AC 2009-1821: ENHANCING UNDERGRADUATE PERFORMANCE THROUGH PEER-LED TEAM LEARNING (PLTL)

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Enhancing Undergraduate Performance through Peer-Led, Team-Learning (PL-TL)

Abstract

Numerous studies have proven that students who are provided hands-on training perform better academically than those without active learning[1, 4]. Students may pass a written test on the scientific method but find it difficult to solve a real scientific problem outside of the classroom unless they have had related experience[1]. It has been shown, also, that students who are involved in small groups learn and retain more than students whom are working alone[3]. A method that encourages students to get involved effectively is the peer-led, team-learning (PL-TL) model. The PL-TL model is designed to supplement the lecture by introducing formalized groups which require students to engage in active learning. This model creates an atmosphere which simulates real life situations and introduces factors such as as operating as a team, understanding responsibility, communicating, and making use of the techniques learned in class.

The Experimental Vehicles Program (EVP) at Middle Tennessee State University (MTSU) is a prime example of a modified and extremely successful PL-TL program. MTSU engineering and engineering technology students voluntarily participate in the EVP as an exciting and challenging academic supplement, and some seniors within the program also use elements of the projects for their capstone research course[6]. This program is currently comprised of five different student projects: Moonbuggy, Solar Vehicle, SAE Formula One, SAE Mini Baja, and Solar Boat. Instead of the original, established PL-TL model which has been implemented to improve classroom progression, the EVP includes real-world simulation and implements its own unique style which is designed to encourage upper level college students, such as seniors and juniors, to supervise and mentor younger college students. A faculty advisor

manages and approves the overall project, while student members deal with the day-to-day operations. These student projects engage individuals from all college levels and backgrounds while simultaneously encouraging high school students and teachers to participate. The popular projects provide an opportunity for students to apply themselves and their learned coursework within an exciting environment of competition. Each project uses the PL-TL model as its infrastructure to develop and enhance personal qualities such as teamwork, dedication, and communication.

Introduction to Peer-Led, Team-Learning

Peer-led, Team-learning model is a new and innovative twist on the original design of teacher-to-student teaching model. Based on the theory of hands-on-learning, this type of model allows students to learn the requested material while developing interpersonal skills that will prove to be invaluable upon entering the work force. The students benefit by participating in a working environment while following a meticulously structured learning experience. This, in turn, will improve their knowledge of the subject material. Skills students can acquire using the PL-TL model are team-work, confidence, and overall ability to troubleshoot problems individually and through group work. Such skills are highly sought after traits in the work force.

The original design of the PL-TL model consists of groups containing 6-8 students facilitated by a student (peer) leader who interacts closely with a university appointed advisor. At MTSU, advisors are presented with a PL-TL plan in order to ensure that the model is used consistently. The formal purpose of the PL-TL model is to accomplish the following goals:

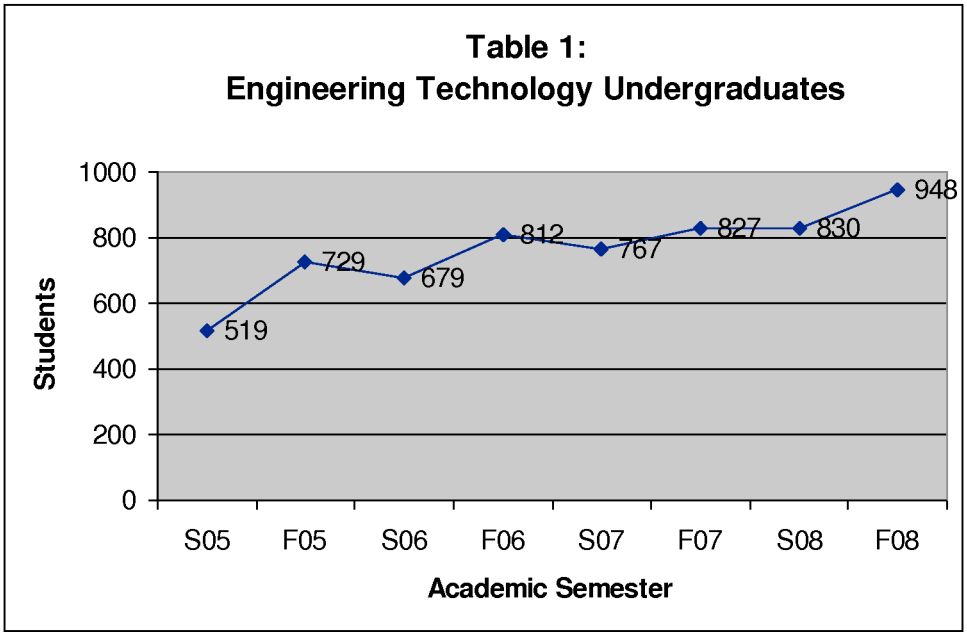
- To teach undergraduates how to work effectively and efficiently in a group setting
- To improve students' problem-solving skills
- To provide facilitated help for students

