Training Engineering Upperclassmen to Facilitate Freshman Design Teams

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Introduction

As part of a comprehensive effort to redesign the freshman basic engineering curriculum, members of the College of Engineering at the University of Tennessee are utilizing design teams in first year engineering courses. Industry representatives and faculty who teach engineering design have suggested that freshmen in engineering could benefit from early exposure to a team based design component.[1,2] 60 freshman students were divided into twelve design teams to work on five design problems over the course of the semester. However, there was some concern about the teamwork skill level of the average entering freshman. It was decided that one way to help build the teamwork skills necessary to complete the problems would be to place a group facilitator with each design team.

Because of financial realities and to offer engineering students additional educational opportunities, it was decided to use engineering upperclassmen as facilitators. Therefore, members of the College of Education and the College of Engineering at the University of Tennessee designed a facilitator training program for engineering students. The training program was taught through the College of Education as a pilot course for engineering honors upperclassmen during the Fall semester of 1997. The program ran with eighteen facilitators.

Program Design

The design of the training program followed principles set forth by Goldstein[3] and incorporated two main phases: developing learning objectives and structuring the training environment.

Learning Objectives. Specifying a skills set necessary for group facilitation has been much discussed in the literature.[4,5,6] Several useful books have been published on the subject.[7,8,9,10] When evaluating these various skills sets four themes consistently emerged. These recurring themes became the learning objectives of the training program and can be specified as follows: (1) understanding the team, (2) facilitating structure, (3) problem solving, and (4) building cohesion.

The first skill base, understanding the team, focused on observing and diagnosing team dynamics and choosing interventions. Trainees learned team observation and diagnosis skills by observing other trainees working in group simulations and by working with various assessment tools such as the Myers-Briggs Type Indicator.[11] Also, facilitators were taught the relationships between various diagnoses and appropriate interventions. Finally, facilitators were taught the appropriate skills for deciding if a situation warrants intervention.

The second skills base, facilitating structure, was geared towards helping teams accomplish the task. Facilitators learned skills to help teams begin and end team meetings. They also learned how to set and negotiate an agenda, keep a team discussion focused, and help teams set up timelines. Because of the level of knowledge about engineering that these facilitators had, special care was taken in teaching this skills base to instruct trainees that they were not to influence the actual content of the project.

The third skills base, problem solving, was also geared toward helping teams accomplish the task. Teams were taught standard problem solving steps for design teams.[12] Facilitators were also taught how to help teams work through each of these problem-solving steps. For example, facilitators ran brainstorming exercises with their teams to help team members generate ideas and postpone critical evaluation.

The fourth skills base, building cohesion, focused on the social and interpersonal aspects of the team. Facilitators were shown how to encourage participation by asking team members to anonymously rate others contributions to the team.[13] This information would then be averaged and fed back to the teams. Facilitators also attempted to build communication skills by teaching team members how to listen to one another and express their viewpoint to the rest of the team. Finally, facilitators attempted to help team members resolve conflict by urging team members to "get their problems out on the table" and process them while differences were still minor.

The training environment. The training program was offered as a class designated as a humanities elective for engineering students and offered through the Counselor Education and Counseling Psychology Unit (CECP) in the College of Education. The program was team taught by members of CECP, the College of Engineering, and the University Counseling Center. Using suggestions by Pearson[14] and Harvill, Masson, and Jacobs,[15] training was conducted twice weekly in two hour blocks. The first block was an hour on theory of facilitation and mainly utilized a lecture and discussion format. The second hour long block was structured as a lab on facilitation technique and included a number of hands on instructional methods. For example, students participated in and observed group desert survival simulations to help them experience group dynamics and build observation skills. These exercises were designed to illustrate facilitation techniques and placed the trainees in different roles and staged situations. Video was frequently made use of as an instructional tool. Training films on facilitation and team building were shown. Also, facilitators were shown clips of working groups in movies and asked to analyze these groups for their various group dynamics.[16] In the final portion of the lab, facilitators planned a tentative agenda to use when they next met with their freshman design teams.

