Early Internships for Engineering Technology Student Retention: A Pilot Study

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Abstract

Research in engineering technology major retention suggests that early internships present an outstanding opportunity for freshman and sophomore students to engage, socialize, and learn in communities of practice and to “discover” the link between theory and practice early in their academic tenure, leading to a consequent improvement in retention rates. At Texas State University, the traditional senior-level capstone internship program was reengineered and converted into a sophomore level program with minimal prerequisites so as to enable sophomore-level engineering technology students to participate early in the internships, explore their majors, and undergo experiential learning in the world of practice in their chosen disciplines. The motivation for this project came from onsite internship industry interviews and the department’s three industrial advisory boards, which strongly suggested that early, immersion-type industrial experiences would prepare students to become better learners. This conversion coincided with the strategic imperatives that stemmed from a university-wide second year STEM major retention effort. This latter effort culminated in a four-year NSF funded project, of which the early internships are a module. This paper presents research that was conducted at Texas State University on the STEM major retention issue and the intervention measures that were adopted to enable students to become more integrated socially and academically and become effective learners. Also included are a description of the internship program reengineering effort, the details of the early internship program implementation, and aspects of how the program is facilitating the assessment of student learning outcomes for ABET and other accreditation processes. The paper concludes with preliminary results that were harvested from the pilot implementation in Summer 2015 and with directions for future work.

Introduction

In the summer of 2015, the Department of Engineering Technology at Texas State University made a significant and fundamental change in its long-standing internship program. For nearly two decades, the internship program was a senior-level course that was offered once a year; in the summer. Students pursuing internship would have completed most of their general education, math, science and technology courses prior to commencing their internship. Thus, the internship program was a capstone experience. For most students, the internships translated into full-time jobs upon graduation. This capstone nature has historically been the key characteristic of internship programs in professional disciplines, unlike cooperative education programs, which involve multiple cycles of alternate academic and industrial learning experiences.

The change essentially entailed moving the internship from the senior year to the sophomore year. Naturally, the prerequisites for the internship changed notably. Now students complete a significant portion of their undergraduate studies upon the completion of the internship experience. These changes resulted in fundamental changes in the perspectives and educational objectives of the internship program. Essentially, the internship program lost its capstone, integrative character and gained a cornerstone, educational experience character. Thus, this early internship experience and the expected outcome of such intervention, which is improved retention, is the key contribution of this work to the body of research in internships.

Reasons for Changing the Internship Program

There were two key drivers for the change in the internship program. Since the impact of early internships on STEM (specifically, engineering technology) major retention is the focus of this paper, this driver is first presented.

