IMPLEMENTATION OF COOPERATIVE LEARNING IN ENGINEERING EDUCATION : A CASE STUDY ON THE UTeM PERODUA ECO – CHALLENGE PROJECT

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Implementation of Cooperative Learning in Engineering Education: A Case Study on the UTeM Perodua Eco-Challenge Project

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Abstract—**Engineering education practice has evolved from traditional teacher centered learning to student centered learning in order to provide better understanding of the knowledge to the students in preparation towards job demands. One of the approach in student centered learning is the cooperative learning technique. In this paper, the implementation of cooperative learning technique to students from Faculty of Mechanical Engineering, Universiti Teknikal Malaysia Melaka which participated in the 2011 Perodua Eco-Challenge competition are discussed. Both formal and informal cooperative learning approaches were applied during the project which consists of a group of students with diverse level of knowledge and skills. The effectiveness of the technique was measured in term of project outcome and survey on the participant feedbacks. Limitations of this technique were also highlighted with several recommendations included to better improve on the delivery of the active learning technique for similar project in the future.**

Keywords- Cooperative learning; engineering education; Perodua Eco-Challenge

I. INTRODUCTION

Outcome-Based Education is being actively implemented in Universiti Teknikal Malaysia Melaka, particularly in Faculty of Mechanical Engineering since it has been introduced to guarantee the effectiveness of teaching and learning in engineering education. As OBE's is an instructional planning process which is a reverse of that associated with traditional education planning (Sekhar et. al., 2008), it is expected that students are able to do more challenging task such as formulating problems, analyzing case studies, delivering presentations and making decisions based on their studies.

One element of effective course design under OBE is delivery stage, which the instruction of students learning has been delivered through various methods and one of them is active and cooperative learning. There are many recent studies demonstrate that cooperative learning provides a variety of educational advantages over more traditional instructional models, both in general and specifically in engineering education (Haller et. al, 2000).

Prince (2004) said that cooperative learning is based on the premise that cooperation is more effective than competition among students for producing positive learning outcomes. Thus, cooperative learning will provides a natural environment in which to promote teamwork and interpersonal skills (Prince, 2004). It has been observed that the effectiveness of cooperative learning is that students will shift the focus from teachers to learners. They are also will start to participate and there will be more active discussions among their team members.

This paper examine how cooperative learning technique affected the outcome' of UTeM Perodua Eco-Challenge Project, which one of the most structured, challenging and successful ever student's project held by Faculty of Mechanical Engineering, UTeM. Besides, the study provides an overview of how cooperative learning technique helps to improve student's technical knowledge as well as their decision making and communication skills during their Perodua Eco-Challenge Project execution.

II. LITERATURE REVIEW

Cooperative learning can be described as a modern technique of learning and has been used by many academicians to draw student's interest in learning, especially in the institutions of higher education such as UTeM. This method generally practiced during tutorial or practical sessions in a subject because it is only situation in which students can learn in a group.

As what has been defined by Johnson, Johnson and Smith (1991), cooperative learning is the instructional use of small groups so that students work together to achieve shared goals and maximize their own as well as each other's learning. Since cooperative learning is implemented in a groups, Johnson and Johnson (1989) has set out some basic elements for cooperative teams, which are:

i. Positive interdependence:
   Team members perceive that they need each other in order to complete tasks.
ii. Individual accountability:
   Accessing the quality and quantity of each member's contribution and giving the results to the group and the individual.
iii. Face to face promotive interaction:

Team members promote each other's productivity by helping, sharing, explain, discuss and encouraging efforts to produce.

iv. Interpersonal and small group skills:
Needs of social skills, include instructorship, decision-making, trust-building, communication and conflict-management skills.

v. Group processing:
Group need specific time to discuss how well they are achieving their goals and maintaining effective working relationships among members.

Many academicians who has practiced cooperative learning agrees that the methods has provide many benefit to students to learns more by doing activities rather than just listening. By doing cooperative learning, lecturers can mix up weak students with strong students so that they can get advantages from each other. Based on Edgar Dale's Cone of Learning (1969), 70% of learning occurs when students engage in learning activities such as participating in discussion and giving talk. Further, students will remember 90% of what they say and do by doing the real thing such as hands-on activities and simulating the real experience.

