teams at the end of the semester;

however, effect sizes were small [Mid-semester Team Average: $t(1,697)=-1.33$, $p=.184$, partial eta squared $=.003$; Second-half Team Average: $t(1,697)=-4.00$, $p<.001$, partial eta squared $=.022$]. For the individual performance measures, Matched-performance teams had higher averages than those in the Self-selected teams, with that difference being significant at mid-semester, but only showing a trend for the second half of the semester [Mid-semester Individual Average: $t(697)=-2.16$, $p=.03$, partial eta squared $=.007$; Second-half Individual Average: $t(697)=-1.61$, $p=.11$, partial eta squared $=.003$]. The final course average showed a significant difference with the matched-performance groups having higher grades [$t(697)=-2.65$, $p=.008$, partial eta squared $= .01$]. Overall these findings support our first hypothesis that the manner in which teams are formed impacts student performance.

Table 3. Academic Performance Measures for the Two Methods of Team Formation

	Self-Selected		Matched-Performance	
	Mean	*(Std Dev)*	Mean	*(Std Dev)*
Academic Composite Score	3269	*(355)*	3276	*(326)*
Mid-semester Team Average (125pts)	88.2	*(6.7)*	88.9	*(8.1)*
Second-half Team Average (230pts) ***	86.7	*(5.1)*	88.3	*(5.3)*
Mid-semester Individual Average (235pts) *	87.7	*(6.9)*	88.8	*(6.4)*
Second-half Individual Average (310pts)	77.1	*(8.6)*	78.2	*(8.4)*
Final Course Average (900pts)**	83.9	(4.9)	85.0	(5.2)

 * Significance of difference between groups: *p $\leq$ .05, ** p<.01, ***p $\leq$ .001.

Self-reported Attitude, Behavior, and Outcome Analyses

Our measures of self-reported team attitudes, team behaviors and dynamics, and team outcome were collected via the self-report questionnaire. Prior to analyses, all questionnaire responses were converted to a numeric rating based on a 5-point itemized scale using Table 4. Lower scores represented less positive responses.

Table 4. Feedback Response Numerical Conversion

Response Choices	Survey Response				
	A	B	C	D	E
A, B, C, D, E	*Strongly Disagree* *1*	*Disagree* *2*	*Neutral* *3*	*Agree* *4*	*Strongly Agree* *5*
A, B, C, D, E (reversed scored)	*Strongly Agree* *1*	*Agree* *2*	*Neutral* *3*	*Disagree* *4*	*Strongly Disagree* *5*
A, B, C, D	*Never* *1*	*Once* *2.33*	*Twice* *3.67*	*3 or more times* *5*	*invalid*
A, B, C	*Unfair* *1*	*Doesn't Matter* *3*	*Fair* *5*	*invalid*	*invalid*
A or B	*No* *1*	*Yes* *5*	*invalid*	*invalid*	*invalid*

The objective of this portion of the research was to investigate whether team formation method affected team attitudes, behaviors, and outcomes. Tables 5, 6, and 7 show the results of a series of 2 Group (Self-selected and Matched-performance) X 2 Time (Mid-semester and End-semester) mixed ANOVAs for each question in team attitudes, dynamics, and outcomes respectively, as well as group means at each of the time periods for each question.

Table 5 presents the statistical findings for questions related to team attitudes. In most cases, the response averages were generally at the level of "agree" (ranging from 3.7 to 4.3). The slight exceptions were the end-semester ratings of satisfaction about the method of team formation (averages of 3.4 and 3.5). There were four significant main effects for Time, two significant main effects for Group, and one significant interaction. All had small effect sizes. Significant main effects for Time included a decrease in overall team attitude for both team formation methods, a decrease in satisfaction with the manner by which the team was formed, a decrease in reported enjoyment for working with the team, and a decrease in perceived effectiveness of working with the team. The two significant Group main effects indicated that Self-selected teams believed their team formation method was "more fair" than the Matched-performance teams, and they were less likely to agree that they wished the teams had been formed differently. These main effects for Group are consistent with the generally more positive team attitudes seen in the self-selected group from Chapman et al. (2006) and Mahenthiran et al. (2000), who also found improved student attitudes by giving students some control of the team selection process. This result supports our hypothesis that self-selected teams show more positive ratings of social factors. However, an interaction regarding overall satisfaction with how teams were formed showed a decrease for both groups with a greater drop in satisfaction for the Self-selected group. Thus, over time, Matched-performance teams may form bonds that offset the lack of choice in initial formation.

