

# An Assessment of Teamwork in Projected-based Instruction

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**Abstract** <sup>3/4</sup>This paper presents an assessment of the project-based learning process in an engineering design course at National Central University in Taiwan. To evaluate students' development toward becoming engineering professionals, an assessment system which analyzed web-pages, pre-interview surveys, individual interviews and reflective journals was used for this senior design course. These four elements would present an integrated view of the important components of the teamwork process, and they can be used for continuous improvement in following semesters.

## I. INTRODUCTION

### 1. Rationale of Project-based learning

Project-based learning emphasizes peer learning and active participation (Baillie & Walker, 1998; Blicblau & Steiner, 1998). However, many university students have never worked in a group before. Even at the college level, students receive little training on how to work as a team, and only students who have been in a work environment realize that most projects in industrial environment require group effort. Therefore, our goals for this project-based course are to:

- Encourage students to choose topics related to their backgrounds, and
- Help students to become empowered as individuals by contributing to and learning from collaborative group efforts (Cabera, A. F., Colbeck, C. L., & Terenzini, P. T. (2001).

During the course, students worked in teams to carry through mechanical design and testing of their prototypes (Hsiau et al., 2000). We also encouraged students to make presentations to the class in order to learn how to analyze a problem, and most importantly, how to communicate the results of their analysis and synthesis to the class.

### 2. Integrate Portfolios into Curriculum Planning

Engineering education's current interest in using portfolios of student work has been driven by the adoption of the U. S. Accreditation Board for Engineering and Technology's (ABET) Criteria 2000 ( McGourty, Sebastian,

& Swart, 1998). In this document, portfolios are mentioned as one way to document and assess students' perceptions of course content (Rogers & Williams, 2001).

This course also provided opportunity for students to design their own web site, and encouraged them to use their portfolios as they pursue a master degree, and seek internships or employment after graduation. Some of the primary purposes of developing a portfolio are to develop a stronger sense of personal responsibility for learning, increased motivation to achieve results and reach goals, and heightened interest in learning (Wiedmer, 2000). For students, the portfolio was presented as a means of documenting their thought process in identifying their motivation for choosing engineering, choosing areas of interest within engineering, and learning fundamental concepts involving engineering design. Portfolios are also a useful tool for assessing learning because they require students to review their work and engage in a process of reflection, selection, and description (Christy & Lima, 2001). For teachers, our objectives were to evaluate the success of portfolios in curriculum planning, to reflect on the use of this instrument, and to make recommendations for future work.

## II. SETTINGS FOR STUDENT COOPERATION AND TEAMWORK PROCESSES

### 1. Student Discussion Groups

In order to stimulate creative and effective learning from teaching others, we first divided the students into groups of three to five students, with each group taking the roles of presenters and observers in turn. Generally the presenting group had the same members of the corresponding project design team. The presenting groups summarized the results of their work, highlighting key progress related to the design project, after which the observing group then made suggestions as to how the project might have functioned more effectively.

The student work groups not only create opportunities for students to learn from one another, but also enable students to participate and interact. The emphasis of this approach is to take responsibility as an active learner and to

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develop the ability to ask questions and make comments about the projects of the other groups.

### 2. Interactions via Internet

We employed a web-based learning environment called the *creativity activity bulletin board* as the basis to deal with students' difficulties that emerged during problem solving. The key concept of the bulletin board was to be responsive to students' comments and help them with their problems on-line. The purposes of the creativity activity board were:

- To encourage students to seek help from teachers as well as from peers and thereby examine their problems from various perspectives.
- To monitor and encourage participation, and
- To foster informal interactions and immediate feedback between teachers and students.

The bulletin board was an area for students to discuss a particular topic, to post messages, and to share information or experiences with others. In addition, it allowed the participants to contribute ideas at different points in time. The ideas generated by these participants were stored in the board and could be accessed by other participants at their convenience.

## III. METHODOLOGY

### 1. Sample

Fifty students who were university junior or seniors enrolled in the course called, "Open-ended Creative Mechanical Design" as a part of this study. Before entering this course, they had taken certain courses (e.g., fluid dynamics, ergonomics, mechatronics, etc.) completed in the first two years after they entered college. This shared knowledge base and common experience allowed them to share problems with one another and thereby to develop a community of learners (Chang, et al, 2000; Hsiau, 1998).

### 2. Data Collection

To begin observing students in the process of becoming engineering professionals, an assessment system which consists of content analysis of web-page, the pre-interview survey, interview and reflective journals are chosen to be the key elements of the assessment plan for this senior design course. Researchers (Besterfield, Atman & Shuman, 1998) indicate that these three methods would best represent an integrated view of the various important components of the teamwork process. Furthermore, they will be used and applied for continuous improvement from semester to semester.

