

## **Factors Affecting the Team Formation and Work in Project Based Learning (PBL) for Multidisciplinary Engineering Subjects**

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### **ABSTRACT**

*The main challenges facing a project based learning (PBL) facilitator in our institution is addressed here in team forming for multidisciplinary PBL subjects of diploma students in mechanical and civil engineering. These challenges include the type of projects, how to team up students, how to proceed with planning, how to swap planning outputs among teams, and how to proceed with implementation of a project. Having executed several multidisciplinary subjects over few years in our institution, a survey was conducted from the facilitators and students at the school of engineering to identify the main concerns of both facilitators and students in creating teams and maintaining teamwork to tackle a real life engineering problem. A questioner consist of 7 questions were distributed and the answers were collected from 10 facilitators and 60 students from both diploma programs. Analyzing the data collected from the survey, the ideal number of students in each team was identified as four students per team; two students from each discipline. Moreover, students believe that they can perform better if they are allowed to select their teammates rather than be grouped randomly by the facilitator. The preferences of students on selecting their teammates was based on the criteria of friendship, hardworking, flexibility in personal character, or being helpful. Moreover, the results of survey indicate that the social/cultural issues such as gender, religion, and ethnicity are also important in forming the teams.*

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**Keywords:** Engineering; Multidisciplinary; Project Based Learning; Team formation.

## **A DESCRIPTION OF CONTEXT**

To prepare the engineering students for the market and real life industrial environment, it is required to encounter them with similar real life work conditions in terms of nature of given project. Multidisciplinary engineering subjects are required to finish an engineering task completely, dealing with people of different and various experiences, education, and skills. Learning methods are needed to be incorporated in student-centered team based learning pedagogy such as project-based, case-based, inquiry-based and problem-based scenarios (Oliver, 2001). The selected approach in our institution is the project based learning (PBL), where certain courses were designed to incorporate students from two or more major engineering disciplines to work together in a real life engineering project and to implement successfully the project while enhancing their learnings and workplace skills.

## **THEORETICAL AND PEDAGOGICAL FRAMEWORK**

The school of engineering at our institution offers a variety of courses based on the PBL approach. Some courses are offered exclusively for students in one discipline where the students work only on one discipline related projects. The corresponding learning outcomes are also mainly related to one engineering discipline. On the other hand, other courses were designed which require multidisciplinary projects and learnings where students are required to form teams and work together, where the work cannot be achieved without the cooperation of students from two or more disciplines within the school of engineering. As stated by Johnson & Johnson (1979,1995), team work help when one student's ideas, information, conclusions, theories, and opinions are incompatible with those of another, and the two seek to reach an agreement. In the literature, many definitions of teamwork are available and according to Scarnati (2001), team work is defined as a cooperative process that allows ordinary people to achieve extraordinary results. Harris & Harris (1996) also explain that a team has a common goal or purpose where team members can develop effective, mutual relationships to achieve team goals. Literature focuses on one of the essential elements of a team which is its focus towards a common goal and a clear purpose (Fisher, Hunter, & Macrosson, 1997, 1999; Parker, 1990; Harris & Harris, 1996).

In this work, the challenges for the single and multidisciplinary courses utilizing a PBL approach will be discussed. The results of a survey on team forming are also demonstrated from responses of both facilitators and students.

## CONCRETE IMPLEMENTATION AND ACTION

One of the multidisciplinary courses in our curriculum is “ENEG12006 - Engineering Design and Management Implementation” where mechanical and civil engineering students are working together on a real industrial problem. The first step in this course is to form a team with equal number of mechanical and civil engineering students. However, this step can be performed either by random selection of the students in each team or allow the students to select their teammates. It should be mentioned here that the number and size of each team depends on the total number of students in the class.

In PBL, to resemble a real life work environment, a random selection procedure is recommended, but this procedure may face the following challenges:

**Culture:** Mainly if there are male/female students in the same group, as some students (from different gender) may refuse working with the opposite gender. So, allowing students to select their teammates will solve the issue.

**Personal:** Some of the students may feel very shy if they work with others if they do not know or have previous friendship.

**Scientific/Knowledge:** Random selection of the group members by the facilitator may result in an uneven experiences in one team, while allowing students to select their teammates based on their needs to finalize the project can result in a better performance. For example, using computer and up to date technologies in solving the problem like 3-D printing and engineering software like ANSYS is mandatory in getting high evaluation of the learning outcomes of the course. Due to the difficulty involved in the design and development of complex software systems, wide ranges of software engineering paradigms have been developed, such as object-oriented programming, structured programming, procedural programming and declarative programming (Genza & Mighele, 2013). If the students selected their teammates based on their previous knowledge and skills can result in better performance than forcing the team to work with same skills and experiences.