- To provide an active-learning environment for students

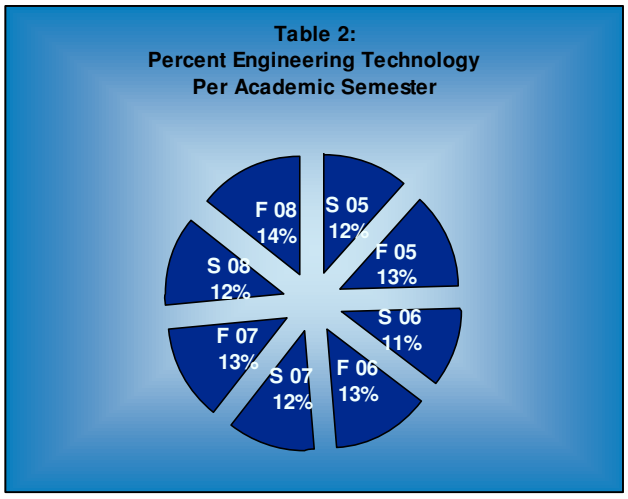
Middle Tennessee State University has modeled the Experimental Vehicles Program in the Engineering and Technology Department around the established Peer-Led, Team-Learning model in order to create a program that not only enhances student learning but encompasses real-world simulation.

Experimental Vehicles Program Effect on Middle Tenneessee State University

At Middle Tennessee State University (MTSU), the Engineering Technology (ET) department was experiencing steady decline in the retention rates of students. However, since the inception of the Experimental Vehicles Program in the fall of 2004, this trend ceased and there was a noticeable student increase[5]. Through an amplified interest in the EVP, student enrollment and retention within the department has drastically increased (see Table 1). Studies of the EVPMT program and its learning environment have shown high retention rates due to elements such as research communities and collaboration with faculty[7].



The amount of students who choose Engineering Technology majors within the department has increased from 12 to 14 percent and is expected to continue in this trend (see Table 2).



Recruitment levels in ET have increased largely due to on-campus events hosted by the EVP, including high school events that focus on stimulating interest in science and technology. The EVP members are able to give advice to high school students and display opportunities that the program has opened up to them. These events expose students who are undecided about a major to the Engineering Technology department. The five projects offered through the EVP (Moonbuggy, Solar Vehicle, SAE Formula One, SAE Mini Baja, and Solar Boat) offer academic variety and the chance to work as a team in exciting competitions.

Figure 1: Baja SAE

Figure 2: Formula SAE

Figure 3: Moon Buggy

The essential factor of the EVP retaining students in the Engineering Technology department lies in the infrastructure of the PL-TL model which enables students to create bonds on the basis of similar interests. Through close interaction and daily activities, members create a support unit within themselves which creates a strong team. When members sense they are a part of something exceptional, they are compelled to continue even when they are faced with tough obstacles. Engineering Technology is a notoriously difficult degree and the support that each member gives and receives in this model is essential to the retention rates of the department.

Another positive factor increasing enrollment and retention rates is a mentoring program that is developed through the PL-TL model. This model is designed to encourage upper level students to advise younger students on a wide variety of subjects. The mentoring affect directly correlates to the retention rates of students in the ET department.