## FINDINGS

### 1. Questionnaire for the teamwork process of the course

For the questionnaire, we divided the education aspect of group discussion into four parts:

- (A6.1) frequency of attendance at meetings,
- (A6.2) listening to group members' opinions,
- (A6.3) ability to provide one's own ideas, and
- (A6.4) cooperation within the group.

From the data of the questionnaires, 80.4% of the students considered that group cooperation was helpful to the project, indicating that group cooperation would be a good strategy to foster students' learning.

Under the significance level of 0.01, both Kendall's rank correlation analysis and Spearman's rank correlation analysis show that (A6.2) listening to group members' opinions and (A6.3) being able to provide one's own ideas were significantly correlated, with correlation coefficient of 0.422 and 0.429. That is, students who are willing to listen to others' opinions also tend to contribute their ideas more during the group discussion.

In general, most of the students did well on "the frequency of meeting attendance", "listening to the opinions of other group members" and "providing their own ideas positively" in group meetings. However, the attitude of attending in meetings cannot indicate the actual working effect. That is, factors that influence results not only depend on students' ability, but also the group cooperation and the interactions between group members. Furthermore, the interactions between group members and the group cooperation are positively correlated. Therefore, the cooperation between group members is more important during the process of project design.

In the course evaluation, we listed the following six criteria for the students to determine the scores for each part:

- attitude of interactions on the internet;
- contents of project memoir and creative thinking process;
- class participation;
- production of the project;
- supervising effects of observation groups; and
- peer evaluation among group members.

After collecting the questionnaires, we compared the students' own evaluation as shown the following table:

|                            | attitude of making discussions on net | contents of project memoir and creative thinking process | Class participation | Production of the project | the supervising effects of observation groups | peer evaluation by group members |
|----------------------------|---------------------------------------|--|---------------------|---------------------------|---|----------------------------------|
| Course evaluation standard | 17 %                                  | 21 %   | 13 %                | 33 %                      | 8 %   | 8 %                              |
| Average of questionnaires  | 11 %                                  | 19 %   | 17 %                | 30 %                      | 11 %  | 12 %                             |

As the above table indicates, the percentages of the criteria for the grading suggested by the students are almost

the same as the original evaluation standard set by the teachers, with only slightly differences in the attitude of internet discussion, the peer evaluation among group members, and class participation. Apparently, students' attitude towards discussion on the Internet is not active. The reasons might be:

(1). Group members did not actually need to discuss on the Internet: Because the students formed their groups by themselves, and most of the group members were classmates or roommates, therefore they were reluctant to discuss the problems of their projects via the Internet. In addition, since most of the students were busy doing the project, they did not have extra time to check other groups' web pages to discuss the contents, progress and problems. (2). Unable to receive immediate feedback: At the beginning, we invited expert professors and experienced older schoolmates who could offer professional solutions and suggestions to serve on the net.

However, this situation didn't last long. By the end of this semester, professors did not serve on the net very enthusiastically and couldn't promptly offer help, so the students had less motivation to discuss via Internet. Since the web interaction is not as effective as in-class activities or face-to-face discussions, students accordingly scored it lower.

## 2. Interview results

The students' reactions, enjoyment and insights were presented as follows:

Most students thought that teamwork was very valuable because their strengths and weaknesses were gradually identified during the group process. Through group discussion, the students compensated for their weaknesses and developed more ideas from one another. Therefore, they felt a sense of involvement and commitment to the project. Many of students said that sometimes it was hard to find a solution by independent work. They also said that it would be easier to perceive the problem more widely and see it from different perspectives by using group discussion. In addition, group discussion not only helped to clarify their own misconceptions, but the students indicated that it was a more enjoyable experiences than solitary study.

During the discussion process, some students were willing to seek help from peers, and thereby learned valuable insights from one another. It was at this point that they started to focus on the improvement of their skills and learn from previous mistakes. Their enjoyment came from sharing the success of their intra-team achievements. For instance, although one student initially was confused by the opened-ended nature of divergent thinking, the process of interacting with peers led him to feel that he was very interested in and challenged by the demands of divergent thinking and eventually increased his potential to develop his problem-finding ability.

