Using Cooperative Learning in a Freshman Summer Engineering Orientation Program

Connie Kubo Della-Piana, Elsa Q. Villa, Sylvia D. Piñon
The University of Texas at El Paso

ABSTRACT

The College of Engineering at the University of Texas at El Paso (UTEP), the largest university in the continental United States with a majority-Hispanic student population, has offered a variety of freshman summer orientation programs for entering freshmen since 1976. Drawing from past experiences, the program has evolved into the Summer Engineering Enrichment Experience (SEEE) which is now a required, one-week, non-credit, 40 contact-hour program for all first-time entering freshmen into the College. Students are immersed in mathematics, college survival skills, advising, and engineering design.

The underlying objective of SEEE is to create an environment for entering students which is supportive both academically and socially. UTEP is for the most part a commuter university which elicits many challenges in program delivery. In particular, students must have the opportunity to develop a strong sense of community with faculty, professional staff, and students.

In this paper, the fundamental SEEE program components will be discussed in detail with a particular emphasis on the cooperative learning aspects of those components. Preliminary data along with informal evaluation have indicated program success and will be included in this paper.

INTRODUCTION

Founded in 1914 as the School of Mines & Metallurgy, the University of Texas at El Paso (UTEP), is located in the foothills of the Rocky Mountain Range in Far West Texas. UTEP is poised to develop, implement and test strategies that address the needs of non-traditional students. Since 1976, UTEP's College of Engineering has offered a variety of programs aimed at the recruitment and retention of engineering students through its Engineering Programs Office (EPO) which reports directly to the Dean of Engineering.

The proliferation of Minority Engineering Programs (MEP) in universities across the nation is testimonial to the national awakening of the need to develop a prepared technical workforce, particularly among non-traditional groups. MEPs traditionally focus on a subset of the engineering student body and employ a variety of successful retention strategies such as structured study groups, summer bridge programs, study centers, and orientation courses, to name a few.

While these retention strategies have been implemented at UTEP, they have been introduced to the greater student body and are not focused particularly on traditionally underrepresented students. " Scaling up" retention strategies at UTEP has been a challenge for the EPO for the last few years and a variety of new/modified' strategies have been introduced to meet that challenge. One such modification is the introduction of structured cooperative

learning in UTEP'S College of Engineering summer bridge program, which "bridges" students between secondary and post-secondary institutions and is required of all entering engineering freshmen. Since the program is required, one week sessions implemented throughout the summer accommodate the more than 200 entering engineering freshmen. With only one week to deliver a program which is designed to build a community of learners, the cooperative learning paradigm was implemented in this non-credit program to meet the challenge of building social networks among the program participants.

COOPERATIVE LEARNING

As the trend toward exploring pedagogical methodologies is expanding, many college classrooms today are moving away from the traditional lecture model. These "new" methodologies are commonly referred to as active learning in which less emphasis is placed on transmitting information (passive learning) and more on developing students' skills in knowledge acquisition (active learning). Research cited[3] clearly indicates that students in traditional lectures assimilate far less information than those in which some type of active learning is taking place. Various types of active learning exist such as peer teaching, cooperative learning (formal and informal), writing in the classroom, computer-based instruction, visual-based instruction, to name a few.

One particular type of active learning is cooperative learning which is the instructional use of small groups in which students work together to maximize their own and each other's learning[5]. Research shows that small groups using cooperative learning techniques are positively correlated with student cognitive development, retention, and sense of community. The effective use of cooperative learning in the college classroom, particularly in technical programs, is on the rise and its use leads students to higher academic achievement, greater persistence through graduation, higher levels of reasoning and critical thinking skills, deeper understanding of learned material, lower levels of anxiety and stress, greater intrinsic motivation to learn and achieve, more positive relationships with peers, and higher self-esteem[4].

A formal cooperative group must have clear positive interdependence, must promote each other's learning face-to-face, hold each other individually accountable for his/her share of the work, appropriately use the interpersonal and small group skills, and process group effectiveness. *Positive interdependence* ensures that all members of a group are responsible for their own learning as well as the learning of the other group members, *Face-to-face promotive interaction* is characterized by group members interacting effectively and efficiently through the learning process while *individual accountability* ensures that all members are responsible for the final product. The use of *group social skills* ensures that all members communicate effectively while *group processing* allows group members to reflect on the effectiveness of the group.