Table 5. Team Attitudes Measures

Questions Relating to Team Attitudes	Main Effects and Interaction						Response Means	
	Group Main Effect		Time Main Effect		Interaction		Self-Selected	Matched-Performance
	F	p	F	P	F	p	*Mid-sem*	*Mid-sem*
	η_P^2		η_P^2		η_P^2		*End-sem*	*End-sem*
My overall attitude toward my team was **positive**	1.99 <.01	0.16	**8.74** **0.01**	**<.01**	0.67 <.01	0.41	4.1 4.0	4.2 4.1
Overall, I believe my team formation method (instructor assigned, cadet choice) was **fair**	**9.08** **0.02**	**<.01**	0.38 <.01	0.54	0.59 <.01	0.44	4.3 4.3	4.1 4.0
Overall, I wish my team had *not* been **formed** in a different way[R]	**8.29** **0.01**	**<.01**	**13.5** **0.02**	**<.01**	**5.44** **0.01**	**0.02**	3.8 3.5	3.5 3.4
Working with my team was a **bad/good** experience	0.00 <.01	0.98	0.66 <.01	0.42	0.25 <.01	0.62	3.9 3.8	3.9 3.9
Working with my team was **valueless/valuable** for my learning	0.09 <.01	0.76	1.80 <.01	0.18	0.07 <.01	0.79	3.8 3.8	3.8 3.7
Working with my team was **not enjoyable/enjoyable**	0.06 <.01	0.80	**5.04** **0.01**	**0.03**	0.44 <.01	0.51	3.8 3.8	3.9 3.8
Working with my team was **ineffective/effective**	0.00 <.01	0.99	**7.37** **0.01**	**0.01**	3.39 <.01	0.07	3.8 3.8	3.9 3.7

[R] indicates question was reverse scored italic words added for analysis clarification

Bold values indicate a significant effect of at least p≤ .05.

For team behaviors and dynamics measures, shown in Table 6, the range of average scores was much wider (1.9 up to 4.2). Again, there were relatively few significant effects, and most of them had small effect sizes. Group main effects included the Self-selected group reporting higher levels of meeting outside of class and the Matched-performance group reporting more collaborative contributions. Significant main effects of Time included a decrease in reported worrying about grades on team projects, a decrease in being task oriented, a decrease in going "straight to work" in and out of class work sessions, an increase in meeting outside of class (medium effect size), and a decrease in reporting that they did not complete work for their team members. These Time main effects indicate that our entire population behaved similarly over time regardless of team formation method, and that team dynamics change in measurable ways across the semester. The one significant interaction indicated that the Self-selected group reported higher levels of good communication at mid-semester, but by the end of the semester, the Matched-performance group reported higher levels of good communication. This finding is in contrast to Chapman et al. (2006), who found that self-selected teams reported significantly higher levels of communication at the end of the semester.

Taken together, these results suggest student engagement in their groups show many shifts over time. Overall, these changes seem intuitive as the team members became acquainted over the course of the semester, leading to effects on teamwork measures (e.g., less worry, more socialization during meetings so less task-focused, more meetings outside of class, increase in completing work for teammates). The result that Self-selected teams met outside of class more often than the Matched-

performance groups suggests that early familiarity with team members leads to an advantage with respect to making plans to work together outside of class time. Again, this supports our hypothesis that self-selected teams may show more positive ratings of social factors since they have friends on their teams. Matched-performance groups' greater levels of self-reported collaboration may be a result of greater similarity in academic ability, or perhaps greater similarity in their approach to academic tasks.

