AC 2008-1081: EVALUATING EFFECT OF FIRST YEAR ENGINEERING TEAMS' PERFORMANCE USING THE STRENGTH DEPLOYMENT INVENTORY (SDI) ASSESSMENT TOOL

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Evaluating effect of first year engineering teams' performance using the Strength Deployment Inventory (SDI) assessment tool

Abstract

The Engineering Department at the University of San Diego with the support of Personal Strength Partners (PSP) is currently using Strength Deployment Inventory (SDI), an assessment tool based on the Relationship Awareness Theory of Dr. Elias Porter. The assessment tool is used to educate the team members about each other. The theory behind the tool is that all behavior is based on motivation and that motivation changes in conflict. The tool is intended to provide an effective means for understanding one-self and for understanding others so that interpersonal relationships can be mutually productive. The tool has proven to be essential in enhancing communication and preventing conflict in different types of environments. While Myers Briggs and other assessment tools have previously been used in teaming to understand personality types and preferences, the SDI goes further by identifying the conflict sequence an individual goes through when things are not going well. In addition, SDI provides insight on how peers will potentially respond during the conflict and opposition.

The well known Tuckman model provides stages for team transformation (forming, storming, norming, performing, adjourning). However during short projects such as a semester long course, the model may not be adequate. We need a tool or model to assist teams to become effective and perform in a relative short period of time. Our focus in this study is on the performance evaluation of teams in a classroom environment with a comparison of teams exposed to the SDI tool versus teams with no knowledge of the assessment tool. The SDI team members are expected to learn how to communicate better with their peers through acceptance and appreciation while avoiding conflict which will may deteriorate or delay the success of the team. If conflict is prevented the team is able to reduce the amount of time at the "storming" stage, therefore becoming more effective in a shorter time period.

In this paper, we provide an analysis of the preliminary results based on observation and statistical analysis. The pilot group is comprised of freshman engineering students utilizing the assessment tool to study their effectiveness and hopefully aid in the success of a team assignment. We show examples of the assessment tool as well as activities to assist in the interpretation of results and recommendations.

Introduction

Working in teams has been a vital part of modern engineering practice and has found its way into engineering education. This paper examines the performance of engineering teams in a first year engineering design course that have been exposed to the Strength Deployment Inventory (SDI) tool. Developing teaming skills while in college provides important skills to prepare graduates for the workplace. However, a poor performing team could be detrimental to students experience and learning. In this research we explore the use of the SDI to enhance the team experience in engineering courses.

In reality, individuals working alone are usually ineffective in solving large, complex engineering problems; instead well-trained multidisciplinary teams can address complex problems more productively. Many companies such as GE, Intel, Motorola, General Motors, and others have all publicly stated their commitment to a team-based work environment. ABET EC 2000 Student Outcomes Engineering accreditation criteria, EC2000, state that engineering programs must demonstrate that their graduates have "an ability to function on multi-disciplinary teams". Recognizing the importance of teams in industry, engineering education has begun to focus more effort on this desired student outcome.[1, 2, 3] Experts also agree on the importance of involving undergraduates in teamwork.[4, 5, 6] Seat and Lord observed that while industry seldom complains about the technical skills of engineering graduates, industrial employers and educators are often concerned with performance skills such as interpersonal, communication, and teaming.[7]

The key to a successful team is the ability of each team member to develop their team skills during the life of the team activity or project. The well known Tuckman model provides stages for team transformation (forming, storming, norming, performing, adjourning). However during short projects such as a semester long course, students need additional tools to achieve effective team performance in a relative short period of time. If the students don't go beyond the storming stage or cannot resolve conflicts that arise in a healthy manner, it could hinder their experience.

Our focus is on the performance evaluation of teams in a classroom environment. We did a comparison of teams exposed to the SDI tool versus teams with no knowledge of the assessment tool. The SDI team members were expected to learn how to better communicate with their peers through acceptance and appreciation while avoiding conflict which will usually deteriorate or delay the success of the team. If conflict can be prevented, the team may be able to reduce the amount of time at the "storming" stage, thus becoming more effective in a shorter time period.

Strength Deployment Inventory (SDI)

The SDI is a established tool for improving team effectiveness and reducing the costs of conflict. It is the flagship of assessment tools based on Relationship Awareness — a learning model for effectively and accurately understanding the motive behind behavior.[8]

New ideas, initiatives, and programs all have structure – a framework which provides us with what has to be done to ensure the success of a project. However, it is the people and the way they relate to each other that will dictate the degree of achieved success. Improving the quality of these relationships is where the SDI has immediate and long lasting impact.