However, based on our observation and discussion among faculty members in university, there are still have skeptical views of the implementation of cooperative learning, particularly in engineering education. This is due to instructional and experimental structure of engineering education in nature. Thus, to find an alternative to the traditional way of teaching and learning in engineering education is very necessary to meet the needs of the industry and cooperative learning is the only way to breakthrough this barrier.

Huang (2004) in his studies said, the People's of republic of China has set a curricular reform whose goal are the establishment of an active teaching model, where the students stop becoming a passive receptor and become active participant. Such technique that Huang proposed such as promoting problem solving, cooperative learning and social practiced. In that method of learning, lecturer must become advisor or facilitator while learning responsibility lies on the students.

In Faculty of Mechanical Engineering, there are several attempts to incorporate Huang's curricular reform and cooperative learning method with the courses where the students exposed to design, fabricate, testing and prototyping. Among them were the Formula Varsity 2010 and the Perodua Eco-Challenge 2011. In both events, a group of students from the Bachelor of Mechanical Engineering specializing in Automotive Engineering were selected and were given the task of building a working prototype of a vehicle and later put their end product to test with fellow participant from various Malaysian higher learning institutions at the national level competitions. The aim was to strengthen their hands-on engineering skills and give practical experience to the students in applying the theory learnt in class as well as to enhance their interpersonal skills. The students were assisted by faculty members (lecturers and technicians) throughout the projects.

III. PERODUA ECO-CHALLENGE PROGRAM

The Perodua Eco-Challenge program was started in January 2011 in conjunction with the engine handling ceremony to the selected participating teams at the Perodua (M) Sdn. Bhd. headquarter in Rawang, Selangor. Since then, the recruitment process was conducted to select 20 students to become the team members as required in the rules and regulations set by the event organizer and a team of faculty lecturers and technicians was formed as the advisor for project. The students selected were from year 4, year 2 and year 1 undertaking Bachelor of Mechanical Engineering (Automotive) in the faculty.

During discussion, due to the nature of the event where it resembled a multidisciplinary project with combined hands on and theoretical solutions, cooperative learning approach was decided to be applied to the solution process in order to achieve the project objectives. The home group of 20 persons strong student team was divided into four subgroups (expert group) which are the vehicle chassis, vehicle bodywork, vehicle powertrain and vehicle manufacturing as shown in Figure 1 below.

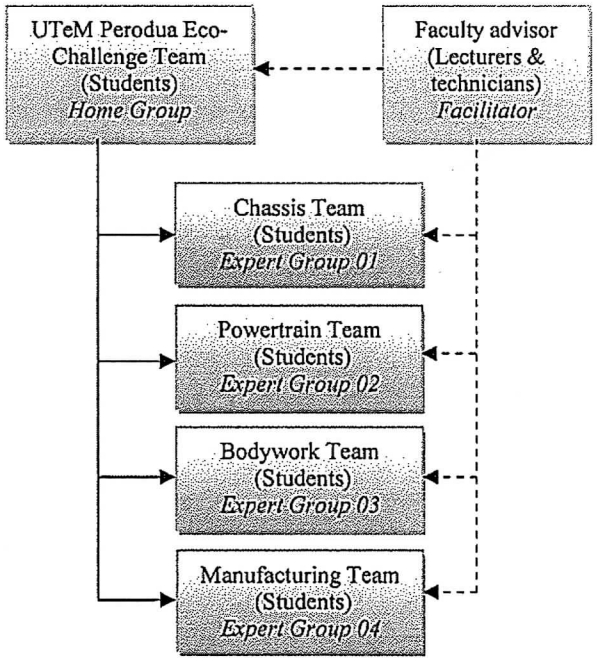

Figure 1. Group structure for UTeM Perodua Eco-Challenge team

Each expert group comprise of minimum of 4 team members with different level of expertise based on their current year of study and was given different task to be completed in the project. The blending of students with diverse level of expertise in technical knowledge and skills into the same group was made for several reasons such as to promote knowledge sharing and transfer among team members, to promote interaction and also to develop communication competency among them. A team leader for

each subgroup was also selected to manage his team members while a principal project manager was selected among them to manage the whole team and as a liaison officer to the event organizer.