Table 6. Team Behaviors and Dynamics Measures

Questions Relating to Team Behavior and Dynamics	Group Main Effect		Time Main Effect		Interaction		Self-Selected	Matched-Performance
	F / η_P^2	p	F / η_P^2	p	F / η_P^2	p	*Mid-sem* / *End-sem*	*Mid-sem* / *End-sem*
I was **enthusiastic** about working together with my team	0.49 / <.01	0.40	0.24 / <.01	0.62	0.00 / <.01	0.99	3.9 / 3.9	3.9 / 3.9
I *was not* **worried** about my grade on team projects[R]	1.41 / <.01	0.24	**15.9** / **0.02**	**<.01**	2.02 / <.01	0.16	3.3 / 3.1	3.3 / 3.2
My team had good **communication** (timely, respectful, informative)	0.13 / <.01	0.72	0.14 / <.01	0.71	**7.15** / **0.01**	**0.01**	3.7 / 3.6	3.6 / 3.7
My team **resolved conflict** effectively	3.31 / <.01	0.07	1.38 / <.01	0.24	0.79 / <.01	0.37	4.0 / 3.9	4.1 / 4.0
I asked other team members for **help** when needed	0.38 / <.01	0.54	0.01 / <.01	0.91	1.58 / <.01	0.21	4.0 / 4.0	3.9 / 4.0
My team met outside of class	**17.3** / **0.03**	**<.01**	**80.1** / **0.11**	**<.01**	0.07 / <.01	0.79	2.9 / 3.4	2.5 / 3.0
During in or out of class work sessions, my team was **task oriented**	3.27 / <.01	0.07	**26.6** / **0.04**	**<.01**	0.64 / <.01	0.42	4.1 / 3.9	4.2 / 4.0
During in or out of class work sessions, my team went straight to work	3.26 / <.01	0.07	**30.2** / **0.04**	**<.01**	0.47 / <.01	0.49	4.1 / 3.9	4.2 / 4.0
My team made **collaborative contributions**	**5.68** / **0.01**	**0.02**	1.87 / <.01	0.17	0.78 / <.01	0.38	3.9 / 3.8	4.0 / 4.0
My team *did not* **divide-and-conquer** the tasks[R]	3.01 / <.01	0.08	1.63 / <.01	0.20	0.03 / <.01	0.86	2.0 / 2.0	1.9 / 1.9
My team **reviewed our final turn-in product as a team** so we could make final revisions together	0.01 / <.01	0.91	0.54 / <.01	0.46	0.38 / <.01	0.54	3.2 / 3.2	3.2 / 3.2
I *did not* complete work for other team members[R]	3.44 / <.01	0.06	**7.70** / **0.01**	**0.01**	0.03 / <.01	0.86	2.9 / 2.7	3.0 / 2.9

[R] indicates question was reverse scored italic words added for analysis clarification

Bold values indicate a significant effect of at least p≤ .05.

Although there were no significant effects, the means for "my team did not divide-and-conquer the tasks" were very low (1.9 and 2.0) compared to all other responses (which ranged between 2.5 and 4.2), suggesting that dividing-and-conquering was a common strategy for both groups (and arguably also a non-ideal approach for team tasks). This finding could be an indication of confidence in team members' abilities or simply a strategy to cope with time constraints. More positively, some

of the highest response means for both groups were for being task oriented, going straight to work, asking team members for help, and resolving conflict. All of these factors are indicators of healthy team behaviors.

Table 7 summarizes the statistical results of the team outcome measures. Again, there were few significant effects. We found no Group difference in making new friends, and overall our students reported high levels of making new friends. There was a significant Group difference for already having friends on the team; not surprisingly, the Self-selected group reported higher levels than the Matched-performance group. This was consistent with other research in the literature (Pociask et al., 2017; Rienties, Alcott, & Jindal-Snape, 2014; Chapman et al., 2006). We found no Group difference in the self-assessed level of the quality of the team work, but we did find a significant decrease over time. These results suggest that Matched-performance groups achieve similar team outcomes to Self-selected groups, even though they self-report starting out with fewer friends on their teams.

Table 7. Team Outcome Measures

| Questions Relating to Team Outcomes | Main Effects and Interaction | | | | | | Response Means | |
| | Group Main Effect | | Time Main Effect | | Interaction | | Self-Selected | Matched-Performance |
	F η_P^2	p	F η_P^2	p	F η_P^2	p	Mid-sem End-sem	Mid-sem End-sem
Some of my **friends** were on my team	**31.6** **0.05**	**<.01**	1.39 <.01	0.24	0.12 <.01	0.73	2.9 3.0	2.2 2.2
I made **new friends** on my team	0.24 <.01	0.63	0.74 <.01	0.39	1.91 <.01	0.17	4.5 4.5	4.5 4.6
My self-assessed quality of our **team work**	0.73 <.01	0.39	**3.90** **0.01**	**0.05**	0.30 <.01	0.59	3.9 3.8	3.9 3.9
My self-assessed quality of my **individual work** on the team	0.62 <.01	0.43	0.03 <.01	0.85	0.03 <.01	0.85	4.0 4.0	4.0 4.0
My self-assessed quality of my **individual work in this course**	0.06 <.01	0.81	1.98 <.01	0.16	0.01 <.01	0.91	4.1 4.0	4.1 4.0

Bold values indicate a significant effect of at least p≤ .05.