The Strength Deployment Inventory is a learning resource that has been proved to be effective in building strong relationships worldwide for more than 25 years. It enables everyone to understand *the reason why* people do things rather than just observe and react to *what* is done. The SDI also identifies personal strengths and motivations for each team member and how these relate to their team. It then demonstrates how to use these strengths effectively to improve working or personal relationships with other team personnel.[9] When things are going well, almost all behavior is an effort to get affirmation of positive worth either in our own eyes or through the response of others. There are seven identifiable styles of relating to others when things are going well for an individual, also called Motivational Value Systems.[10] In SDI, these seven styles are represented by the use of green, red and blue colors or some combination of them. The term "hub" is used to refer to the balance or combination of all three colors.

Using 20 multiple-choice self reporting questions, the SDI calculates the relative importance of separate value systems in an individual. Ten questions the seven Motivational Values Systems (listed below):

- Altruistic-Nurturing (Blues) – concern for the protection, growth and welfare of others.
- Assertive-Directing (Reds) – concern for task accomplishment and organization of resources to achieve results.
- Analytic-Autonomizing (Greens) – concern for well-thought out approaches, order, individualism, and self-reliance.
- Flexible-Cohering (Hubs) – concern for flexibility, group welfare, and team members.
- Assertive-Nurturing (Red-Blues) - concern for the protection, growth and welfare of others through task accomplishment and leadership.
- Judicious-Competing (Red-Greens) – concern for intelligent assertiveness, justice, leadership, order and fairness in competition.
- Cautious-Supporting (Blue-Greens) – concern for affirming and developing self-sufficiency in self and others, concern for thoughtful helpfulness with regard to justice.

The other ten questions determine the individual's conflict sequence. The conflict sequence consists of three stages and behavior changes that one goes when in conflict. For example, if an individual Motivational Value Style is Red, they do not necessarily exhibit Red behavior during the first stage. Instead, they might go from Blue to Red to Green or any other combination. The three stages of conflict are:

- Stage 1 – Focus on self, problem and others
- Stage 2 – Focus on Self and problem
- Stage 3 – Focus on self

Understanding these styles helps anticipate others' reactions to difficult situations to provide strategies for altering traditional approaches.[11] This is vital information because it means we can understand why certain people have the impact on us they do and how we may be impacting them! Furthermore, we learn how to recognize the real issues in relationships and how to tailor our language accordingly to communicate in more flexible and effective ways.

Recognizing and dealing with inter-personal conflict is a crucial element in all relationships especially within teams. The SDI provides insights into how to recognize the first signs of conflict in others and shows how to respond appropriately to resolve the dispute before it gets out of hand or unwittingly causes further antagonism.[9] The SDI can reduce the amount of time an engineering team member spends resolving conflict and ultimately reduces the amount of time a team spends at the "storming" stage.

Data Collection

The study consisted of a survey distributed to first year students in the University of San Diego Engineering Department. The course, ENGR 102 – Intro to Engineering Design and Practice, consisted of three separate sections. One section was given the SDI assessment tool to introduce students to the concept of "Relationship Awareness" while the other two sections were not exposed to the assessment tool. The total number of students participating in study is 48 with 17 students in the control group. The semester-long design project consisted of teams with three or four team members working together from 4 to 8 hours per week. This project introduces freshmen engineers to the design process while emulating the methods followed by practicing engineers. They propose, implement, and document the design of a computer controlled electromechanical system made using fischertechnik components.[12] The project provided an opportunity for students to encounter common team building concerns such as time conflicts with several project milestones. It also provided the instructors a great avenue to collect and compare team dynamics. We gave the following survey to all students in ENGR 102.

Team Survey Questions:

1. All members worked together without conflicts most of the project
2. Our team worked effectively together
3. Working as a team on this project was a positive experience
4. Our team developed cohesiveness as the project progressed
5. We subdivide the work effectively
6. We resolved conflict easy and did not affect the outcome
7. The team worked toward solutions and compromises that were acceptable
8. Team member encourage ideas and opinions even when they differ from his/her own
9. Team members accept criticism openly and non-defensively
10. Team members helped each other reconcile differences of opinion
11. Team members listened attentively to others without interrupting
12. Look forward to working in other team projects in the future

Each question on the survey would be ranked on a scale from 1 to 5 with the following descriptions; (1) Strongly Disagree, (2) Disagree, (3) Average, (4) Agree, and (5) Strongly Agree.

Analysis

The goal of the analysis is to determine if providing the SDI assessment tool had any effect on student teams' awareness of relationships while participating on the semester-long engineering design project. Our hypothesis is that administering the SDI assessment tool does have a positive impact on their team awareness. Our analysis begins with analyzing each section of the engineering class as a whole and then determining which individual questions have the largest impact.

