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Characteristics of Good Teams

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Abstract

The performance of forty-two teams and various characteristics of the 159 students on those teams have been evaluated in four sophomore design classes over a two-year period. The individual characteristics monitored were: gender, ethnicity, age, work experience, academic prowess, personality indicators, team citizenship and interest. Surprisingly, there was only weak or no correlation between team performance and the average individual characteristics of its members. For example, the average age of the members of the poorly performing teams was exactly the same (22.4 years) as that for the better performing teams. The same was true for work experience, personality type, academic performance, gender, and ethnicity. These and additional results related to the mix of the characteristics within the teams are presented in this paper. A related, informal survey of the students indicated that team effectiveness was much more dependent on such "external" and practical factors as success in establishing meeting times.

Introduction

Working in teams is becoming more and more common in engineering as well as in other work environments. At last year's ASEE Annual Conference a paper [1] reported on the characteristics of a "good (individual) team player." The data were based on a horizontal study of two engineering design courses, one at the sophomore level and the other at the senior level. The individual performances of 214 students working on 57 projects during the 2002-3 academic year were evaluated. Individual demographic, academic, personality, and personal data, as well as interest and skill levels, were gathered from the four classes. The conclusions reached are listed below:

- The better team players tended to be older with more work and more engineering related work experience.
- The better team players tended to have better drawing abilities and were better self-critics of their own drawing abilities.
- Factors appearing to have little influence were personality type, gender, and high school and college grade point averages.
- The expressed motivation for the course or for working in teams and interest in the project seemed to have little influence on ones own performance on the team.
- Issues related the ethnicity and SAT scores were discussed, but no conclusions were presented.

That paper addressed the characteristics of individuals who were judged by their peers on their teams to be "good" or "poor" team players (regardless of the team's performance). The current paper analyzes the characteristics of individuals on "good", "average," and "poor" teams, to determine how individual characteristics influence team effectiveness. The data have been gathered over two years from a sophomore design class in mechanical engineering. The demographics and academic data for 159 students working on 42 teams have been studied. The variables addressed above (age, work experience, gender, gpa, personality type, etc.) as well as the mix of these variables within each "good" and "poor" team have been analyzed.

Last year's paper[1] provided a short review of the literature [2-4] related to methods and criteria for forming teams with the intent of making the teams more successful. Their conclusions were logical (heterogeneous teams [gpa, interests, and experiences] tended to outperform the homogeneous teams), but these conclusions were based on very limited data. The Myers-Briggs Type Indicators (MBTI) are discussed by McCaulley[5] as related to success in working in engineering and design teams. She points out the theoretical desirability of having a diverse set of indicators represented on a design team and the fact that N (intuition) and to a lesser extent I (introversion) and P (perceptive orientation), which support creativity, would be desirable characteristics for the design team to have. Jensen et altera[6] provide an algorithm for team formation based on MBTI but again provide limited evidence that it works. The present paper presents results which tend to indicate that few if any of these rules have validity.

Methodology

All students in the four classes[7] for the fall 2002 through spring 2004 completed

- the questionnaire in Fig. 1 (which requests demographic and personal data as well as the students' opinions on nine statements about themselves and the course),
- a Keirsey Temperament Sorter[8] (which was used to determine MBTIs), and
- a peer rating form (The peer rating scheme, the autorating method, was first proposed by Brown[9] and discussed by Kaufman.[10]).

The students also provided a drawing sample (Students were instructed to draw a three-dimensional sketch of an object given two views.) which was evaluated by the instructor.

The attempt was made each semester to form teams of four. However, due to the facts that the total number of students that need to be accommodated was not necessarily a multiple of four and that a few students dropped the class after teams were formed, not all teams actually had four members at the end of the semester. Sufficiently complete records were obtained from 168 students initially enrolled in one of the four classes. One hundred and sixty-three of them completed the course working on one of 44 teams. However, two of the teams ended up with only two members each, and their data were not included in this study. The data reported therefore will be for 159 students working on 42 teams (eleven teams of three, twenty-nine teams of four, and two teams of five). The grade point average and SAT score data were self reported (see Fig. 1) and were not verified. The SAT data were approximately 70% complete. Only the University of Houston grade point average (current UH gpa in Fig. 1) and the high school grade point average (high school gpa in Fig. 1) were used in this study. The reporting of the other grade point averages was very inconsistent and based on written comments from the students,