Trainees met the next two hour block later in the week. In the first hour, facilitators met with their freshman design teams to practice the theory and technique of facilitation. In these team meetings facilitators used both structured and unstructured approaches. Using more structured approaches, facilitators would engage the team members in some of the same structured training exercises in which they had participated earlier in the week. These exercises were for the purposes of illustrating some principle of team work. Working in a more unstructured fashion, facilitators would observe team members working on their project and intervene when they deemed it necessary. In the final one hour block facilitators would break up into smaller groups and meet with an instructor from the training team to process their previous meeting. The rationale for this meeting was based on research provided by Gladding who demonstrated that facilitators who met with supervisors to process their group meetings

developed at a faster rate than those who do not have supervision. The structure of these meetings was to allow the facilitators to process their efforts with each other, and to turn to each other for solutions to their problems.

Program Evaluation

An evaluation of this program followed a format established by Cascio.[17] Although this evaluation program has many facets, this paper will focus on two important criteria. The first is trainees' subjective reactions to the training program as measured by a feedback form given at the end of the semester.

In addition to subjective reactions, the researchers wished to evaluate the freshman design teams according to selected dimensions of group performance. The dimensions selected for evaluation purposes were from theory and instrumentation developed by Bales.[18] He proposed that two important components of a team's dynamics can be assessed by obtaining individual team members' scores on two scales measuring task orientation and team orientation. Task orientation scores refer to a team member's acceptance of and desire to perform correctly the procedures set up by external authorities. High scorers on this dimension are very concerned with doing things in the prescribed manner. Lower scorers on the task orientation scale can be characterized as more interested in challenging established procedures, preferring to innovate or change the existing order of things. Lower scorers can also be less interested in the organization of the task. Team orientation scores discriminate between group members who behave in a more self-interested and self-protective way on the lower end of the scale and those who are more cooperative and protective of others on the high end.

Bales[19] has found that the most effective teams consistently have positive scores on both scales. Also, Knight et al.[20] used the scales with senior level students in engineering design teams. Using both facilitated and unfacilitated teams, these researchers found that only facilitated teams maintained consistent team orientation scores, while unfacilitated teams reported a significant drop in team orientation scores. Both facilitated and unfacilitated teams were able to maintain consistently positive task orientation scores. Based on these findings, the researchers expected that the facilitated freshman design teams would maintain positive task and team orientation scores throughout the semester.

Procedure

The participants in this study were 18 engineering upperclassmen who had signed up for the facilitation program and 60 freshman students in basic engineering. Of the 18 upperclassmen six were female. All were Caucasian. Of the 60 freshman eleven were female, two were African-American, and one was oriental.

A subjective reaction form for the training program was developed for the facilitators based on suggestions by Goldstein.[3] The form asked a number of broad questions about the various elements of the program. First they were asked if the learning objectives were appropriate in terms of the skills that were necessary for them to facilitate. Next they were asked about the structure of the learning environment. Specifically, they were asked about the distribution of training time into the four one hour blocks, and what techniques worked most and least well in each of these blocks. Finally, they were asked for an overall summary of their

experience. The response format was designed to be essay style and instructions encouraged the facilitators to provide lengthy feedback.

Members of the freshman design teams were given scales developed by Bales. to measure task and team orientation. These scales are measured by an eighteen item adjective checklist. Respondents are asked to rate themselves according to how they see themselves in their team. Each of the eighteen items consists of an adjective followed by a series of five responses ranging from "never" to "always". The adjective checklist yields scores with a possible range of -18 to +18 on each scale. Both the task and team orientation scales have demonstrated acceptable internal consistency and interrater reliability estimates. In addition, evidence for the concurrent and construct validity of the scales has been established.[21 22]

Prior to the beginning of the semester 60 entering freshman students were chosen as a stratified random sample of the incoming freshman population. These students were assigned to teams during the first part of the semester. Freshman and facilitators were assigned to teams according to demographic variables and scores on the Myers-Briggs Type Indicator. According to suggestions by Kroeger and Thuesen[23] efforts were made to ensure as much diversity as possible on each team. Facilitators met with their teams one hour per week for 16 weeks. The freshman design team members were administered the task and team orientation scales at the beginning of the semester and at the end following the presentation of their final design project. Facilitators were administered the subjective feedback form during the final week of class. They were instructed to take as much time as they need to fill out the reaction form.