The first step was to look at the three section's question averages in order to search for any anomalies. Table 1 shows the different class sections broken down by questions with their respective student average scores. Since it is difficult to see any trends or patterns, in the data table directly, we performed several graphing techniques to shed light on the data.

Table 1. Average of Student's Scores in each Class Section by Question

	Class Sections			
	SDI	Class 1	Class 2	Class 1&2
Question	Avg	Avg	Avg	Avg
1	4.24	3.61	4.15	3.88
2	4.41	3.61	4.31	3.96
3	4.65	3.56	4.23	3.89
4	4.65	3.61	4.23	3.92
5	4.29	3.44	3.85	3.65
6	4.35	3.61	4.00	3.81
7	4.71	3.72	4.54	4.13
8	4.53	3.67	4.31	3.99
9	4.29	3.39	4.23	3.81
10	4.12	3.78	4.23	4.00
11	4.24	3.56	4.23	3.89
12	4.41	3.39	3.92	3.66
Std Dev	0.19	0.12	0.19	0.14
Average	4.41	3.58	4.19	3.88

The first diagram used was the boxplot, which graphically displays the central tendency and variability of each class section. Based on the boxplot in Figure 1, it appears that the overall average student score is higher for the control group (SDI) than the other two sections. The boxplot on the right combines the two sections in one group to compare against the control group. It appears that the control group section has a higher average score than the other sections. Although, one would argue that the graph is subjective. A statistical hypothesis test was performed on the question average scores to determine if in fact there is a statistical difference between the control group and the other sections. The t-test showed that the two groups were statistically different based on a p-value of approximately zero, therefore, one could conclude that administering the SDI awareness seminar would increase their team survey scores and ultimately have a positive affect on students and their teams.

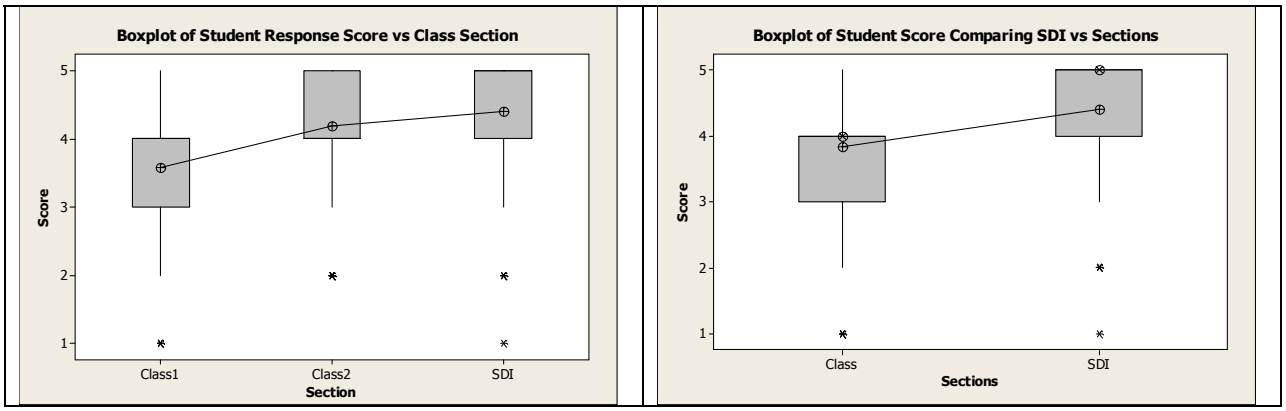

Figure 1. Boxplots of Student Scores for Individual and Combined Class Sections

The next step was to inquire which questions had the largest impact on the overall score averages. Initially, the student scores were plotted to observe any possible trends over each question. The line plot below in Figure 2 shows each of the student section scores for each question. The graph shows that on average the SDI group has higher scores for each question as compared to the other two sections. A Pareto Chart of the question score differences