Table 8 shows our end-semester data alongside the matched question results from Chapman et al. (2006)[3]. This comparison allows us to evaluate how their randomized groups might compare to our matched-performance groups when comparing to self-selected groups (both studies). Chapman et al. found significant group differences for 11 of their 15 questions, with eight of them showing more positive ratings for their self-selected group compared to their randomized group. In contrast, we found no significant group differences for the 15 similar questions; however, we did find significant group effects for a few of our questions that did not match those from Chapman et al. Overall, the lack of group differences in the current study compared to those found by Chapman et al. support

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[3]The results from Chapman et al. (2006) shown in Table 8 have been normalized to a 5-point scale for direct comparison with the current study. The study by Chapman et al. (2006) had 16 sections, with 583 end-semester survey respondents. The group size was 2-6 members with 4 as the mean. The composition of the study was 81% seniors, 14% juniors with 62% male and the remainder female.

our prediction that our group differences would be smaller than those found when comparing self-selected and randomly-selected teams.

In most cases, the overall mean scores for each question were similar across the two studies, except our students self-reported more positively (greater than a 0.3 point difference on the five-point scale) in terms of positive attitude, being enthusiastic to work together, worrying about grades on group projects, going straight to work, and completing the work of others. Overall, there was more than a 0.85 point difference with our students making new friends on the team. These more positive self-reported data could be due to the common shared experiences unique to that of a military academy.

Table 8. Self-Report Response Comparison with Chapman et al. (2006)

	Questions	Response Means (End-semester)			Chapman (2006) Response Means		
		Self-Selected	Matched-Performance	Overall	Self-Selected	Random Assignment	Overall
Team Attitude Measures	My overall attitude toward my team was **positive**	3.97	4.08	4.03	3.81*	3.67	3.73
	Working with my team was a **bad/good** experience	3.84	3.86	3.85	4.00	3.89	3.94
	Working with my team was **valueless/valuable** for my learning	3.77	3.74	3.75	3.79*	3.61	3.69
	Working with my team was **not enjoyable/enjoyable**	3.78	3.77	3.77	3.76	3.66	3.71
	Working with my team was **ineffective/effective**	3.79	3.72	3.76	3.89**	3.71	3.79
Team Dynamic Measures	I was **enthusiastic** about working together with my team	3.93	3.89	3.91	3.81***	3.44	3.59
	I **worried** about my grade on team projects	3.07	3.23	3.15	2.56	2.77	2.69
	My team had good **communication** (timely, respectful, informative)	3.58	3.72	3.65	4.13***	3.85	3.96
	My team **resolved conflict** effectively	3.92	4.05	3.98	4.19*	4.00	4.08
	I asked other team members for **help** when needed	3.97	3.99	3.98	4.09*	3.91	3.99
	During in or out of class work sessions, my team was **task oriented**	3.95	4.01	3.98	3.73	3.91*	3.84
	During in or out of class work sessions, my team went straight to work	3.91	3.98	3.94	3.33	3.68***	3.53
	I completed work for other team members	2.74	2.88	2.81	2.23	2.56**	2.42
Team Outcome Measures	I made **new friends** on my team	4.50	4.62	4.56	3.92***	3.53	3.69
	My self-assessed quality of our **team work**	3.80	3.87	3.83	4.51	4.48	4.49

For Chapman et al. (2006): Ratings were based on a 7-point itemized scale where 1 = unfavorable and 7 = favorable. These were normalized to a 5-point scale for direct comparison with the current study. Significance of difference between random and self-selected groups: *$p \le .05$, **$p \le .01$, ***$p \le .001$.