**Nature of the project:** Some projects need professional skills in workshop activities, in which mechanical engineering students may perform better than civil engineering students and even within the same discipline some students are more skilled and handy in doing practical jobs than other students.

Based on the above mentioned reasons, it is better to allow the students to select their mates only on the first phase, i.e. the design phase, whereas in the implementation phase, the facilitator can randomly assign a team to implement the design of other teams to give the students a flavor

of real life environment. Even if the students are allowed to generate their teams by themselves, many problems arise such as the inability to reach agreements, lack of innovative ideas, conflicts, or complacency of team members.

To help the facilitator in delivering the course in its best way, our registrar office should facilitate enrolling a balanced number of students from each discipline.

**Communication skills:** Some of the students are professional and active in communicating with other people inside and outside the college. Communication in their team, with other teams and with the instructor are very important and different communication means should be used, such as verbal and written communication, since they contribute to achieve ten learning outcomes. For instance, the 10<sup>th</sup> learning outcome in ENEG 12006 states: “Provide evidence of a professional capacity to communicate, work and learn; individually and in peer learning teams”.

## RESULTS AND REFLECTIONS

To determine the best way to form teams in the aforementioned multidisciplinary PBL units, a survey was conducted in which facilitators and students were interviewed on the following questioner consist of 7 questions tabulated in Table 1. The participated numbers of facilitators were 10 while 60 students attended the survey.

Question	Answer	
	Students	Staff
1) What are the three most difficult challenges in building student teams? (most difficult first, least difficult last)	<p><b>Most Difficult:</b></p> <ul style="list-style-type: none"> <li>• Nationality.</li> <li>• Age.</li> <li>• New members (not acquainted with)-Friends-Knowing our teammates-Friends that we have to choose.</li> <li>• Not enough students from the other department.</li> <li>• Choosing the team knowledge.</li> <li>• Finding chemistry between members.</li> <li>• Different cultures and different way of thinking.</li> <li>• Team dynamics.</li> <li>• Being in class without my friends.</li> </ul> <p><b>In between:</b></p> <ul style="list-style-type: none"> <li>• Gender (<i>mentioned 4 times</i>)</li> <li>• Not being acquainted enough with other students.</li> <li>• Teams members that work.</li> <li>• Assigning tasks.</li> </ul>	<p><b>Most Difficult:</b></p> <ul style="list-style-type: none"> <li>• Unequal number of civil &amp; mechanical students.</li> <li>• Some students are not welcome in groups due to either unprofessional behaviour/bad experience.</li> <li>• Ensuring effective teamwork.</li> <li>• Social interest.</li> <li>• Culture sensitivity.</li> </ul> <p><b>In between:</b></p> <ul style="list-style-type: none"> <li>• Academic levels.</li> <li>• Balance in disciplines.</li> <li>• Gender.</li> <li>• All good students want to team up together.</li> </ul>