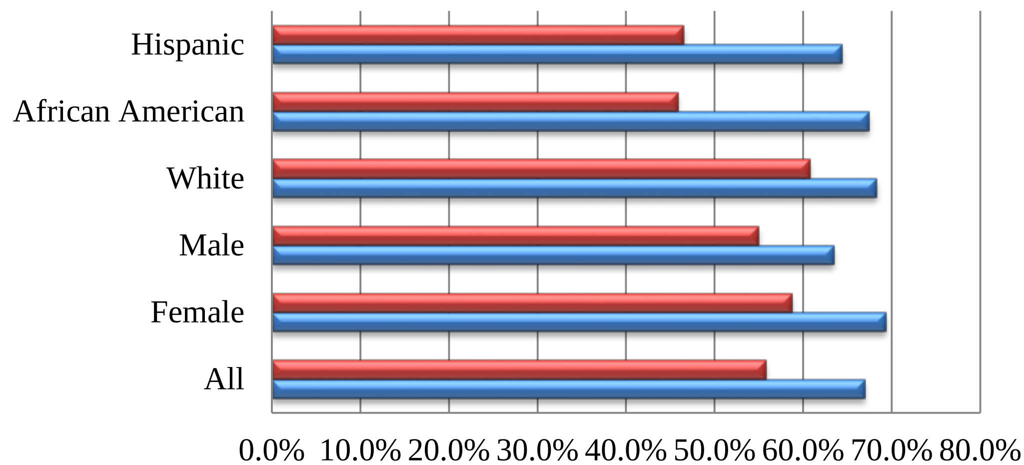
A. The Issue of STEM Major Retention

The President's Council of Advisors on Science and Technology's (PCAST) recent report [1] predicts that the U.S. workforce's supply will be 1 million short of the demand for graduates in science, technology, engineering and mathematics (STEM), but less than half of those who enter U.S. colleges to pursue majors in STEM persist to graduation. According to the National Science Foundation, in 2006 the relative percentage of students receiving STEM degrees were at levels no different or lower than those of the past ten years [2]. However, the Bureau of Labor Statistics reports that by 2018, more than 3 million job openings will be created in STEM disciplines [3]. The Department of Commerce estimates that in the coming years STEM occupations will grow 1.7 times faster than non-STEM occupations [4]. Thus, there is a critical need to remedy this shortage of STEM professionals to ensure continued growth in the U.S. economy.

Texas is the second most populous state in the nation, surpassed only by California and followed by New York. According to the Texas Comptroller of Public Accounts [5], Texas is one of the fastest growing states in the nation. Since 2000, the state's population has increased by 12.7%, nearly twice that of the nation. The U.S. Census Bureau data indicate that Hispanics/Latinos accounted for 38.2% of Texas's population in 2012. This makes this group the second largest in the state. According to the Pew Research Center, Hispanics will likely become the largest group in the state within ten years, outnumbering whites [6]. Similar projections have been made at the national level as well. According to the U.S. Census Bureau, by the year 2050 African American, Hispanic, Asian and Native American populations will account for 50% of the total U.S. population [7]. Thus, while it is imperative that the number of STEM graduates in Texas be increased it is equally important to accomplish this outcome in the context of the increasing Hispanic population in the state. One approach to pursue is to focus on retaining undergraduate students of diverse backgrounds who are currently in STEM fields of study and to support them to successfully graduate.

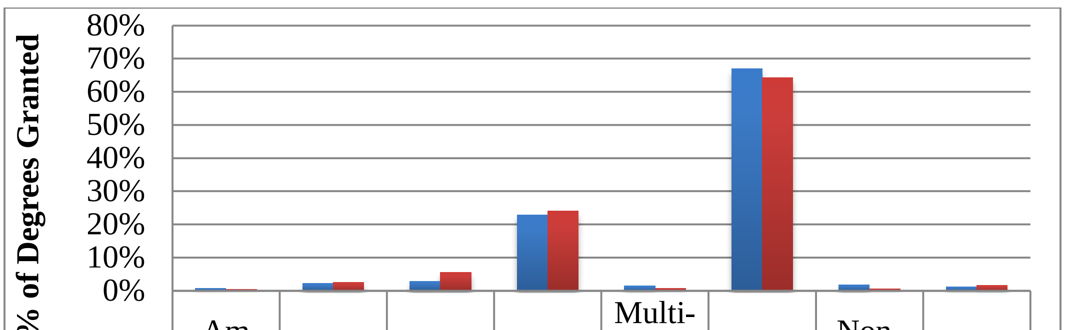
Given that Texas State University is located in a state that has a very vibrant economy, while simultaneously facing a grave workforce shortage issue, it was imperative for Texas State University to get involved in the search for remedies to the workforce issue. The first part of our research was an in-depth multi-year data analysis of student retention statistics for STEM students at Texas State University. Such an analysis is important to the institution and should also prove to be very relevant to the national dialogue on STEM retention. The Figures 1-4 and Table 1 summarize our findings. Figure 1 compares the two-year retention rates at Texas State

University for all majors (University) versus the STEM majors (STEM). Figure 2 presents the degrees granted in 2012 at Texas State University by demographic, the percentages are of all degrees awarded at the university (Overall) or in STEM (STEM). Table 1 lists the 4-, 5-, and 6-year graduate rates by demographic for the 2012 student cohort at Texas State University. Figure 3 presents the 2012 university's STEM student demographics. Gender distribution is compared between the overall university undergraduate population (Undergrads) and the STEM undergraduate population (STEM) in Figure 4.