Team number or name: _____

Individual name _____

1 Age (in years) _____

2 Ethnicity: Hispanic, Caucasian, African-Am, East Asian, Asian, other _____

3 Sex M or F

4 Work experience (effective years) _____

5 Engineering related work experience (years) _____

6 Equivalent full time college experience
(years or approximate hours completed) _____

7 High school gpa _____/4.0

8 College Board Standard Aptitude Test

Verbal _____/800

Analytical (Math) _____/800

9 Estimated college gpa _____/4.0

10 Overall UH gpa _____/4.0

11 Science/engineering related gpa _____/4.0

12 Non-science/non-engineering gpa _____/4.0

13 Academic Major _____

Please respond to the following statements indicating the degree to which you agree or disagree with each.

	definitely no	no	neutral	yes	definitely yes
14 I was looking forward to taking this class					
15 I am enjoying (or expect to enjoy) this class					
16 I like working in teams					
17 I like working in MY team					
18 I would change teams if I could					
19 I think my team is working effectively					
20 Learning to work in teams is important					
21 I have experience with hand and power tools					
22 I have above average drawing skills					

23 Please add any comments regarding your special skills that make you more likely to succeed in this design class: _____

_____

Figure 1: Demographic Questionnaire

was unreliable. There was a 90% reporting rate on the UH gpa. (Most of those not reporting were in their first semester at UH.) The reported high school gpas were also suspect but were reported at about a 75% rate. (A significant number of the students did not attend high school in the USA and several had not seen the inside of a high school for many years.)

The peer evaluations were used to provide a basis from which to identify the "good" and "poor" team players. The autorating method asks students to rate their team members on a qualitative scale based on their team citizenship, i.e., how well each member fulfilled his responsibilities to the team. The students are told not to rate their teammates on academic ability or on their total contribution to the project, but simply whether or not or to what degree they did what was expected of them. The rating of each team member is then compared to the team average rating and an individual (quantitative) ranking is determined with some students possibly above or below average in each team. These results were then examined by the instructor, who had worked closely with all teams and was not surprised by any of the results. None was modified.

Half of the semester grade was based on a two-month "major project". (For more details on this class see Reference 7.) For these projects (a different one in each class) each team had given a team oral presentation, tested their artifact twice publicly, had three formal meetings with the instructor during which team members were questioned, had several informal meetings with the instructor, had some phone conversations with the instructor and had numerous email exchanges with the instructor. With some level of subjectivity (10% above or below the team average rating) forty-four (28% of the classes) "good" team players and thirty-two (21%) "poor" team players were identified for the four classes. The remaining 80 (51%) students were judged to be average team players.

Finally, the issue of deciding how to define the effectiveness of the teams had to be addressed. As noted above there were several aspects to the final team grade, but it was decided that the evaluation of artifact itself and its performance would be the best measure of the "team" effectiveness. After the final presentations in which each team must demonstrate that its artifact satisfies the minimum requirements for the design (the constraints), the artifacts were impounded and evaluated by the instructor. The artifacts were evaluated according to the following rubric, all elements of which had been discussed with the class during the semester:

- Concept (20%): rationality of approach and selection of design concept
- Creativity (20%): application of the concept
- Performance and robustness (20%): based on the testing and repeatability
- Esthetics (15%): craftsmanship and overall appearance
- Description (15%): operations manual submitted with the project
- Attention-getting (10%): measure of interest generated during testing.

Each of these six components was evaluated based on the scale that 50% was "adequate"; 100% was "excellent". Bonus points were also awarded for particularly meritorious work. Based on this evaluation a "grade" between zero and hundred was assigned to each artifact and therefore its team. These grades ranged from 22 to 100. A natural break occurred between 56 and 65 and one was imposed at 75, such that sixteen teams involving 57 students (scores 22 to 56) were viewed as "poor"; eight teams involving 29 students (scores 65 to 75) were viewed as "average"; and eighteen teams involving 70 students (76 to 100) were viewed as "good."

Results

Team size: Table 1 indicates that team size had little effect on team effectiveness.
Demographics: Table 2 indicates that gender and ethnicity produced no remarkable effect on team effectiveness.

Team Size	Good Teams	Average Teams	Poor Teams	Total
Teams of three	3	3	5	11
Teams of four	14	5	10	29
Teams of five	1	0	1	2
Avg. Team Size	3.89	3.62	3.75	3.79
Total Teams	18	8	16	42

Table 1: Team Size as a Function of Team Effectiveness

	Good Teams	Average Teams	Poor Teams	All Teams	
	N=70	N=29	N=60		
	%	%	%	N	% of Total
Male	76	81	75	121	76
Female	24	19	25	38	24
Caucasian	46	39	36	65	41
Hispanic	31	26	31	48	30
Asian	11	26	14	24	15
African Am	6	3	8	10	6
Middle East	4	6	8	10	6
Other	1	0	2	2	1
TOTALS	99	100	99	159	99

Table 2: Individual Membership of Teams by Gender and Ethnicity by Per Cent of Group.
N = Number of Students in Associated Group

Age and Experience: The major discriminators, from the previous study[1], indicating "good" or "poor" individual performance on a team were age and work experience, the older more experienced students being the better team players. However, as seen in Table 3, the age and experience edge does not contribute to team effectiveness.
Academic Prowess: The previous study[1] indicated a very weak positive correlation between gpa and individual performance on a team. There was also a weak positive correlation with SAT Verbal scores and a weak negative correlation with SAT Analytical scores. It would be difficult

to make similar cases for correlations between team SAT scores and grades and team effectiveness as seen in Table 4.