	<ul style="list-style-type: none"> <li>• Time schedule.</li> <li>• Team dynamics.</li> <li>• Time management.</li> <li>• Communication</li> <li>• Those who don't work or do every effort.</li> </ul> <p><b>Least Difficult:</b></p> <ul style="list-style-type: none"> <li>• Age (<i>mentioned 2 times</i>).</li> <li>• Different approach in doing things.</li> <li>• Friends.</li> <li>• Getting the full workload.</li> <li>• Mix group.</li> <li>• Knowledge.</li> <li>• Time management.</li> <li>• Chemistry.</li> </ul>	<ul style="list-style-type: none"> <li>• There are weak students who want stronger team.</li> </ul> <p><b>Least Difficult:</b></p> <ul style="list-style-type: none"> <li>• There are undecided students unsure.</li> <li>• According to their needs</li> <li>• Having the team agree on topic</li> <li>• Being responsible.</li> <li>• Assigning students to teams.</li> </ul>
2) What is the most suitable number of students in each team? Why?	<p><i>Ranked from top to down according to most favored answer.</i></p> <p>4 members in one team:</p> <ul style="list-style-type: none"> <li>• Easy to communicate.</li> <li>• Ease to distribute tasks fairly and equally.</li> </ul> <p>5 members in one team:</p> <ul style="list-style-type: none"> <li>• Distribution of work and saving time.</li> </ul> <p>6 members in one team:</p> <ul style="list-style-type: none"> <li>• More idea generation.</li> </ul> <p>3 members in one team:</p> <ul style="list-style-type: none"> <li>• To be able to focus on tasks with all members working.</li> </ul> <p>2 members in one team:</p> <ul style="list-style-type: none"> <li>• Less stress of coordination.</li> </ul> <p>1 member in one team:</p> <ul style="list-style-type: none"> <li>• To get the entire knowledge of PBL</li> </ul>	<p><i>Ranked from top to down according to most favored answer.</i></p> <p>4 members in one team:</p> <ul style="list-style-type: none"> <li>• Two department for multidisciplinary.</li> <li>• Every group will have 2X2.</li> <li>• Enough work for each students</li> <li>• Equal number of both majors.</li> </ul> <p>4-5 members in one team:</p> <ul style="list-style-type: none"> <li>• Less makes it difficult and more means less people work.</li> <li>• Everyone needs to contribute.</li> </ul> <p>3 members in one team:</p> <ul style="list-style-type: none"> <li>• Students interact more efficiently.</li> </ul> <p>5 members in one team:</p> <ul style="list-style-type: none"> <li>• Diversity</li> </ul> <p>6 members in one team:</p> <ul style="list-style-type: none"> <li>• Equal numbers</li> </ul>
3) The performance of teams is better if they select themselves than if I assign them to teams.	<p>Most answered with Yes 1 answered with No</p>	<p>7 answered with Yes 3 answered with No</p>
4) If you assign students to teams, how do you assign them?	<ul style="list-style-type: none"> <li>• Based on reputation of hard work.</li> <li>• Strong knowledge with good manners.</li> <li>• If I know them or not.</li> <li>• Based on their thrust for knowledge</li> <li>• Helpful</li> <li>• Based on their disciplines and skills.</li> </ul>	<ul style="list-style-type: none"> <li>• 2 civil + 2 mechanical</li> <li>• Diverse</li> <li>• According to their major-Combination of different department</li> <li>• I should know them in advance to team up fairly based on their background.</li> <li>• Equal distribution between disciplines.</li> </ul>

5) Teams perform better if all team members are equally strong. Why?	<p>All answered with Yes:</p> <ul style="list-style-type: none"> <li>• Mutual help</li> <li>• They know what to do.</li> <li>• Keep same pace to all members.</li> <li>• Competition.</li> <li>• Better outcomes for the project.</li> <li>• Save time. Respect their work and others.</li> </ul>	<p>3 answered with Yes:</p> <ul style="list-style-type: none"> <li>• The team strength is driven by its members.</li> <li>• They should have enough strength in different fields.</li> </ul> <p>7 answered with No:</p> <ul style="list-style-type: none"> <li>• More conflict.</li> </ul>
6) Teams perform better if a team consists of a mix of strong and weak students. Why?	<p><i>The answer was equal between Yes, No, and sometimes.</i></p> <p>Students answered with Yes:</p> <ul style="list-style-type: none"> <li>• Help each other and work together.</li> <li>• They can accomplish more</li> <li>• Learn from each other.</li> </ul> <p>Students with No:</p> <ul style="list-style-type: none"> <li>• Lack of experience.</li> <li>• Strong ones land doing the job alone.</li> <li>• Mis-communication.</li> </ul> <p>Students answered with sometimes:</p> <ul style="list-style-type: none"> <li>• If the weak students are willing to learn.</li> </ul>	<p>7 answered with Yes:</p> <ul style="list-style-type: none"> <li>• In some cases, weak students work harder to reach the level of strong students.</li> <li>• Yes diversity</li> <li>• Yes, because weak students may perform better</li> <li>• Yes, weak students will work hard to catch-up</li> </ul> <p>3 answered with No:</p> <ul style="list-style-type: none"> <li>• Weak students affect the performance.</li> <li>• If good team culture exists.</li> </ul>
7) When you have interdisciplinary PBL courses, do you prefer to have equal number of students from the two majors in each team? Why?	<p>Most students answered with Yes:</p> <ul style="list-style-type: none"> <li>• Skills exchange</li> <li>• Faster performance of work.</li> <li>• More idea generation.</li> <li>• Divide tasks equally.</li> <li>• Learn more</li> <li>• Each focus on their expertise.</li> </ul> <p>2 answered with No:</p> <ul style="list-style-type: none"> <li>• Mechanical students can do the job alone.</li> </ul>	<p>7 answered with Yes:</p> <ul style="list-style-type: none"> <li>• Knowledge exchange.</li> <li>• Avoid bias.</li> <li>• Equal resources for all teams.</li> <li>• Easier to build groups/tasks distributed fairly.</li> <li>• Allows sub-teams for discipline work.</li> </ul> <p>1 answered with No:</p> <ul style="list-style-type: none"> <li>• Diversity</li> </ul> <p>2 answered with Not sure:</p> <ul style="list-style-type: none"> <li>• Depends on the students and work required from them</li> </ul>