Based on the characteristics of the UTEP student population entering engineering and computer science, cooperative learning was selected as the fundamental pedagogy used in the SEEE program administered by the College of Engineering at UTEP in summer 1995. It was used in all components of the program which included math enrichment workshops, computer science and engineering design, and college survival skills workshops.

Research shows that creating social involvement, integration and bonding with classmates is strongly related to retentions. This is particularly true for disadvantaged underrepresented minorities who have been found to be passive in academic settings'. Thus, in the summer of 1995, the College of Engineering completely modified the program delivery for SEEE to create an active learning environment. The fundamental pedagogy for delivery of all programmatic components of the SEEE program was cooperative learning. As noted by Roger Johnson, David Johnson, and Karl Smith in *Cooperative Learning: Increasing College Faculty Instructional Productivity*, ASHE-ERIC Higher Education Report No. 4, " ... cooperative learning is the instructional use of small groups so that

students work together to maximize their own and each other's learning." Research indicates that cooperative learning increases students' achievement and creates positive relationships among students. As predicted, the cooperative learning paradigm created a strong sense of community and team building among program participants.

PROGRAM DESCRIPTION

SEEE is a one-week, 40 contact-hour, non-credit, required program for all engineering and computer science students admitted into the university who are entering their freshman year in the subsequent fall semester. Six sessions are administered each summer which provide students with a preview of college life on the UTEP campus while discovering the worlds of engineering and computer science through design laboratories. Students have the opportunity to meet faculty, staff, and undergraduate/graduate engineering students. A non-credit college level math short course and workshop is conducted to strengthen students' mathematics background and assist them in appropriate mathematics placement for the upcoming semester.

The fundamental goal of SEEE is to prepare entering engineering and computer science students for the rigors of undergraduate study. The objectives of the SEEE program are: 1) to acclimatize students to a commuter university environment and college requirements; 2) to develop a community of learners; 3) to develop skills that foster academic and professional success; 4) to encourage students to form valuable ties with undergraduates, faculty and staff; 5) to place students into appropriate mathematics course for the subsequent fall semester; 6) to increase awareness of engineering programs; 7) to advise and register students for the subsequent fall semester.

With the implementation of cooperative learning, the first two objectives were easily met. Cooperative learning created caring, committed friendships and work relationships. The informal assessment of the behavior of the first semester engineering students during the 1995 fall semester reveals the positive influence of cooperative learning.

PROGRAM COMPONENTS

SEEE has three fundamental components: college survival skills, mathematics workshops, and design. The college survival skills component provides students with the fundamental knowledge of "what it takes to succeed" in college. The mathematics workshops provide students with an intensive review of precalculus in preparation for a placement exam administered during the last day of the program which determines the mathematics course students will take in the subsequent fall semester. In the design component, students are exposed to the computer science and engineering programs offered at UTEP through related projects that provide a challenging and informative glimpse into each aspect of engineering.

SEEE students are first introduced to the cooperative learning paradigm during the first morning session. In that session, they work through exercises which distinguish the differences between individual, competitive, and cooperative learning[6]. An integral part of this initial activity is the "name game" where students are moved into groups and asked to learn the names of the group members. This "name game" is the first step in developing community among the group members.

Using the components of the cooperative learning lesson ensures that the group is working cooperatively and, thus, provides the catalyst for the development of strong interpersonal relationships as well as the knowledge of efficient group skills. It is imperative that the students begin to learn how to work cooperatively since the majority of these students will be placed into a freshman mathematics course that is structured around group projects.

College Survival Skills

The college survival skills component provides an awareness of the attributes of successful college students. Previous SEEE program models introduced the college survival skills component as a "mini orientation course." Students are "taught" such topics as time management, study skills, and test taking skills to name a few. These topics are critical to student success. Our experience has shown that first-semester engineering freshmen exposed to these topics in traditional orientation style were, for the most part, not putting these skills to practice. With this in mind, a new strategy was developed for the 1995 SEEE summer engineering orientation program.