After each subgroup completed their tasks, they then worked together to assemble the fabricated vehicle subsystems and to make the complete unit of the UTeM eco-car. At this stage, the expertise of the subgroup were tested again in order to perfectly match and assembled of the components together as per design requirements. The overall group was later involved in the testing of the completed eco-car in actual track condition as well as to prepare the required documents needed to be presented and submitted during the event.

Throughout the conduct of this project, the students were assessed periodically in order to monitor their performance based on the project schedule proposed by them at the start of the project. The assessment conducted was through progress meetings where the students took part in two progress meetings which involved the faculty advisors and one progress meetings which involved both the faculty advisors and representatives from the Perodua (M) Sdn. Bhd. During the assessment process, the students presented their project planning and vehicle design, activities conducted, outcome achieved and future project activities that will be done for total project completion to the panel of reviewers. During the presentation, questions were asked to them by the reviewers and the students need to defend their decisions by giving sound justifications based on their technical knowledge and experience. The panel of reviewers also visited the project site and was shown the work in progress involved in the UTeM eco-car development during the progress meetings.

Informally, the student themselves also has taken proactive actions for self-evaluation by conducting group and subgroup meetings to discuss their accomplishments, share problems and working together to come out with solutions for their problem, readjusting the project planning and redistributing the workload and tasks among the group members based on current progress. They also managed to make arrangement with lecturer from other faculties in UTeM as well as mechanics from industrial automotive workshops to discuss and find solution to the problems encountered during the project execution.

In this project, the faculty advisors acted as the facilitators for the students and provided them with pre-instructional decisions, explaining and clarifying the instructional tasks monitoring the student activities in order to achieve the project objectives smoothly within the given time limit and cost. A part from that, the faculty advisors were also responsible in providing the students a convenient working environment for them to execute and finished their work. A convenient working environment which involved raw materials, tool and equipments, a dedicated space with acceptable size to work, and financial support is very important to the student to enable them to complete their tasks successfully within the given time limits.

To better enhanced on their knowledge and skill in information relevant to the vehicle development, the faculty advisors has also taken initiatives of organizing technical talk by guest speaker from the automotive industry and visit to the composite bodywork manufacturing company during the project execution to the students involved. These activities were planned to provide the students with the opportunity to gain real world experience in producing a vehicle which meet the industrial standard both theoretically and practically, as well as providing the platform to them to ask questions and gain new innovative ideas of solution for the project by interacting with the engineers from the industry first hand.

IV. PROJECT OUTCOME

The effectiveness of the cooperative learning technique implemented to the student to achieve the project objectives was measured in term of project outcome and survey on the participant feedbacks. In term of project outcome, at the end of the project dateline, the students proved successfully able to develop the required working prototype of the UTeM eco-car which met all the specifications as stated in the Perodua Eco-Challenge rules and regulations as shown in Figure 2 below.

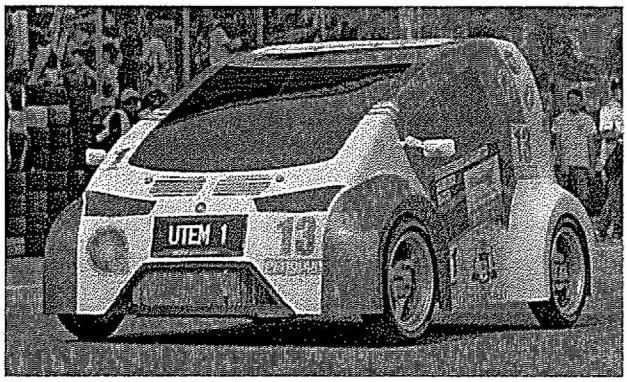

Figure 2. UTeM eco-car in action during the actual race

The UTeM eco-car developed by the student passed the technical inspection and mandatory braking test by the event organizer during the competition day and was allowed to enter race. During the final race, the UTeM eco-car named "UTeM-1" successfully completed the event without any vehicle failure. The students also participated in the presentation session prior to the race event and able to showcase to the panel of evaluators their accomplishments such as vehicle design using computer aided design software, engineering analysis done using finite element analysis software, project management and innovation ideas produced and implemented to the eco-car in order to reduce the car fuel consumption for longer driving mileage per given 0.5 liter of fuel. Meeting the project dateline with the given allocation and producing a competent working vehicle as per

design specifications and competition requirements proved as a measure of success for the UTeM student team and the effectiveness of the cooperative learning technique implemented to them in the event