Figures 4, 5, and 6: EVP Team Member Collaboration

Figure 4

Figure 5

Figure 6

ET students who participate in the EVP have achieved a graduation rate of 95 percent. Of those graduates, 100 percent have received a job within their chosen field. The local industrial community is well acquainted with the research and developmental projects for the students[8]. Interactions between the engineering programs and its industrial contacts include long-term partnerships, informal contacts between faculty members and industrial personnel, and consultation and collaboration on training opportunities, discussions, seminars, and teaching programs. Students found that during the job interview, they were frequently asked questions regarding their experience with projects, especially how they performed within team settings. The Experimental Vehicle Program may be used as a successful PL-TL model for dissemination to other campuses.

PL-TL Model at Middle Tennessee State University

The Experimental Vehicles program at Middle Tennessee State University is composed of five student projects: Moonbuggy, Solar Vehicle, SAE Formula One, SAE Mini Baja, and Solar Boat. A faculty advisor manages each vehicle; however, students are responsible for all aspects of the project such as design, cost analysis, budgeting, purchases, fabrication, repairs, and safety. Each project emphasizes the values of communication, teamwork, budget, and electrical and mechanical engineering—all which contribute to a total project package[9]. Once the assembly is complete, the vehicle is tested and later competes in national level contests. Each competition is composed of several events, providing a unique set of challenges along with the contest of racing against some of the top engineering schools in the country and world.

The EVP projects have been modeled after the Peer-Led, Team-Learning program structure. Student learning is focused around textbook knowledge; however, there is no substitute for hands-on learning. Derived from a small group of college students, ranging from seniors to freshman, these projects create a learning atmosphere that enables students to develop knowledge of what a future in the Engineering and Technology field requires. Since all parts will be manufactured within the laboratory, the project strengthens knowledge concerning control and power systems, instrumentations systems, modern modeling, and testing protocols[10]. It has been proven that students who are involved in these projects perform better in both their ET and general studies classes[5]. The PL-TL model at MTSU creates an internal support group as well as a mentoring program that has aided in sustaining the success of the ET department.

PL-TL Model as Support Group

Faculty members at Middle Tennessee State University realized the need to create an enthusiastic program that will properly train students for careers in engineering. Implementing

multidimensional projects, such as the Experiemental Vehicles Program, was the solution. This program, based on the Peer-Led, Team-Learning model, works efficiently to create a support group within the team members while supplementing a sense of competition.

Students who are envolved in the EVP projects are students from multidimensional career paths and backgrounds. Each member brings a different set of eyes, ideals, opinions, and experiences to the team, which ultimately is an advantage to the project. Through trial and error, many discoveries are made, and many new ideas are tested. Freshmen learn that creativity is encouraged—not stifled. The PL-TL model is an exceptional design for these projects due to the fact that it inspires and enables students to "think outside the box" and to create the unimaginable[4].

Figure 5: 2008 Solar Boat Concept

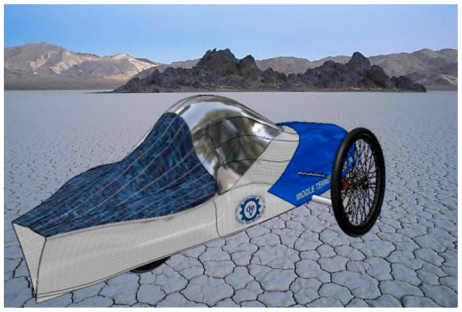


Figure 6: 2008 Solar Vehicle Concept

Because all of the experimental vehicle projects last longer than a semester, students involved with the projects remain in the ET program longer. The first semester of the project allows the students to get to know each other outside of the classroom setting and to develop bonds of trust with one another. This time together allows for drafts of the projects to be developed and for creativity to be expressed during the constructing process. The second semester is utililzed to finalize all the design and prepare the vehicles for competition. This semester is also when members travel together as a team and compete against other colleges and

universities in experimental vehicle competitions. These contests challenge the students and require them to spend numerous hours together planning, constructing, and traveling as a team. These extensive projects encourage freshman and sophmore students to continue the program by creating a support system of team members who have experienced the same trials that they encounter.