Student interest and Self-assessment Issues: Table 5 tabulates the responses to the students' opinions portion of the questionnaire (Fig. 1) sorted by team effectiveness. There are little

	Good Teams	Average Teams	Poor Teams
Age	22.4	22.8	22.4
(std dev)	(4.8)	(4.3)	(4.0)
Work Exp	4.2	5.2	4.9
(std dev)	(4.0)	(3.5)	(4.1)
Eng'g Work Exp	1.1	1.4	1.1
(std dev)	(1.6)	(3.3)	(1.1)
College Exp	2.2	2.5	2.7
(std dev)	(1.1)	(1.3)	(1.2)

Table 3: Age, Work Experience, Engineering Work Experience, and Time in College of the Individuals Team Groups (All entries in years)

	Good Teams	Average Teams	Poor Teams
HS gpa	3.51	3.40	3.35
(std dev)	(0.46)	(0.49)	(0.44)
UH gpa	3.16	3.21	3.07
(std dev)	(0.46)	(0.53)	(0.44)
SAT			
Verbal	567	537	542
(std dev)	(94)	(73)	(116)
Anal	642	624	660
(std dev)	(76)	(82)	(78)

Table 4: Academic Performance of Individuals by Groups: High School and University of Houston Grade Point Averages (based on 4.0) and SAT Verbal and Analytical Scores (Dimensionless)

differences in the responses (about 3% average differences) from those on the "good" to "poor" teams regarding their general thoughts on working in groups (items 1, 2, 3, and 7) and mechanical skills (items 8 and 9). As might be expected, there are some differences (about 12% average differences) when the current situation is addressed (items 4, 5, and 6). However, even greater differences between the "good" and "poor" team responses for these last three items might be expected since at the time of the survey, all the students knew their team (project) grade. These results seem to indicate a strong team bonding even when the team product was deficient. Finally, a positive correlation is seen between the instructor-assessed drawing skills and team effectiveness (items 11). This result was also seen in the previous study[1], in which drawing skill correlated positively with individual performance on a team.

	Good Teams	Average Teams	Poor Teams
1. Looking forward to the class	3.84 ± 0.86	3.86 ± 0.89	3.89 ± 0.85
2. Enjoying the class	3.84 ± 0.95	3.93 ± 1.08	3.97 ± 0.88
3. Like to work in groups	4.17 ± 0.80	4.17 ± 1.12	3.97 ± 0.86
4. Like to work in my group	4.29 ± 0.82	4.23 ± 0.73	3.86 ± 1.02
5. Want to change groups	2.53 ± 1.51	2.31 ± 1.31	2.95 ± 1.32
6. My group is effective	3.44 ± 1.49	3.63 ± 1.19	2.91 ± 1.31
7. Group work is important	4.50 ± 0.70	4.70 ± 0.53	4.38 ± 0.89
8. I am a hands on person	4.29 ± 0.84	4.47 ± 0.90	4.44 ± 0.68
9. Hand and power tool exp.	4.03 ± 1.04	4.20 ± 0.89	4.10 ± 0.95
10. Above average drawing skills	3.42 ± 1.03	3.53 ± 1.17	3.07 ± 1.10
(Self assessment)			
11. Above average drawing skills	2.92 ± 1.05	2.92 ± 1.11	2.45 ± 1.16
(Instructor's assessment)			

Table 5: Responses to Questions by Groups (5 = definitely yes; 4 = yes; 3 = neutral; 2 = no; 1 = definitely no). Average Followed by Standard Deviation.

Individual Performance: Intuitively, one would expect better individual performers on the most effective teams. However, Table 6 seems to indicate that good and poor individual performers are present on all teams. Of course, these ratings are misleading since they rate only relative to each team. However, one would expect that the better teams would tend to receive more uniform contributions from all members and hence have fewer "good" or "poor" individuals. This expectation is realized for the good teams, but perhaps to a lesser extent than expected. Also, the similarity of the results for the average and poor teams is a little surprising.