	All	Female	Male	White	African American	Hispanic
STEM	55.8%	58.7%	55.0%	60.8%	45.8%	46.5%
University	67.0%	69.3%	63.5%	68.3%	67.4%	64.4%

Figure 1: Two-Year Retention Rates by Demographic at Texas State University



	Am Indian/ Alaskan Native	Asian/ Pacific Islander	Black, non-Hispanic	Hispanic	Multi-race, non-Hisp, non-Black	White, non-Hispanic	Non-Resident International	Unknown
STEM	1%	2%	3%	23%	1%	67%	2%	1%
Overall	0.4%	2.6%	5.5%	24.0%	0.7%	64.3%	0.7%	1.7%

Figure 2: Degrees Granted by Ethnicity at Texas State University in 2012

Table 1: STEM student cohort graduation rates

STEM Student Cohort Graduation Rates *[2012]*			
Years	White	Black/African American	Hispanic/Latino
4 yrs	19.8%	0.0%	6.7%
5 yrs	39.7%	0.0%	26.7%
6 yrs	45.5%	16.7%	33.3%

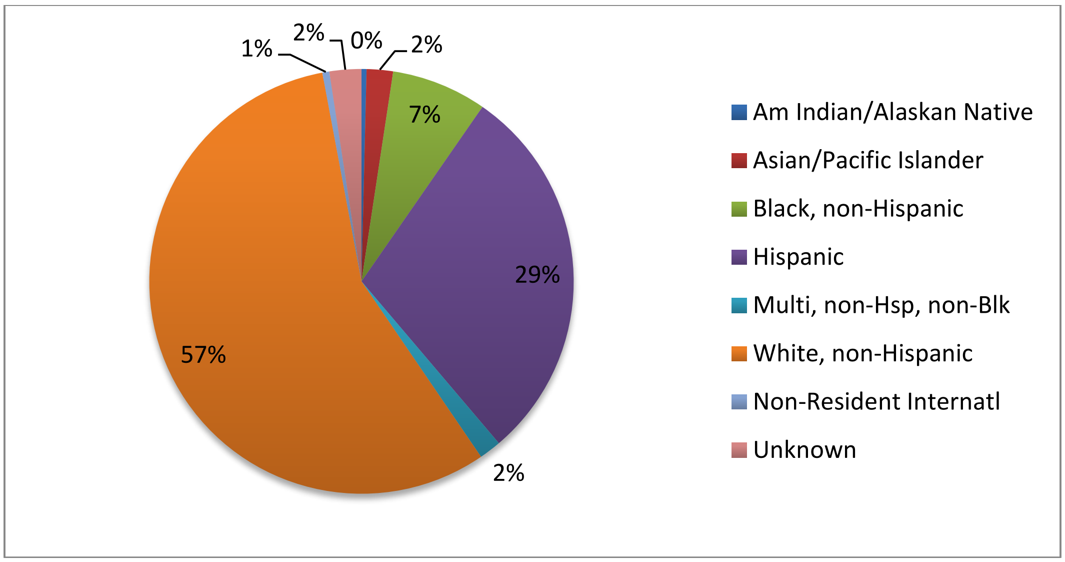


Figure 3: Demographics of STEM Majors at Texas State University

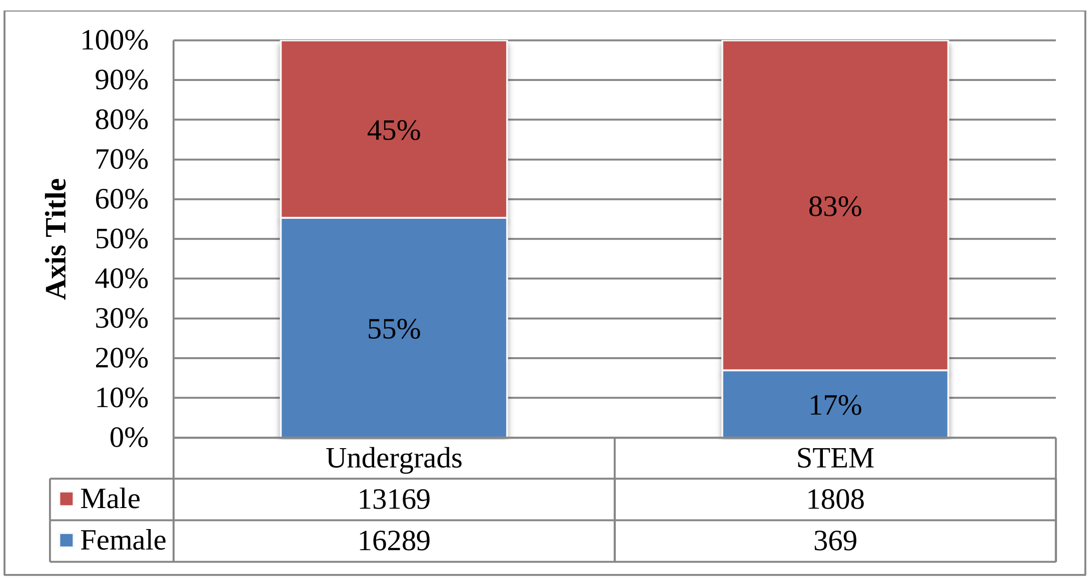


Figure 4: Student Demographics by Gender at Texas State University in 2012

Through analysis of the aforementioned demographic statistics and retention rates, several gaps were detected:

Gap 1: STEM majors are not proportionately retained in their chosen field of study. While 67% of 2nd-year students are retained in their chosen field of study, only 56% of 2nd-year STEM majors are retained in their chosen field of study.

Gap 2: Hispanic and African American STEM majors not proportionately retained in STEM. While 60% of 2nd-year White STEM majors are retained in STEM, only 46% of 2nd-year Hispanic and African American STEM majors are retained in STEM.

Gap 3: Hispanic and African American students not proportionately (in relation to university-wide demographics) represented in STEM majors.

Gap 4: Female students not proportionately (in relation to university-wide demographics) represented in STEM majors.

Next, the research project focused on retention theories to guide the design of intervention measures. While several theories of retention have emerged over the last few decades, two have dominated the theory and practice of retention:

