Improving Freshman Student Success through Undergraduate Research Projects

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Abstract **- Christian Brothers University is a small private, primarily undergraduate institution located in Memphis, TN that primarily focuses on teaching. The Department of Civil and Environmental Engineering at Christian Brothers University has faced several challenges over the years with student retention during the freshman year. Many of these challenges have been attributed to lack of student success through traditional classroom instruction. One solution that was implemented by the Department of Civil and Environmental Engineering, after consultation with current undergraduate students, alumni, and practitioners, was the involvement of freshman-level students in undergraduate technical research projects. This research shows how the morale, success, and retention of the freshman-level students have been impacted by involving these students in undergraduate technical research projects at Christian Brothers University. Students have shown an increased sense of pride and belonging within both their major and the university. This research also shows how student performance in other courses improved through the involvement in undergraduate research projects during the freshman level. Students have shown an increased speed in thought, rationality, and problem solving capabilities in their technical courses (engineering, mathematics, and science).**

Index Terms - Enrollment Growth, Freshman Research, Undergraduate Research, Civil Engineering Research

INTRODUCTION

In engineering academia, the incorporation of research projects at the undergraduate level has always been a topic of discussion. Some scholars believe that undergraduate curriculum should be dedicated only to teaching the fundamentals of topics, while others believe that there should be a balance of teaching fundamental topics in a classroom setting with engaging students in scholarly research projects. Assadollahi and Abdelnaby (2014) [1] showed that an enhancement of understanding technical engineering subject matter can be achieved through non-traditional laboratory projects. Beginning in the fall 2014 semester, the Department of Civil and Environmental Engineering (CEE Department) at Christian Brothers University (CBU) implemented a research program that would involve all levels of undergraduate students, most notably the freshman-level students. The objectives of implementing this research program were to increase the enrollment of the CEE Department through recruiting and retention; as well as enhancing critical thinking abilities, technical skills, and time management qualities. Having an undergraduate research program has been an effective and unique marketing tool for recruiting high caliber high school students to the CEE Department. In addition, this research program has enhanced the current students' sense of belonging and pride in both the department and university, thereby increasing a desire to continue to be a part of the CEE Department and discouraging changes in major or transferring from the university.

OBJECTIVES OF THIS STUDY

The first objective of this research is to show how the morale of the freshman-level students has been impacted through the involvement of these students in scholarly research projects. The second objective is to show how the success and retention of the freshman-level students has been impacted by their involvement in research projects. Additionally, this research shows how student performance in later courses has improved through the involvement in research projects during the freshman year.

CHALLENGES DURING IMPLEMENTATION

Since the CEE Department at CBU is an entirely undergraduate department, many challenges were faced in the implementation of this research program. The first challenge that was encountered was the relatively small size of the department. In the fall 2014 semester, the CEE Department at CBU was only comprised of 46 civil engineering students. Second, the faculty had to continuously keep in mind the mathematical capabilities of the students. The freshman-level students at CBU are typically enrolled in the Calculus courses so any research involving higher-level mathematics was generally not feasible. Having this restriction, laboratory and field research became the more desired path to explore. Next, the academic maturity of the students was noted. The average age of the freshman students in the CEE Department at CBU is 19 years. This age group tends to have the academic maturity closer to that of high school students, which is one of fast-pace gratification and the desire to memorize material, as opposed to comprehending material. High levels of patience are required from the faculty to aid the students in overcoming these traits. Giving the students a

combination of both short-term tasks and long-term tasks seemed to be most effective. The students' desire for immediate results was achieved through the short-term accomplishments while their patience for long-term comprehension was exercised and enhanced through the long-term responsibilities. Another challenge is the issue of social maturity. Students in this age range tend to need more reminders of what actions and language are considered professional. Common unprofessional practices included inappropriate field or lab behavior and attire (e.g. shoes, safety glasses, and gloves), and improper verbal references to equipment. However, with each meeting/interaction, the students showed significant improvement across all levels of maturity. As time progressed and new students became more involved, the older students began to mentor the new students and guide them in what is appropriate.

DEVELOPMENT OF THE UNDERGRADUATE RESEARCH PROGRAM

Beginning in the fall 2014 semester, the faculty of the CEE Department at CBU began advertising the idea of the inclusion of undergraduate students in scholarly research projects. The first two students who expressed an interest in being involved were a junior-level and freshman-level student. Based on the scholarly interests and expertise of the faculty, the first research topic that was initiated with these two students was in the field of geo-environmental engineering (a crossover of geotechnical and environmental engineering). Both students showed high levels of enthusiasm and eagerness to get to work.