Overall, our data indicate a slight benefit on performance using Matched-performance to form teams, and a mixture with respect to impact on the self-reported measures. Because our design

included both types of measures, and we were able to use identifiers to link the data, we are also able to investigate how these two types of measures correlate. Ultimately, our hope is to help instructors make choices that will enhance student learning. Thus, if we find that certain self-reported measures are more predictive of performance, then we should consider prioritizing team formation methods that would maximize those measures. Tables 9, 10, and 11 summarize the correlations for both the Self-selected and the Matched-performance groups between the two team and the two individual performance measures for each question in the three groupings of self-reported questions, respectively.

Several general trends are apparent, as are some interesting item relationships. For both groups, Attitudes measures (Table 9) and Behaviors and Dynamics measures (Table 10) show more and stronger significant correlations between the self-reported measures and team performance measures than between the self-reported measures and the individual performance measures. Overall, the correlations are more frequent and stronger for the Matched-performance group, which also showed more significant relationships between the self-reported measures and the individual performance measures. Finally, the correlations are stronger at the end of the semester than mid-semester. This latter observation suggests a growing influence of the team dynamics and influences.

Table 9. Team Attitudes and Performance Correlations

Questions Relating to Team Attitudes	Self-Selected					Matched-Performance				
	N Mid-semester / N End-semester	Mid-sem Team Avg	2nd half Team Avg	Mid-sem Ind Avg	2nd half Ind Avg	N Mid-semester / N End-semester	Mid-sem Team Avg	2nd half Team Avg	Mid-sem Ind Avg	2nd half Ind Avg
My overall attitude toward my team was **positive**	304 / 304	.18** / .11	.08 / .22***	.07 / .12*	.07 / .01	385 / 386	.16** / .21***	.09 / .20***	.07 / .18**	.03 / .12*
Overall, I believe my team formation method (instructor assigned, cadet choice) was **fair**	266 / 260	.16* / .17*	.17** / .22***	.10 / .10	.01 / .00	322 / 322	.16** / .24***	.12* / .15**	.08 / .18***	.01 / .08
Overall, I wish my team had *not* been **formed** in a different way[R]	306 / 304	.19** / .21***	.13* / .27***	.09 / .09	.04 / .03	385 / 384	.20*** / .29***	.14** / .23***	.14** / .20***	.08 / .15**
Working with my team was a **bad/good** experience	306 / 303	.23*** / .14*	.11 / .22***	.08 / .12*	.03 / -.02	385 / 385	.28*** / .29***	.17** / .32***	.17*** / .23***	.17** / .19***
Working with my team was **valueless/valuable** for my learning	306 / 303	.21*** / .12*	.10 / .16**	.10 / .11*	.05 / .02	386 / 384	.18*** / .16**	.09 / .16**	.07 / .09	.06 / .08
Working with my team was **not enjoyable/enjoyable**	304 / 304	.19*** / .10	.06 / .18**	.08 / .15*	.04 / .02	386 / 385	.15** / .24***	.11* / .23***	.08 / .14**	.03 / .14**
Working with my team was **ineffective/effective**	304 / 304	.24*** / .20***	.15* / .17**	.01 / .12*	-.06 / .00	386 / 384	.27*** / .24***	.15** / .25***	.12* / .15**	.07 / .12*