1. Tinto's academic and social integration model [8, 9, 10] and
2. Astin's involvement model [11, 12]

In a nutshell, Tinto and Astin suggest that retention and persistence to graduation occurs when students successfully integrate into the institution academically and socially and when students are involved and connected. Involvement refers to both formal academic or intellectual pursuits as well as co-curricular activities. Additionally, Bandura [13] ties the concept of persistence as a manifestation of motivation, while Graham et al [14] view motivation as a driver of student engagement. *Self-efficacy* or confidence is one among several constructs underlying motivation. Additionally, our research included a consideration of the learning style preference amongst the different genders and ethnic groups. In brief the following is what research suggests. First, in traditional science and engineering institutions, individual personnel success is highly regarded. However, women and underrepresented minorities commonly place high value on people and group-oriented activity [15]. Pearson & West suggest that the traditional classroom structure is designed to foster independent, non-collaborative thinking and is most supportive of white males [16].

Informed by these findings the research team came up with the following broad intervention strategy the goal of which was to ensure that students are provided with academic support, pedagogies are adopted that promote active and collaborative learning, empower students to take charge of their learning and develop a sense of community or belonging in their professional disciplines and socially:

1. Improve instruction by establishing an active learning in STEM education faculty community and redesign introductory courses.

2. Provide early and motivating field-of-study and career explorations.
3. Foster meaningful engagement experiences into the professional community.
4. Support student academic learning through evidence-based peer instructional approaches.