Results

In filling out the subjective feedback forms the engineering students were typically thorough. When transcribed, their feedback collectively comprised 35 pages of text with an array of answers on all facets of the program. Turning to the skills set specified in the learning objectives, several facilitators commented on the helpfulness of learning about and applying information on team members' scores on the Myers-Briggs Type Indicator. One facilitator reported, "The Myers-Briggs area was most useful for me in dealing with my group. It helped me understand where members of my group were coming from. In addition, I was able to define group roles early on". Also, facilitators commented on the section on learning to facilitate structure. One reported, “The topics relating to structure were the most readily applicable to my group. My team members, like most college freshman, have not yet established structured time management, and study skills”. One skill area that consistently came up as needing an expanded focus was the ability to generate more team buy-in of the facilitation. One facilitator commented, "When they finally understood why we were there and that we actually could help out, I felt very pleased/relieved/accomplished with the work I had done. This took a few weeks, but after it happened I felt as though this class was actually beneficial to them and us."

When considering the structure of the learning environment, facilitators expressed a range of opinions. The thoughts of many of the trainees were expressed by the following facilitator. "More time with the groups would help a great deal. I would suggest meeting with the group for one hour twice a week, spend one hour in discussion about those meetings, and spend one hour in applications and exercises about the reading material. Essentially, this would involve replacing the first hour of Tuesday's class with a team meeting."

When working with the teams facilitators reported more success with observation and commenting on the team's work than with running structured facilitation exercises. One said, "The best thing we did was to tell our group what we observed. This really affected certain individuals' perspectives." Conversely, one said, "Group (facilitation) activities tended to not work so well. They were usually very focused and eager to work (on their design projects) in the meetings. They were never hostile towards my activities, but they were always more focused on the project than the activity."

Facilitators also saw the supervision meetings as necessary. " I definitely think the supervision is needed. It was good to be able to discuss problems and accomplishments immediately after the meetings. Hearing the others' problems and discussing possible solutions helped me to head off trouble in my own group".

Finally, almost all facilitators gave an overall positive evaluation to the training experience in terms of learning how to better work in groups. One commented, "This experience has been one of my most valuable at the University of Tennessee. No other single course I have taken at the university has as much application in my career and my life as this one does". Another commented, “This class has been one of the most profitable classes, as an elective, I have taken while in college. I has given me valuable insight into team and group facilitating that are very valuable in the world today.”

One of the more unexpected findings was how helpful the skills were for facilitators in other areas of their life. "My listening and discussion skills have improved considerably as well as my understanding of others." Also, "Although the focus was on facilitating a freshman team, I learned a lot about myself in the process". And finally, "I learned a tremendous amount about how to deal with people in groups and in my everyday life as well".

In addition to the forms filled out by the trainees, reaction forms about the facilitators were given to the 60 members of the twelve freshman design teams. Eight of the twelve teams reported a favorable reaction to the facilitation. Three of the teams were neutral to negative. Finally, one team was completely negative on the facilitation. Given that this program was a pilot program with inexperienced facilitators, the researchers considered a 75% satisfaction rate with the teams to be a successful start.

Some of the positive comments students had were related to communication: “They helped us to cooperate as a team” and “Helped us to learn to listen to one another’s ideas and be more open to them”. Team members also commented on the help facilitators gave with structuring the project: “He was a great help in keeping our team together and on task. He was always there for us whenever we needed him, even out of class”. Finally, team members appreciated the facilitators objectivity: “The best thing about having him on the team was having someone with a neutral standpoint to keep us all off each other’s back”. Suggestions for improvement to the facilitator program included more time with the facilitators so that they could become a more integral part of the project. Also, team members wished for less emphasis on structured activities, and more observation and feedback during the actual working process.

Turning to the performance of the design teams, data on the team orientation and task orientation measures was subjected to a paired sample T-test analysis. As shown in Table 1, team orientation scores were as expected. They were positive and no significant difference was

found between the two testing periods. Task orientation scores were also positive. However, there was a significant difference between testing times for the task orientation scale. Specifically, task orientation showed a significant drop between the first and second testing.