**Table 1:** Survey results

The results are summarized in table 1. It can be clearly seen that the social/cultural issues are the main challenges in forming the teams, as some of the students refuse to work with others for reasons such as social issues like gender, previous experience, and friendship. It was highlighted by the facilitators that most difficult challenges in building a team is having unequal number of civil and mechanical students while the least difficult challenge is assigning students to teams.

According to PBL facilitators and students, the best size for a group is four students equally divided among participating disciplines. In addition, the facilitators reported that if the students

selected their teammates, they will perform better. Majority of facilitators (7/10) prefer distribute equally across disciplines to ensure fairness and equal distribution of tasks; others (2/10) prefer to distribute them according to the students' experience and skills.

Regarding the performance of the team, students strongly agree that the team performs better if all team members are equally strong whereas most of facilitators disagree with the students because students may tend to have conflicts in this situation. Since strong students usually have a higher intention for leadership and considering the lack of conflict resolution skills (Aarnio, 2013), having multiple strong students resulted in initiation and aggravation of personal conflicts amongst team members during the semester which impacted the team performance negatively.

Different responses were noticed when students with mixed levels are in one team as the majority of the staff noticed better performance because that allows the students to share ideas and this gives the opportunity for the weak students to catch up. The students get suitable support from their colleagues which is part of the learning outcome "lifelong learning". Others observed negative effects among the weak students as they will not keep promises of doing their work and cause a delay in team work in addition to being very dependent.

## CONCLUSIONS AND RECOMMENDATIONS

This paper has explored team forming of multidisciplinary PBL subjects in School of Engineering by surveying the PBL facilitators and the students. It has addressed the challenges that the students and staff face in team formation such as social/cultural issues, members distribution according to their background, and students preference in working with people they are acquainted with. The most preferred size for each group was suggested by most of the interviewees including facilitators and students are four students per team. Due to the lack of experience in team formation among students, this paper recommends that students' awareness on team formation should be raised prior to encountering with teamwork. This would enable them to select their team members wisely and based on accurate rational to facilitate their individual and team learnings.

## References

- Aarnio, M, Lindblom-Ylänne, S., Nieminen, J., Pyörälä, E. (2013), "How do tutors intervene when conflicts on knowledge arise in tutorial groups?", *Advances in Health Sciences Education*, 19(3), pp 329–345.
- Fisher, S.G., Hunter, T.A., &Macrosson, W.D.K. (1997). "Team or group? Managers' perceptions of the differences." *Journal of Managerial Psychology*, 12(4), 232-242.

- Genza, N., & Mighele, E. (2013). "Review on multi-agent oriented software engineering implementation." *International Journal of Computer and Information Technology*, 02(03), 511–520.
- Harris, P.R., & Harris, K.G. (1996). "Managing effectively through teams." *Team Performance Management: An International Journal*, 2(3), 23-36.
- Johnson, D. W., & Johnson, R. (1979). Conflict in the classroom:Controversy and learning. *Review of Educational Research*, 49,51–70.
- Johnson, D.W., & Johnson, R. (1995). Creative controversy: Intellectualchallenge in the classroom (3rd ed.). Edina, MN: Interaction Book.
- Johnson, D.W. & Johnson, R.T. (1999). *Learning Together and Alone: Cooperative, competitive, and individualistic learning* (5th ed.). Needham Heights, Massachusetts: Allyn and Bacon.
- Oliver, R. (2001). "Developing e-learning environments that support knowledge construction in higher education." Presented at the 2nd International We-B Conference, Perth, Western Australia, pp. 407–416.
- Parker, G. M. (1990). *Team Players and Teamwork*. San Francisco, CA: Jossey-Bass.
- Scarnati, J. T. (2001). "On becoming a team player." *Team Performance Management: An International Journal*, 7(1/2), 5-10.