By the spring 2015 semester, three additional freshman-level students expressed an interest of being involved in some type of scholarly research project. By the beginning of the fall 2015 semester, there were a total of seven students who were actively working on a variety of research projects. Five of these students were sophomores, who began working on their projects as freshmen. One of the students was a junior and one was a senior (who began working as a junior). The research topics in which the students were involved included: sustainability engineering, environmental engineering, geotechnical engineering, materials engineering, and structural engineering.

By the middle of the spring 2016 semester, an additional five freshmen-level students expressed interest in being involved and began working with the older students. Currently, the CEE Department at CBU is nearing an enrollment of 60 civil engineering-declared students. The undergraduate research group currently has a total of twelve students who are actively involved in one or more scholarly research projects with faculty members. Ten of the twelve students are civil engineering majors while the other two are mechanical engineering majors. Seven of the twelve students are rising sophomores, four are rising juniors, and one is a rising senior.

Since the fall 2014 semester, members of the undergraduate research group in the CEE Department at CBU have co-authored two conference publications which have been accepted into proceedings. Assadollahi, Harris, and Crocker (2016) [2] showed how different percentages and gradations of shredded rubber tire effect the engineering properties of soils. Assadollahi, Crocker, and Harris (2016) [3] showed how different percentages and gradations of shredded rubber tire effect the growth rate of bean plants.

RESULTS

During this study, seven survey questions were sent to several undergraduate students in an effort to qualitatively gage the effectiveness of the newly-formed undergraduate research group. The survey results show enhancements in several aspects of the students' academic habits and qualities. The survey respondents are comprised of 56% rising sophomores, 33% rising juniors, and 11% rising seniors.

I. Survey Question One

"Since being involved with the planning and/or implementation of a research project within the Department of Civil and Environmental Engineering, how has your morale in the department improved?"

It is all too common to overhear and witness academic frustrations from undergraduate students. Academic frustrations can be caused by a host of different reasons (departmental conflicts, financial burdens, etc.). Oftentimes students' morale and excitement for their department tends to decrease as their academic frustrations increase. One of the objectives of implementing an undergraduate research program was to enhance the morale in the CEE Department, thereby offsetting potential academic frustrations and potentially increasing retention within the department. Figure 1 shows survey data on how students' morale in the CEE Department at CBU has been affected since being involved with the planning and/or implementation of a research project. The data shows that approximately 44% of students surveyed say their morale in the department has "Significantly Increased"; approximately 44% of students surveyed feel their morale in the department has "Somewhat Increased", approximately 11% of students surveyed feel their morale in the department has not changed, and none of the students surveyed feel their morale has decreased.

II. Survey Question Two

"Since being involved with the planning and/or implementation of a research project within the Department of Civil and Environmental Engineering, how has your interest in civil engineering been affected?"

As with morale, students' interest in the technical material of their major tends to decrease as academic frustrations increase. A second objective of implementing an undergraduate research program was to enhance the interest of the profession of civil engineering. Figure 2 shows survey data on how students' interest in civil engineering has been affected since being involved with the planning and/or implementation of a research project. The data shows that approximately 44% of students surveyed say

their interest in civil engineering has "Significantly Increased"; approximately 33% of students surveyed feel their interest in civil engineering has "Somewhat Increased", approximately 22% of students surveyed feel their interest in civil engineering has not changed, and none of the students surveyed feel their interest in civil engineering has decreased.

III. Survey Question Three

"Since being involved with the planning and/or implementation of a research project within the Department of Civil and Environmental Engineering, how has your sense of belonging within the university been affected?"

A third objective of implementing the undergraduate research program was to increase the sense of belonging to CBU. Increasing a sense of belonging to the university can tend to decrease the desire to transfer to another university. Figure 3 shows survey data on how students' sense of belonging within CBU has been affected since being involved with the planning and/or implementation of a research project. The data shows that approximately 44% of students surveyed say their sense of belonging at CBU has "Significantly Increased"; approximately 22% of students surveyed feel their sense of belonging at CBU has "Somewhat Increased", approximately 33% of students surveyed feel their sense of belonging at CBU has not changed, and none of the students surveyed feel their sense of belonging at CBU has decreased.

IV. Survey Question Four

"Since being involved with the planning and/or implementation of a research project within the Department of Civil and Environmental Engineering, how do you feel your problem solving capabilities have been affected?"

The next objective of implementing an undergraduate research program involved the enhancement of students' technical problem solving capabilities. Figure 4 shows survey data on how students' problem solving capabilities have been affected since being involved with the planning and/or implementation of a research project. The data shows that approximately 44% of students surveyed say their problem solving capabilities have "Significantly Increased"; approximately 44% of students surveyed say their problem solving capabilities have "Somewhat Increased", approximately 11% of students surveyed feel their problem solving capabilities have not changed, and none of the students surveyed feel their interest in civil engineering has decreased.