Discussion

These results provided a broad base of subjective feedback to be fed into the design of the next year's facilitator training program in the fall of 1998. In addition, these results provided partial support for our expectations that with the help of facilitation, freshman teams would maintain consistent scores on a measure of their cooperation, positive attitude, and general orientation toward their team. This was consistent with previous research by Knight et al.with engineering design teams that found that facilitated engineering design teams maintain positive task orientation scores across a semester. However, an unexpected result was that design teams did
not maintain consistent task orientation scores throughout the semester.

Two explanations for these results were considered. First, freshman task orientation scores were initially much higher at the pre-test ($\underline{X}$ = 3.60 vs. $\underline{X}$ = 2.92) than a comparable group of senior engineering students. This would seem to indicate that while entering freshman were initially obeying the professors exact instructions, over the semester, they matured to be able to think more for themselves and challenge the professors assumptions.

Another possible explanation for the drop in task orientation scores is that the facilitators needed to place more emphasis on task orientation and structural components of the project. While a structural component was included in the learning objectives, more emphasis was placed on the types of interpersonal skills which would produce a positive team orientation. Again, the emphasis on team orientation skills was based on the data from the senior engineering design students where it was found that senior level engineering design students did not need facilitation to maintain task orientation scores. As mentioned in the previous section, several facilitators did report that they found the skills related to facilitating structure to be helpful. Perhaps freshman students do not have the organizational skills of senior level engineering students, and more facilitation efforts should be made in this area.

Future Research

Suggestions for future research would include increasing the subject number and including a control group. In response to these suggestions next year's research program will make use of a larger sample size. The 1998-1999 basic engineering class will be scaled up to include 150 members and 30 facilitators. During the 1999-2000 class, when approximately 400 freshmen will be involved in the new freshman curriculum, it is planned to designate a control group of 40 unfacilitated freshman teams. These unfacilitated students will be compared to 40 facilitated teams on a number of dimensions of team performance in order to fully understand the implications of placing facilitators with freshman design teams.

The data collected from the facilitators' subjective evaluations and indices of design team performance is being used to develop the program for re-administration in the fall of 1998. Efforts are being made to further develop the elements of the program which appeared most effective and to respond to criticisms. Specifically, more training will be provided on the Myers-

Table 1
Means for task orientation and team orientation

	Task pre	Task post	Change	Team pre	Team post	Change
Team 1	1.93	2.64	.71	7.29	8.36	1.07
Team 2	2.67	2.42	-.25	7.33	6.33	-1.00
Team 3	2.50	1.58	-.92	7.50	6.50	-1.00
Team 4	4.07	2.08	-1.99	6.29	8.58	2.29
Team 5	4.17	2.93	-1.24	7.00	7.57	.57
Team 6	3.08	1.75	-1.33	8.50	8.50	.00
Team 7	3.25	2.50	-.75	5.50	7.75	2.25
Team 8	1.50	1.75	.25	9.08	6.25	-2.83
Team 9	3.25	2.50	-.75	8.50	9.33	.83
Team 10	2.83	1.67	-1.16	7.17	5.75	-1.42
Team 11	2.50	1.00	-1.50	8.14	10.25	2.11
Team 12	3.20	2.40	-.80	10.70	9.40	-1.30
Total	3.60	2.45	-1.15**	7.60	7.58	.02

n=60 **p≤.05

Briggs as it was well received. Also, there will be more instruction on techniques to help with project structure.

Summary

As part of the effort to redesign the basic freshman engineering curriculum, an inter-disciplinary training program was created to train engineering upperclassman to facilitate freshman engineering design teams. The program uses multiple instructors and a number of instructional tools to teach sections on theory of facilitation and facilitation technique. Facilitators spend one hour each week with their team and the next hour processing this meeting with course instructors. Results indicate a general level of satisfaction with this program. Also, freshman design teams maintained a consistently positive orientation toward their team throughout the semester. The researchers plan to use this information to further the design of the training program which is expected to be run in the fall of 1998. Also, the researchers are planning a refinement of the evaluation process using additional team performance measures.

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