Of these four intervention strategies, the one that has relevance to this paper is to provide for "guided professional experiences that would combine academic and professional components" through the vehicle of second year industrial internships [17]. Early internships as detailed in this paper are aligned with strategies 2 and 3 from above. Each student would be assigned an industrial mentor with whom the student would work with for the tenure of the internship. Students would benefit by working with fellow interns and a cross section of company employees. Thereby, students pursuing internship would belong to a "community of practice".

To recap, programs that have been successful in improving the retention and persistence of college students in STEM deploy three interventions, which include: 1) early research experiences, 2) active learning, and 3) membership in STEM learning communities [14]. This research suggested that early internships embody all of the aforementioned interventions. Thus, this project's efforts envision a new orientation to internships that sets it apart from historical versions of these programs. This orientation is the early, immersion nature of the program with retention being a key focus that sets it in contrast to the integrative, capstone nature of the traditional internship program.

Interest in early internships has been recently demonstrated by both industry and academia. Companies such as Intel, Northrop Grumman and GE offer early internships [18, 19, and 20]. Many universities also report their successes with early internships. At the University of New Mexico, internships for early career engineering and computer science students resulted in the participant's increase in self-efficacy [21]. According to researchers at John Brown University, internships enhanced construction management student's learning and problem solving abilities [22]. In turn, these enhancements have led to improved persistence. In response to concerns regarding retention of lower division engineering students at Boise State University, the College of Engineering at this institution has instituted as part of their intervention the placement of first and second year students in industry internships so as to increase students' real world experience and confidence [23].

B. Input from Industrial Advisory Boards

Another key driver for the changes in the internship program came from the department's three industrial advisory boards (IABs) and from communication with internship supervisors in the industry. In May 2012, the three IABs, which are associated with the construction science and management, concrete industry management and metal casting programs, met with the chair and faculty of the department to propose changes to the existing internship program. These members of industry suggested that the internship program needed both conceptual and structural changes to be effective. The key conceptual change proposed was that the internship be an immersion experience in which the industry would provide sophomore-level students, who may have had little or no prior industrial background, with valuable industrial work experiences and perspectives. The philosophy of the past internship program was one of preparing seniors through the vehicle of a terminal or capstone experience for immediate placement in industry. The department's industrial partners had no expectation that interns would have been "prepared" to serve an internship. Rather, they viewed lower division students as "raw recruits" ready to be "shaped" by their exposure to industry, in order that such exposure will add value to their further academic preparation [24].

Structurally, the existing internship program had the following characteristics that were deemed undesirable by the IABs: 1) the program was offered only in the summer sessions; 2) it required considerable academic supervisor oversight; 3) the internship grade was mostly determined by the academic supervisor; and, 4) as a writing intensive course, some of the program requirements were consuming students' working hours in a manner that was inefficient. Specifically, the interns had been required to prepare daily logs that painstakingly described the details of work engagement by the hour and an equally tedious, descriptive account of reflections of the students on those activities. The summer-based, five-week long regimen could not permit the industry to accomplish much of substance with an intern. The department's industrial partners also had to deal with a tremendous demand for intern positions over a very narrow window of time. Given that the internship was an experiential learning experience under the immediate and daily supervision of the industrial supervisor that occurred off campus at a work site, it made little sense to have intense academic oversight and input into the grading process. Lastly, while the importance of written communication skills can hardly be over emphasized, the internship program was not thought to be the best means of accomplishing this outcome. Students were overburdened with painstaking note keeping during and after the workday that could be somewhat distracting from the rich and total attention that a work situation demanded. Further, the department's industrial partners suggested that the internship program should be offered throughout the year, on a 14-week basis (or 10-week when offered in summer) as opposed to only in the five-week summer sessions.

Based on these developments, the authors of this paper designed a second-year, mandatory internship program for all majors in the Department of Engineering Technology with feedback from the faculty and industry. The details of the new program follow.