The new strategy integrated cooperative learning into "teaching" students about the skills necessary for college survival. In this way, students were placed in instructional settings in which they would engage actively engaged in learning the skills necessary to survive the transition from high school to college. For example, students were placed into groups and taught brainstorming techniques. Their task was to brainstorm collectively on what they perceived were "factors to success" in college. Each group was given the charge to prioritize these factors within each group. After a short time (approximately fifteen minutes), the groups were then asked to collectively prioritize the factors.

With the given number of groups (this varied from session to session), say x groups, the top y factors were identified. Each group was given a "factor" and instructed to research and develop a presentation on their respective "factor" which would be delivered on the following day. Each member of the group was given a particular group role and each group was provided guidelines for developing and giving effective presentations. Interestingly enough, the same "success factors" were determined session after session. These "factors" are the same factors identified in traditional orientation courses: time management, study skills, and test taking skills, to name a few.

Mathematics Workshops

Previous SEEE program models incorporated mathematics as a short course with related workshops. The new model eliminated the short course (lecture) and concentrated on students working cooperatively in workshops. The objective of the workshops was to provide students with review in precalculus: analytic geometry, advanced college algebra, and trigonometry.

For those students entering calculus in the fall semester, the mathematics workshops served as a review of the skills necessary for success in calculus. For those who would be placed into precalculus courses, the workshops served as a review to master those skills appropriate to their respective placement. Students were grouped according to the mathematics placement. (Students are required to take the university mathematics placement examination prior to admission into the SEEE program. They all retake the examination at the end of the program to ensure appropriate mathematics placement.)

Given the program time constraints, it was decided that the time allocated for mathematics would be driven by two types of mathematics workshops: one in which students would work on homework sets and the other in which they would work on challenging problem sets. Each of these workshops was driven by cooperative learning in which students were divided into groups using a variety of strategies. Results showed that students improved their course placement, and the improvement was in line with previous SEEE programs which incorporated the short course and workshops.

Design

A critical component of any summer engineering orientation course is the introduction to the various types of engineering majors. At UTEP these are civil engineering, electrical engineering, mechanical and industrial

engineering, materials and metallurgical engineering, and computer science. Traditionally majors are introduced to entering freshmen in an orientation course through lectures or guest speakers. Our new SEEE model introduced the students to engineering through a variety of design projects which represented most of these areas. Each project offered an experiential approach to the development, construction and testing of a related product.

Students were given the option to select one design project which was of interest to them. The five projects were: Surfing the Internet, Beam Bust, Go-Cart Design, Plastic Bricks, and Catapult. *Surfing the Internet* introduced students to the UNIX operating system environment with explorations through a variety of "hidden" files which contained information pertinent to computer science while given the skills to "surf" the Internet. The *Beam Bust* project offered insight into the field of civil engineering with the design and construction of a light wooden beam to maximize support capacity (built to given specifications). The *Go-Cart* project introduced students to mechanical and industrial engineering with the design and construction of a wooden go-cart with safety, maneuverability, speed and aesthetics to consider. The *Plastic Bricks* project in the area of materials and metallurgy involved compression of a variety of unsorted plastic recyclable materials and ground glass into a plastic brick which was tested for strength. The *Catapult* was designed to catapult students into the exciting world of electrical engineering. Building a car with Legos, the catapult on the car was controlled with electronic components (digital, analog and electromagnetic) connected by the students.

A faculty member from each department introduced the students to their department's respective project on the first day of the program. Each of these projects was designed to challenge the students yet be "do-able" given their limited background in the respective subject area. Students met two hours per day for four days for a total of eight contact hours, and the cooperative learning paradigm was imbedded into this component. Since each student could work on only one project, each design group was instructed to give a presentation on the last day of the program. Their charge was to present (in fifteen minutes) their experience and project outcomes. Included in that presentation was information on the related engineering field. The students thus delivered the necessary information regarding each engineering major to all students. Presentations were judged on creativity, communication skills and workmanship, scientific approach, and group participation.