* p≤.0
** p≤.01
*** p≤.001

Table 10. Team Behavior and Dynamics and Performance Correlations

Questions Relating to Team Behaviors and Dynamics	Self-Selected					`Matched-Performance				
	N Mid-semester / N End-semester	Mid-sem Team Avg	2nd half Team Avg	Mid-sem Ind Avg	2nd half Ind Avg	N Mid-semester / N End-semester	Mid-sem Team Avg	2nd half Team Avg	Mid-sem Ind Avg	2nd half Ind Avg
I was **enthusiastic** about working together with my team	309 / 308	.16** / .13*	.02 / .25***	.07 / .13*	-.01 / -.01	387 / 388	.20*** / .20***	.08 / .21***	.14** / .21***	.07 / .12
I *did not* **worry** about my grade on team projects[R]	310 / 307	.31*** / .25***	.11 / .30***	-.04 / .07	-.01 / .03	388 / 387	.37*** / .30***	.25*** / .36***	.15** / .13*	.05 / .09
My team had good **communication** (timely, respectful, informative)	309 / 308	.23*** / .06	.10 / .23***	.07 / .11*	-.06 / -.08	387 / 386	.29*** / .29***	.28*** / .29***	.22** / .15**	.15* / .13*
My team **resolved conflict** effectively	309 / 309	.22*** / .18**	.08 / .15**	.02 / .14*	-.01 / .02	389 / 389	.08. / .13*	.09 / .14**	.06 / .11*	.06 / .10*
I asked other team members for **help** when needed	309 / 310	.10 / .08	.07 / .00	.02 / .10	.04 / .06	388 / 387	.07 / .15**	-.04 / .06	.01 / .07	-.04 / .00
My team met outside of class	296 / 286	-.11 / -.11	.08 / .09	.06 / .06	-.08 / -.07	367 / 367	-.06 / -.17**	.10 / -.10	.07 / -.08	-.03 / -.01
During in or out of class work sessions, my team was **task oriented**	310 / 310	.30** / .07	.07 / .10	.09 / .16**	.07 / .01	387 / 388	.16** / .23***	.13* / .21***	.14* / .07	.11* / .08
During in or out of class work sessions, my team went straight to work	310 / 310	.14* / .05	.05 / .05	.07 / .14*	.05 / -.01	388 / 387	.16** / .16**	.08 / .16**	.14** / .07	.15** / .09
My team made **collaborative contributions**	310 / 310	.18** / .09	.01 / .15*	.02 / .15**	.01 / -.02	389 / 389	.13* / .16**	.10 / .20***	.08 / .14**	.02 / .11*
My team *did not* **divide-and-conquer** the tasks[R]	310 / 310	-.18** / -.07	-.16** / -.19***	-.02 / -.13*	-.03 / -.02	389 / 389	-.16** / -.19***	-.18** / -.23***	-.07 / -.14*	-.03 / -.10
My team **reviewed our final turn-in product as a team** so we could make final revisions together	310 / 310	.23*** / .01	.01 / .09	-.02 / .02	-.13* / -.16**	389 / 389	.17** / .09	.10* / .08	.14** / -.01	-.02 / -.04
I *did not* complete work for other team members[R]	310 / 308	.06 / .00	.08 / .09	-.15* / -.11	-.10 / -.16**	389 / 387	.05 / .10	.11* / .15**	.02 / .04	.05 / .04

* p≤.0
** p≤.01
*** p≤.001

Two interesting item relationships are on division of tasks within the team and having or making new friends on the team. For the Behavior and Dynamics measures (Table 10), the self-reported measure "my team did not divide-and-conquer" had a negative correlation, suggesting that the more the team divided and conquered the task the better the performance, and not surprisingly, this was more connected with team performance measures. While we do not propose that dividing

and conquering is the best team approach to completion of tasks, again this finding could be an indication of strong confidence in team members' abilities. It could also be a strategy for team members to cope with over-demanding time constraints.

For the Outcomes measures (Table 11), there are less obvious differences between the Self-selected and Matched-performance groups, or between the team and the individual performance measures. Rather, the correlations suggest that for both groups, forming new friends is more positively related to performance (team and individual) than already having friends on a team, which tended to negatively correlate with performance. Not surprisingly, self-assessment of work quality correlated strongly for both groups for both team and individual performance measures.

Overall, these correlation results suggest that many student perceptions about their teams capture aspects of team functioning that ultimately could impact team performance, and that in some cases, team perceptions seem related to factors that also impact performance in a broader manner. They reinforce the importance for instructors to establish healthy teams and provide structure and support to foster good team functioning.

Table 11. Team Outcome Measures and Performance Correlations

Questions Relating to Team Outcome Measures	Self-Selected					Matched-Performance				
	N Mid - semester N End - semester	Mid-sem Team Avg	2nd half Team Avg	Mid-sem Ind Avg	2nd half Ind Avg	N Mid - semester N End - semester	Mid-sem Team Avg	2nd half Team Avg	Mid-sem Ind Avg	2nd half Ind Avg
Some of my **friends** were on my team	293 288	-.13* -.05	-.05 .02	-.17** -.09	-.13* -.15*	371 372	.01 .01	-.03 -.06	-.03 -.05	-.05 -.10
I made **new friends** on my team	288 280	.20** .17**	.15* .15*	.13* .19**	.10 .13*	360 360	.13* .04	.11* .08	.15** .14**	.05 .08
My self-assessed quality of our **team work**	305 305	.29*** .11	.07 .23***	.05 .07	.10 -0.05	382 385	.29*** .29***	.22** .34***	.17** .21***	.10 .22***
My self-assessed quality of my **individual work** on the team	304 300	.25*** .20***	.17** .19***	.23*** .29**	.19*** .20***	383 383	.23*** .19***	.10* .19***	.25*** .17**	.20*** .12*
My self-assessed quality of my **individual work in this course**	292 295	.11 .17**	.17** .15*	.32*** .35***	.24*** .24***	365 376	.20*** .19***	.07 .13*	.27*** .27***	.24*** .20***