PL-TL Model as a Mentoring Program

The Experimental Vehicles Program at Middle Tennessee State creates an environment that allows upper level students' knowledge to be tested while conjointly stimulating freshmen and sophomores into learning the fundamentals of engineering. Freshmen students are paired with senior mentors; together these teams are required to complete all aspects of the projects. Modern mentoring relationships have expanded to include focusing on the development of job-related skills[2]. Seniors acquire leadership and project management skills, while exercising their engineering creativity based upon their prior knowledge of practical workings. Freshmen and sophomores gain lots of hands-on experience and are able to see the engineering principles they are being taught in the classroom put into practice.

A team leader is designated for each student project and directly interacts with the faculty advisor. The team leader must also assess his or her members and assign responsibilities and duties effectively and efficiently. Each project consists of members from all levels of college. Senior and junior members mentor younger students on aspects such as designing ideas, fabrication, and repairs of the vehicles. However, not all mentoring is related to the projects. Mentoring topics can be related to classes, professors, and life in general. This arrangement teaches responsibility and leadership and enables older members to gain the trust of younger members. This trust ultimately aids in strengthening the existing bonds between the members.

Summary of PL-TL Model Benefits

The Peer-Led, Team-Learning model characterized by MTSU's Experimental Vehicles Program has been proven to enhance undergraduate performance and increase enrollment in the Engineering Technology Department. It supplements engineering technology lectures by introducing formalized groups which require students to engage in active learning. Older students work with younger students to complete the projects together. Working together encourages an environment where mentoring and leadership skills are greatly enhanced. Group work also enables students to retain more information and apply classroom knowledge to real-world problems, such as those expressed in the national and international competitions. While the skills learned through Peer-Led, Team-Learning in the Experimental Vehicles Program at MTSU will undoubtedly be useful after graduation; the confidence the students build through such experiences will benefit them for a lifetime.

References

(1) Sarkar, Somnath, & Frichard Frazier. "Place-based investigations and authentic inquiry: hands-on activities are elevated to a meaningful level that fosters student engagement and purposeful learning." The Science Teacher. 75.2 (Feb 20 2008):29.

(2) Keller, R. "Make the most of mentoring: hands-on coaching can maximize the potential of your firm's young talent." Journal of Accountancy.206.2 (August 2008). p.76(4).

(3) Hockings, SC, DeAngelis, KJ, & Frey, RF. "Peer-led team learning in general chemistry: implementation and evaluation." Journal of Chemical Education. 85.7 (July 2008).p.990-996.

(4) Foroudastan, S.D. & Anderton, M.B., "Implementing a National Competition Design Project as a Capstone Course at Middle Tennessee State University," 2006 ASEE Southeast Section Conference, Tuscaloosa, AL, Apr. 2-4.

(5) Foroudastan, S.D. & Campbell, I.D., "Student Projects: Hands-on Experience with Mechanical Engineering Technology," 2005 American Society for Engineering Education Annual Conference & Exposition, Portland, OR, June 12-14.

(6) Foroudastan, S.D., "Enhancing Undergraduate Education through Innovative, Applied Research Projects," 2007 ASEE 6th global Colloquium on Engineering Education in Istanbul, Turkey, Oct 1-4.

(7) Foroudastan, S., Et al, "Innovative Applied Research Projects Using Industry Collaboration," 2003 ASME Annual Conference and Exposition, Washington, D.C., November 2003.

(8) Akins, L., "Partners in Recruitment and Retention," 2001 Proceedings of the ASEE Annual Conference and Exposition, Albuquerque, NM, June 24-27.

(9) Vavreck, A.N., "Project Management Applied to Student Design Projects," 2002 ASEE Annual Conference and Exposition, Montreal, Quebec, Canada, June 16-19.

(10) Foroudastan, Saeed, "Capstone Design Projects: More than a Matter of Meeting a Program Requirement," ASEE Southeast Section Conference, 2004.