## 3. Content analysis of reflective journals

Finally, we analyze the reflective journals on the web page and the process of creative thinking that relate to group cooperation, and compare with the above questionnaire results.

| Group | Method   |
|-------|--|
|       | At the beginning, we weren't very devoted to this project. Although we each had got our own job, we didn't do our jobs because we didn't have the same free time. Afterwards, we decided to divide the group in two, and then we could call a meeting more easily and more efficient.  |
|       | At the very beginning, we had already distributed our jobs. However, we faced a problem with circuit, so we decided to ask the parents of one of our members. Later on, the problem was solved, but our project was delayed for several days. Unfortunately, we dropped the circuit board by accident, so we couldn't continue our original project. We changed our project a month before the deadline, but fortunately, the final project was easier. Finally, we finished our project positively and nervously. |
|       | One of our group members thought about the topic of the project, he asked all the others' opinions and then we did it together. During the process of group cooperation, some group members weren't very happy because they had to do more work.   |
|       | When we meet the third time, we divided our group members into three groups, but most of the time, we made the appointment distributing jobs, and then discussed it in group.  |
|       | After deciding the topic, we started to imagine how to design this project, but during the process, the project seemed to be delayed. At last, we divided our group into two smaller groups: background and base. We hope it can be more efficient.  |
|       | At the very beginning, we did well on group cooperation. During the process, we worked in smaller groups again and again.  |
|       | We worked well on doing our own jobs, and we kept it till the last moment.   |
|       | Doing our own jobs and group participation interact ed well in our group.  |
|       | At first, the group leader did all the work. Then we got some problems, and that made the leader quit. Therefore, we started to distribute the work. All the work began going more smoothly.   |
|       | We distributed the work carefully, and all of our group members participated well.   |
|       | We distributed the work well, and mostly all the group members acted together.   |

From the above content analysis of the web pages of the eleven groups, we discover that if the students didn't distribute the work among the group, it seemed that everybody would delay repeatedly, and wouldn't have the commitment to keep up with the scheduled progress (e.g., group 1 and 5). Or, in one group, the students couldn't do well on their work, always troubled other members for help and end up delaying the whole team (e.g., group 3). And the groups that distributed better would check their work schedule in every meeting, and then distributed the work for next time and schedule the next meeting (e.g., group 6, 7, 8

and 10). The results conform to the non-significantly correlation of the attitude during group discussion and the results of project design.

Furthermore, based on the content analysis of students' journals, we conclude that the teamwork process of the projects began with the topic that they discussed during the meetings, after which they contacted factory owners, received suggestions from those practitioners, and then modified their prototypes afterwards. When they encountered problems, they often went back to the factory owner for answers. Gradually, they became more aware of the professional theory by hands-on development of the products. From this process, there are four characteristics revealed by more successful groups: (1) seeking information more broadly and in-depth; (2) develop more alternative problem-solving strategies; (3) demonstrate more effective use of teamwork skills; and (4) provide more feedback toward other's projects.

#### 4. Overall Abilities Students Learned From the Course

In the questionnaires of class evaluation, we asked students to arrange the following six elements based on their importance: (a) interpersonal communication; (b) group cooperation; (c) leadership; (d) skills of oral presentation; and (e) method of report writing. The most beneficial element received 5 points, and the rest of them get 4, 3, 2, and 1 subsequently.

|       | interpersonal communication | group cooperation | Leadership | skills of oral presentation | methods of report writing |
|-------|-----------------------------|-------------------|------------|-----------------------------|---------------------------|
| Total | 148                         | 177               | 126        | 164                         | 150                       |

From the above list, we can find out that the orders of benefits from this course are

group cooperation □ skills of oral presentation □ methods of report writing □ interpersonal communication □ leadership. However, during the interviews, we also found that these engineering students had had very few opportunities to make a oral presentation in this class because of the larger number of members in each group.

In addition, students indicated that they had gained other abilities, such as learning different kinds of thinking styles, hands-on design skills, etc. Because in this course the students divide the groups, distribute the works, and choose topics all by themselves, thereby they tend to learn in a non-authoritative environment. Therefore, they are more willing to spend their time and energy to implement their projects. In turn, they achieve high satisfaction and sense of achievement at the end of the class.

## IV: CONCLUSION AND FUTURE IMPROVEMENTS

The findings generated by the survey, interviews, and reflective journals can add to our understanding of rewards inherent in students' teamwork and can provide information that suggests how the instructional activities might be made more enjoyable, meaningful, and productive. The four characteristics of the more successful groups are: (1) seek information more broadly and in-depth; (2) develop more alternative problem-solving strategies; (3) demonstrate more effective use of teamwork skills; and (4) provide more feedback toward other's projects.

In the future, we plan to collect further information through our school's alumni to obtain some suggestions to modify, renew and improve the course according to industrial needs. Regarding the problems of group cooperation and distribution and interactions among group members, we can introduce useful techniques of group dynamics to improve the interactions of group members.

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