V. Survey Question Five

"Since being involved with the planning and/or implementation of a research project within the Department of Civil and Environmental Engineering, how do you feel your study habits and skills have been affected?"

Along with technical problem solving capabilities comes an effective means by which students must manage their study habits. Figure 5 shows survey data on how students' study habits and skills have been affected since being involved with the planning and/or implementation of a research project. The data shows that approximately 33% of students surveyed say their study habits and skills have "Significantly Increased"; approximately 33% of students surveyed say their study habits and skills have "Somewhat Increased", approximately 33% of students surveyed feel their study habits and skills have not changed, and none of the students surveyed feel their study habits and skills have decreased.

VI. Survey Question Six

"Since being involved with the planning and/or implementation of a research project within the Department of Civil and Environmental Engineering, how do you feel your time management skills have been affected?"

One of the greatest challenges for anyone is the enhancement of personal time management skills. As students are transitioning from high school to the college-level, having adequate time management skills becomes a more essential aspect of personal and academic success. Figure 6 shows survey data on how students' time management skills have been affected since being involved with the planning and/or implementation of a research project. The data shows that approximately 33% of students surveyed say their time management skills have "Significantly Increased"; approximately 44% of students surveyed say their time management skills have "Somewhat Increased", approximately 22% of students surveyed feel their time management skills have not changed, and none of the students surveyed feel their time management skills have decreased.

VII. Survey Question Seven

"Since being involved with the planning and/or implementation of a research project within the Department of Civil and Environmental Engineering, what has been your opinion on the pursuit of a higher degree (master's degree or Ph.D.)?"

Because of the inherent short-term thinking that many undergraduate-level students experience, it is uncommon that the majority of them would seriously consider pursuing a graduate-level degree. Often the students who are considering it are not fully exposed to the level of academic rigor for which a graduate student is responsible. Figure 7 shows survey data on how students' opinion on the pursuit of a graduate degree has been affected since being involved with the planning and/or implementation of a research project. The data shows that approximately 67% of students surveyed say their opinion on the pursuit of a higher degree has "Significantly Increased"; approximately 11% of students surveyed say their opinion on the pursuit of a higher degree has "Somewhat Increased", approximately 22% of students surveyed say their opinion on the pursuit of a higher degree has have not changed, and none of the students surveyed feel their opinion on the pursuit of a higher degree has decreased.

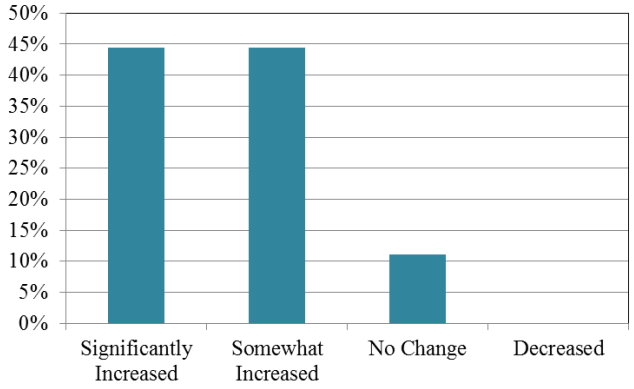

FIGURE 1
DATA ON THE MORALE OF THE CEE DEPARTMENT AT CBU.

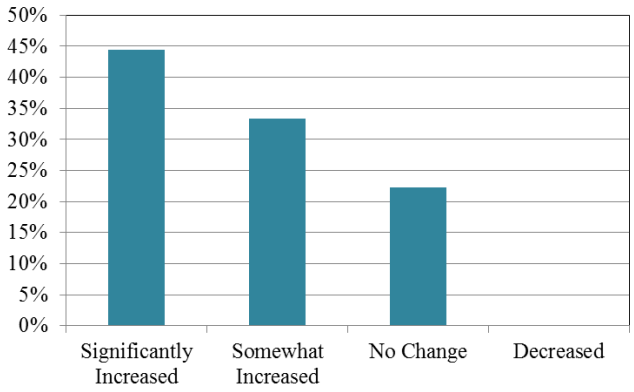

FIGURE 2
DATA ON THE INTEREST IN CIVIL ENGINEERING.

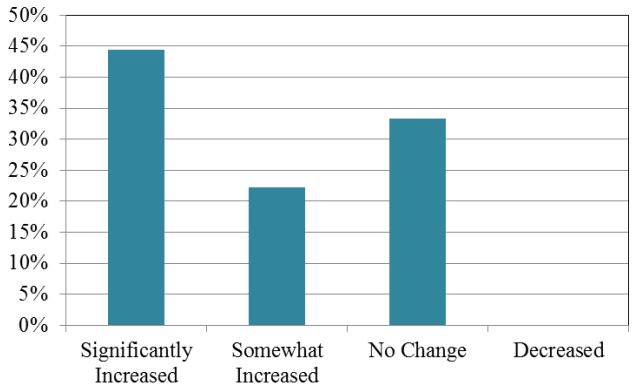

FIGURE 3
DATA ON THE SENSE OF BELONGING WITH THE UNIVERSITY.