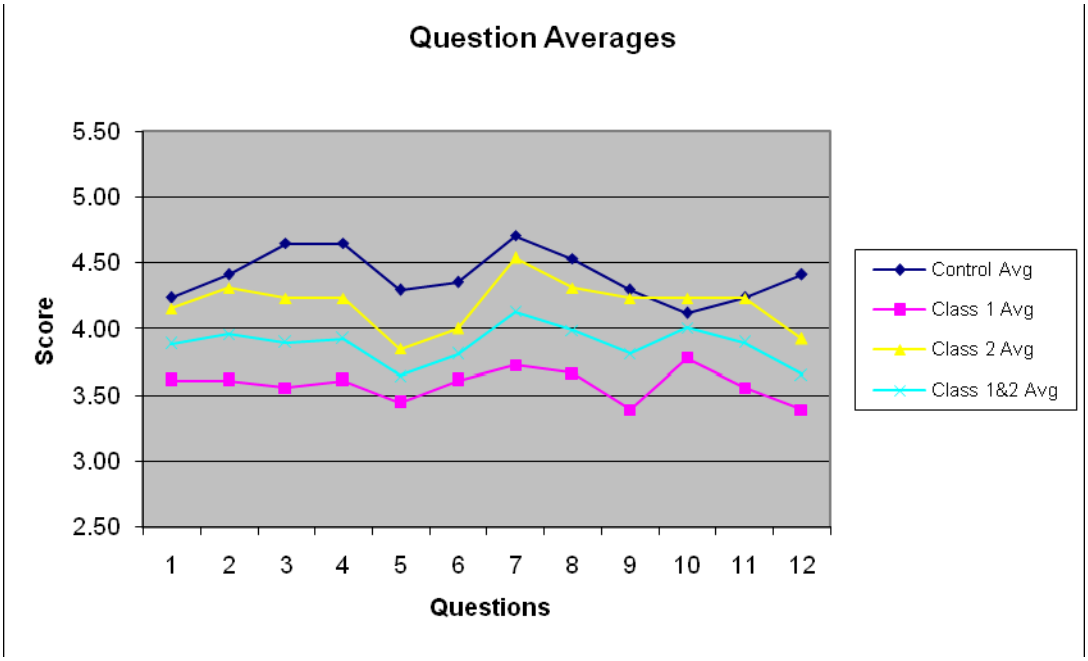

Figure 2. Line Chart of Question Scores by Class Section

was created to show which questions have the largest absolute difference between the control group and the other sections. In Figure 3, the disparity between the two groups for each question is shown.

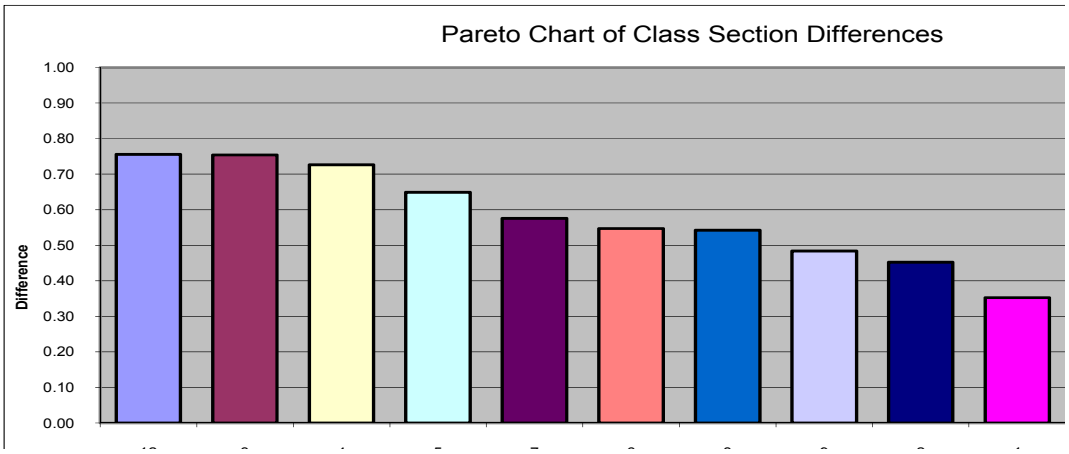

Figure 3. Pareto Chart of Questions: Class Section Differences

Questions 12, 3, and 4 all exhibited differences greater than 0.70. The next step would be to investigate each question in greater detail. The questions that showed the largest difference include:

3. Working as a team on this project was a positive experience
4. Our team developed cohesiveness as the project progressed
12. Look forward to working in other team projects in the future

A hypothesis test (t-test) was performed on these three questions to determine if the difference was statistically significant. Based on a critical value (alpha) equal to 0.05, all three questions were considered significant showing the impact of administering the SDI tool.

Conclusion

This paper examines the use of the SDI as a tool to provide an effective means for understanding one-self and others so that interpersonal relationships can be mutually productive in an engineering team.

As we discussed in the analysis, one could conclude that administering the SDI assessment prior to team activities would increase their individual team survey assessment score at the end of the project and ultimately have a positive affect on students and their teams.

The SDI could be an asset in semester long projects when performance is needed in a relatively short period of time. As can be seen from the analysis, students that received the assessment, have reported a more positive experience, higher team cohesiveness, and looking forward to future team projects that those who did not receive the SDI assessment. These differences were statistically significant.

Even with this success, a great deal of work remains to be done. Further experimentation is currently underway at USD to reinforce the findings. Future collaboration with other educational researchers will offer a greater and more rapid understanding of this tool in the academic

environment. This will lead to enhancing not only the students' teaming experience but the engineering learning environment.

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