In other hand, the survey was done to all the 20 student team members to measure the cooperative learning effectiveness implemented in their project. The survey questions were designed based on the suggestion by Kim et. al (2010) and comprised of 9 questions to be answered in the scale of 1 to 5 (where scale 5 correspond to the strongest agreement) and one open written comments. The questions asked were:

1) Do you think the approach used in the event enhanced your interest in the course you are currently studying?
2) Did the approach used throughout the event (from start of project until the competition day) help you to understand how the theory and practice in class are used to solve practical engineering problems?
3) Did the participation in the event improve your problem solving skills?
4) Did the project improve on your communication skill?
5) Did the project help you to understand the course materials taught in class/laboratory/design studio?
6) Was the project helpful in relating the course materials learnt in class/laboratory/design studio with real world problems?
7) Did the approach improve your interest in fundamental science and engineering subjects?
8) Was the project well organized in a systematic and orderly manner?
9) Will you recommend other colleague to participate in similar project?
10) [open ended question] In your opinion, what is/are the disadvantages for the project and what is/are the recommended action to be taken to improve it for future Perodua Eco-Challenge project?

The results of the survey are summarized in Figure 3 above. The final score obtained for all the questions after the survey was between the scales of 3 to 5 only.

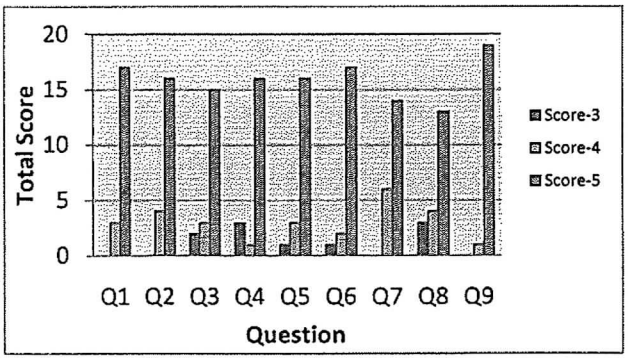

Figure 3. Summary of student survey responses taken for the cooperative learning technique implemented

The findings show that the majority of the students strongly agree that conduct of the event using the cooperative learning technique help to improve their current technical knowledge and skills as well as their interpersonal skills such as problem solving and communication. The majority of the students also strongly agree that the project help to increase the interest in the course they currently take and the project was executed in systematic and orderly manner.

Result for question 9 also show that the project was well accepted by the participating student while for question number 10 which is an open ended-question, the comments received from the students are generally positive where the approach benefited them in term of providing a new effective way in their learning achievement and the approach should be more aggressively implemented in formal classes. However, few comments were also obtained where the project duration given should be extended in order for them to develop a better car for the race and opening the team member recruitment to students from other faculties.

V. Discussion and Conclusion

The project objectives are mainly evaluated by examined the final result of the project that is the complete vehicle and its performances. The vehicle proved to be functioning very well with a better fuel efficiency than the normal passenger car. It also proved to be reliable as it had run for quite a distance (approximately 120 km) until the competition day.

After conducting this project we found out that the objectives can be achieved and have a good feedback from the students who participated in this program. We concluded the following facts from our project results:

i. Cooperative learning can be implemented with good response in engineering education.
ii. Cooperative learning also could help in developing the students' interpersonal skills.
iii. However lecturer support and supervision play a very important role as facilitator especially for time and human management aspect.
iv. A good and convenient environment is also one of the key aspects to make the project successful. For examples, the financial support, space and facilities required should be provided.

VI. Acknowledgment

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