Personality issues: Table 7 indicates the distribution of the MBTIs for the students as a function their teams' effectiveness without remarkable results. Of course, more interesting is the

distribution of these personality types within each team. However, given that the overall averages are essentially the same for the three effectiveness levels for the teams, it seems unlikely that the distributions within the teams are much different either. However, Jansen et altera[6] have proposed that team effectiveness should be improved if the following combination of MBTIs are present among the members of the team: EN or IN plus T, F, P and J. Table 8 seems to contradict this thesis. A total of 13 teams satisfied their criteria, but as can be seen these teams were equally likely to be "good" or "poor."

	Good Teams		Average Teams		Poor Teams		Total	
Players	Good	Poor	Good	Poor	Good	Poor	Good	Poor
Number	18	9	11	8	21	16	50	33
Per Cent	26%	13%	35%	26%	34%	26%	31%	21%

Table 6: Number and Per Cent of Good and Poor Players as a Function of Team Effectiveness

	Good Teams	Average Teams	Poor Teams	Average
	Per Cent	Per Cent	Per Cent	Per Cent
E	59	75	66	65
S	57	60	60	59
T	74	67	81	75
J	83	82	81	82

Table 7: Myers-Briggs Temperament Indicators as a Function of Team Effectiveness

Satisfies the EN or IN Plus T, F, P, and J	Good Teams	Average Teams	Poor Teams
Number	6 of 18	1 of 6	6 of 16
Per Cent	33	17	38

Table 8: Per Cent of Teams Satisfying Criteria[6] Proposed for Good Team Make-Up

Discussion

The purpose of this study was to gather data that might lead to a better understanding of what characteristics or combinations of characteristics of team members might make teams more effective. The approach taken was to allow teams to self-select members, to gather information

about the members of each team, to evaluate the team product, and then to determine if the parameters measured could be correlated to the quality of the team product. There were no revelations except that despite the theoretical benefit of diversity of various types, none seemed to be particularly beneficial in assuring improved team effectiveness. However, it is clear that some teams do better than others. In an attempt to learn something constructive about the origins of a team's reduced effectiveness, the statement reproduced in Fig. 2 below was added to the normal end-of-the-semester questionnaire in the sophomore design class in the fall 2004. The number of times a response occurred in the "top three" for any of the 54 students in the class was counted with the results tabulated in Table 9. Sixty-nine per cent of the students selected "conflicting work/class schedules" and 50% selected "long travel distances for meetings" as the

Please place the appropriate numbers ("1" for most effected, "2" for second most effected, etc.) in the spaces to the left of the phrases below that best complete the sentence: **"The effectiveness of my team was reduced because of……**

_____ our inability to establish a team leader
_____ one (or more) disruptive team members
_____ personality conflicts among team members
_____ long travel distances for meetings
_____ one (or more) disinterested team members
_____ conflicting work/class schedules
_____ too many team leaders
_____ _____(fill in any other reason)

Figure 2: Question on End-of-Semester Questionnaire of Design Class in Fall 2004.

# of times	%	Completing Phrase
37	69	conflicting work/class schedules
27	50	long travel distance for meetings
12	22	one (or more) disinterested team member(s)
9	17	personality conflicts among team members
5	9	one (or more) disruptive team member(s)
5	9	our inability to establish a team leader
2	4	lack of time
1	2	too many team leaders
1	2	poor decision making
1	2	arrogance
1	2	lack of resources

Table 9: The Number of Times that the Indicated Response Occurred in the "Top Three". The Responses Completed the Statement, "The Effectiveness of My Team Was Reduced Because of….."

two factors contributing to their team's reduced effectiveness. Leadership, personality, participation, and disruption issues taken together (representing all the remaining factors on the list) accounted for only 59% of the top three factors. (Not all students identified three factors.) To provide a basis by which to better understand these results, the following information, obtained from a class survey at the beginning of the semester, is given. The students in the class worked an average of 16.8 hours a week and were enrolled in an average of 13.7 hours that semester. Few live on campus.

Conclusions

An attempt has been made to identify the desirable characteristics of successful teams. A range of characteristics of the members of the more successful teams were compared to those of the less successful teams. These characteristics included: gender, ethnicity, age, work experience, academic prowess, personality, team citizenship and interest. Few of these characteristics correlated with team effectiveness and even for those that did, the correlation was very weak. In a more informal survey students identified their inability to establish times for team meetings (due to work and school conflicts) and long travel times to attend these meetings as their teams' major obstacles to effectiveness. Personality and leadership issues that are usually cited as critical team issues were cited only about a fourth as often as problems by the students.

Recommendations

Too much time may be spent micro-managing team make-up. For academic situations in which all students tend to be full time and live on campus, have similar life experiences, and exhibit similar life styles perhaps there is value in forming teams with attention to some of the characteristics addressed here (although this study does not even support this practice). However, for other less homogeneous academic situations, it appears that teams can be helped most by providing them with more assistance in scheduling and meeting arrangements.

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