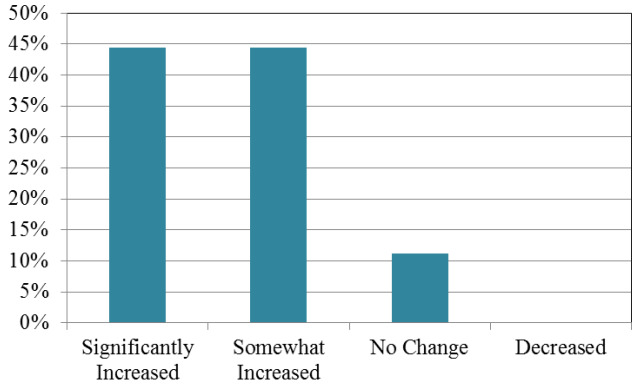

FIGURE 4
DATA ON THE PROBLEM SOLVING CAPABILITIES OF STUDENTS.

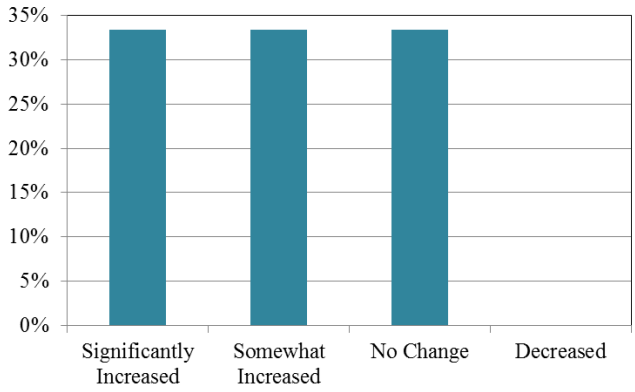

FIGURE 5
DATA ON THE STUDY HABITS AND SKILLS OF STUDENTS.

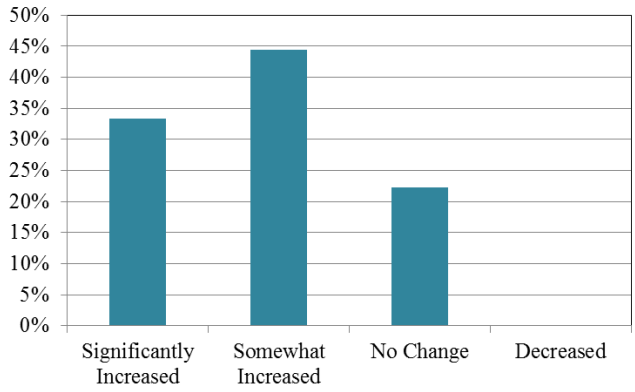

FIGURE 6
DATA ON THE TIME MANAGEMENT SKILLS OF STUDENTS.

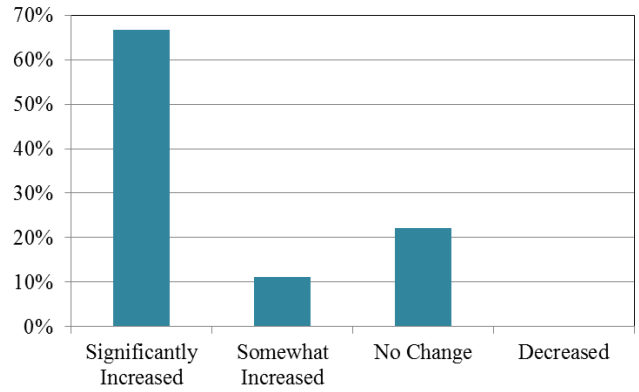

FIGURE 7
DATA ON THE INTEREST IN PURSUING A GRADUATE DEGREE.

CONCLUSIONS

The purpose of this research study was to show several positive effects that implementing an undergraduate research program can have on students, namely at the freshman-level. This research has shown how the morale of the undergraduate students in CEE Department has been positively impacted by involving these students in technical research projects. Students have shown an increased sense of pride and belonging within both their major and the university. This research has shown how students' performance in their academic courses has improved through the involvement in research projects. This was shown through the positive impact on students' problem solving capabilities, study habits, and time management skills. This research shows how the development of an undergraduate research program where students, beginning at the freshman-level, are actively engaged in higher-level engineering activities can have an overall, positive impact on a department. The next phase of the undergraduate research group within the CEE Department at CBU is to reach out to junior and senior-level high school students in the Memphis area to engage them in our scholarly research endeavors. This has the potential of being a valuable recruiting tool for the department.

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