EVALUATION

In 1995a questionnaire was developed and administered to participants of the new "bridge program," SEEE. This informal data collection was the initial step in the development of a design for more systematic documentation and evaluation of the program. Upon the completion of each of the six sessions, students were asked to rate the components of the program and the SEEE program as a whole (1-dull, 6=fantastic). A total of 208 students attended the summer sessions. Based on an analysis of the data, which is reported below, the 1995 SEEE program was a success. In addition, various anecdotal accounts support this conclusion. A number of entering students who attended the SEEE program, have (1) joined engineering student organizations; (2) accepted leadership positions in those organizations; (3) accepted undergraduate research assistantships; and (4) been accepted as outreach facilitators. The results of this informal evaluation provide the basis for the formal evaluation plan which is to be implemented during the summer of 1996. In this section, a summary of the results of the analysis of the questionnaire data and the design for the formal evaluation are presented.

A majority of the students attending the Summer Engineering Enrichment Experience during 1995 rated each of the program components as being helpful: Success Factors (75%, N=l 66); Design Presentations (8 1 %; N=l 65); Mathematics Workshops (67%, N=l 67). Nineteen percent of the students reported that the program components, Success Factors and Design Presentations, were "somewhat helpful," while 30% of the students reported that the Mathematics Workshops were "somewhat helpful." Five percent of the students felt that the Success Factors were

not helpful at all and 3°/0 of the students reported that the Mathematics Workshops were not helpful. None of the students reported that the Design Presentations were “not at all” helpful.

In addition, a majority of students reported that the topics presented during the week-long session were somewhat informative to very informative.

Topic	Informative	Somewhat	Not At All	Number of Responses
Undergraduate Research	113 (71%)	43 (27%)	3 (2%)	N=159
Resume Presentation	90 (77%)	22 (19%)	5 (4%)	N=117
Student Organizations	106 (65%)	50 (31%)	7 (4%)	N=163
Presentation Skills	117 (77%)	30 (20%)	5 (3%)	N=152
Problem Solving Skills	103 (64%)	56 (34%)	7 (4%)	N=166

Ninety-nine percent of the students (N=1 29) responded that the advising overview was informative to somewhat informative. In addition, 99% of the students (N=1 59) rated their advisor as helpful to somewhat helpful. Ninety-seven percent of the students (N=153) would recommend the summer session to their friends. When asked if students planned “to maintain contact with any of the SEEE participants,” 810/0 of the students (N=1 64) responded with “yes.”

CONCLUSION

As one of six awardees of National Science Foundation’s Model Institution for Excellence (MIE), UTEP will emphasize a variety of support programs for entering engineering and science students as one component of a larger model to strengthen the bachelor degree production and ultimately produce more doctoral-level scientists and engineers. In particular, the summer transition program will be a critical piece of this entering student component as a mandatory program for all entering engineering majors. Thus, a model that is one week in length is essential to effectively accommodate the 200-300 entering students (five to six sessions are delivered). Another component of MIE is to accelerate the introduction of active learning strategies like cooperative learning into all of its engineering, science and mathematics courses.

With only one week to deliver a summer orientation to engineering, UTEP’S College of Engineering is committed to maximizing the effectiveness of the program. The 1995 pilot indicates a giant step toward creating a ‘community of learners’ within the entering engineering student body. This is especially critical given the arrival of the MIE and the eventual change in the university-wide classroom environment to a more active learning one.

There is little doubt among the engineering orientation staff that the cooperative learning model was a critical factor in developing a ‘community of learners.’ With a formal evaluation in place for 1996, it will be determined just how critical the cooperative learning component is in creating that community.

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AUTHORS

CONNIE KUBO DELLA-PIANA

An assistant professor in the Department of Communication at the University of Texas at El Paso, Dr. Della-Piana has been published in **Communication Studies, Theory of Practice, Journal of Teacher Education, and Educational Technology.** She received her Ph.D. from the University of Utah and her research interests include the socialization and communication of professionals, organizational ethnography and program evaluation.

ELSA QUIROZ VILLA

As Director of Engineering Programs for the College of Engineering at the University of Texas at El Paso, Ms. Villa develops and implements a variety of pre-college and college recruitment and retention strategies. She received her Bachelor of Science in Mathematics and Master of Science in Computer Science from the University of Texas at El Paso.

SYLVIA D. PIÑON

Ms. Piñon received her B.S. in Industrial Engineering in 1991 from the University of Texas at El Paso and is pursuing her M.S. in Industrial Engineering. She is Assistant Director of Engineering Programs at the University of Texas at El Paso and has developed and implemented the pre-engineering advising system for the College of Engineering as well as numerous other retention strategies.