* p≤.0
** p≤.01
*** p≤.001

Conclusions

Our study compared groups formed by matching students based on similar academic potential with groups self-selected by students. Our inclusion of mid- and end-of-semester performance measures as well as self-reported attitudes and behaviors allowed an analysis of the developing dynamics of team formation and how they impact both individual as well as team assignment performance. The finding that many of the questionnaire items significantly correlated with performance measures, and that the correlations strengthened from mid to end of the semester, reinforces our conclusion that it is important to thoughtfully consider how teams are formed and to support the development of well-functioning teams.

As predicted, we found that the Matched-performance groups had significantly higher grades on several performance measures, with a larger effect on the team grades than the individual grades; however, overall the effect sizes were small, approximately 1% of the course grade. Although small, the fact that the impact on team grades increased across the semester suggests a growing positive influence when using Matched-performance teams. Students in the Matched-performance groups might take longer to bond, but once they do they become more effective with respect to the team activities.

The self-reported team attitudes, dynamics and outcomes responses supported our prediction that as a group our Matched-performance and Self-selected teams reported similar attitudes and behaviors. Furthermore, our group differences were smaller than those obtained when comparing self-selected and randomly-formed teams (e.g., Chapman, et al., 2006). We found significant group differences for some of questions we developed for this study, and these help us understand some of the differing influences of our two methods of team formation, especially when combined with the time data (mid versus end of semester) and when correlated with the performance measures. For example, both the sense of fairness (higher for Self-selected) and the likelihood to collaboratively contribute (higher for Matched-performance) showed significant group differences as well as significant correlations with several of the performance measures. Further, for both groups there were small but significant decreases from mid to end of semester in satisfaction with team formation method, general enjoyment, and task-orientation over time.

All of these time-related factors also showed significant correlations with the performance measures. Therefore, these factors seem like natural points for instructor attention when using teams in a course. For example, if an instructor chooses to use Matched-performance groups due to the potential benefits for performance and likelihood for collaboration, the instructor should explicitly address fairness issues.

One of the most salient correlation findings relates to the impact of already having friends on the team versus making new friends. Both groups reported similar levels of making new friends, and making new friends was strongly and positively related to better performance. However, already having friends on the team was our largest significant group difference (much more often true for Self-selected versus Matched-performance teams), and it was negatively correlated with performance. Based on this combination of factors, along with the performance results previously discussed, we recommend Matched-performance groups over Self-selected groups.

Although we make the recommendation for Matched-performance teams over Self-selected teams, we acknowledge that there are many other team formation techniques we did not study (e.g., the hybrid teams used by Mahenthiran & Rouse, 2000, randomly-formed teams), and that there are contextual factors that might also impact team performance and attitudes. For example, this study was conducted at the U.S. Air Force Academy (USAFA), a military institution, with all participants being first-year (freshman) students. Students in first-year courses are less likely to already know each other than students in upper-level courses within a major. Additionally, our institution has a rigorous course attendance policy, which makes it more likely that all members are present during team interactions in class. None of these factors are completely unique to our institution, but they may have influenced our results and should be kept in mind by others who may form teams in different contexts.

Future research can build on our work and that of other researchers to further investigate factors that might impact generalization, how team dynamics shift over time, and whether or not team dynamic interventions might influence team functioning. For example, instructors and other team leaders might incorporate intentional team-building activities or implement tracking of individual accountability on team efforts. Team performance and dynamics are complex, but given the key role teams play in academic, industry, military and other endeavors requiring cooperative productivity of

individuals, it is important to continue research efforts that help us identify and enhance factors that contribute positively to team functioning and mitigate those factors that are detrimental to team functioning.

Acknowledgements

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