Details of Implementation

The implementation of the new internship program consisted of the following phases:

Phase I – Formation of the Sophomore Internship Course

As detailed in the previous section, administrators, faculty, and industry representatives met formally and informally to discuss and come to a consensus on the changes desired in the department's internship course. It was from these discussions that the one-hour Sophomore-level internship course was designed and offered for the first time in Summer 2015.

Phase II – Policies and Procedures for the New Internship Program

A. Application Procedures

Similar to the prior internship course, the new one requires the student to fill out an application to take the course and provide supporting documentation for the internship coordinator to make a determination as to the eligibility of the student to undertake the internship. These forms include an application and prerequisite worksheet that has been revised for the new requirements of the course. The main differences that affected these two pre-existing forms were the requirement changes from 75 hours of completed coursework to 45 hours and from all math and sciences completed to only two completed math and/or science courses.

B. Assessment Methods

Based upon the results of the above decision, the evaluation forms to be filled out by the industry supervisor and student were created to limit the time-intensiveness of past reports/evaluations (as detailed in the earlier section) while still capturing data that faculty supervisors could use to ascertain the effectiveness of the internship program and the experiential learning process. Remaining a summer course at 400 hours and 50 days, it was decided that there should be intervals of contact between all parties to keep channels of communication open: preliminary evaluations during the first week, midterm evaluations at five weeks, and the final evaluations at ten weeks. The design of these forms thus followed the level of immersion the student would have had at those intervals. The first week makes contact between all parties while evaluating the appropriateness of the student to the internship. At five and ten weeks, the industry supervisor and student were asked to verify hours worked, rate of intern pay, recommendations for improvements they might have, and for any other comments they wanted to share. The industry supervisor was also given a five-point Likert-scale list and was asked to rate the students on: critical thinking and problem solving, ability to learn, taking initiative and the ability to engage in self-directed professional development (lifelong learning), interpersonal skills (people skills), team working skills, able to work well in a diverse environment (cultural, gender, age, company position, etc.), oral communication, written communication, professional skills, good work habits, sound ethics and integrity, timeliness, time management, knowledge of contemporary issues, and understands the societal impacts of technical solutions. These attributes were derived largely from ABET's student outcomes for Engineering Technology programs. The student's evaluation contains open-ended questions for the student to share their experiences. The final evaluations are intended to be the vehicle that the faculty supervisor will use for grading. An accreditation course assessment form focused on the appropriate program is the last document collected. Thus, the assessment includes both formative and summative elements.

C. Method of Delivery of Application Forms

The disbursement of the application forms for the prior internship course has been online via the department's website. With the amount of forms required at different stages of the process, a checklist has been created identifying the forms and their appropriate deadlines for submission. The new internship course forms were also placed on the website under the new course title. The forms were published in pdf and Microsoft Word formats as students have had issues in the past with software. The reduction of hours eliminated the need for the college level advisors to review the degree audits before the student could submit the application forms. The prerequisite sheet requires the student to become familiar with their degree audit so they may fill out the form.

Phase III – Internship Management and Student Supervision

A. Course Requirements and Meetings with Students to Explain the Course Changes

The internship coordinator hosts three internship meetings every year to introduce and explain the internship program to students. The first meeting, held in October, introduces students to the course, degree audits, and networking opportunities. The second meeting, in February, is held to review the application process and deadlines. The final meeting, at the end of the spring semester, is to finalize all paperwork and review the forms that will be utilized during the internship when students will be out in the field. This schedule is based on the fact that internship is currently (and historically) a summer-only program. As the internship expands to provide students and companies the opportunity to engage in internships all year long, the schedule and intent of meetings will be accordingly revised. In all three meetings, the differences between the old, senior-level internship course (TECH 4390) and the new sophomore-level course (TECH 2190) are reviewed. As those students required by their degree audit to complete the upper level course graduate, TECH 4390 will be deleted from the course catalog. Figure 5 presents the similarities and differences between the two internship courses.

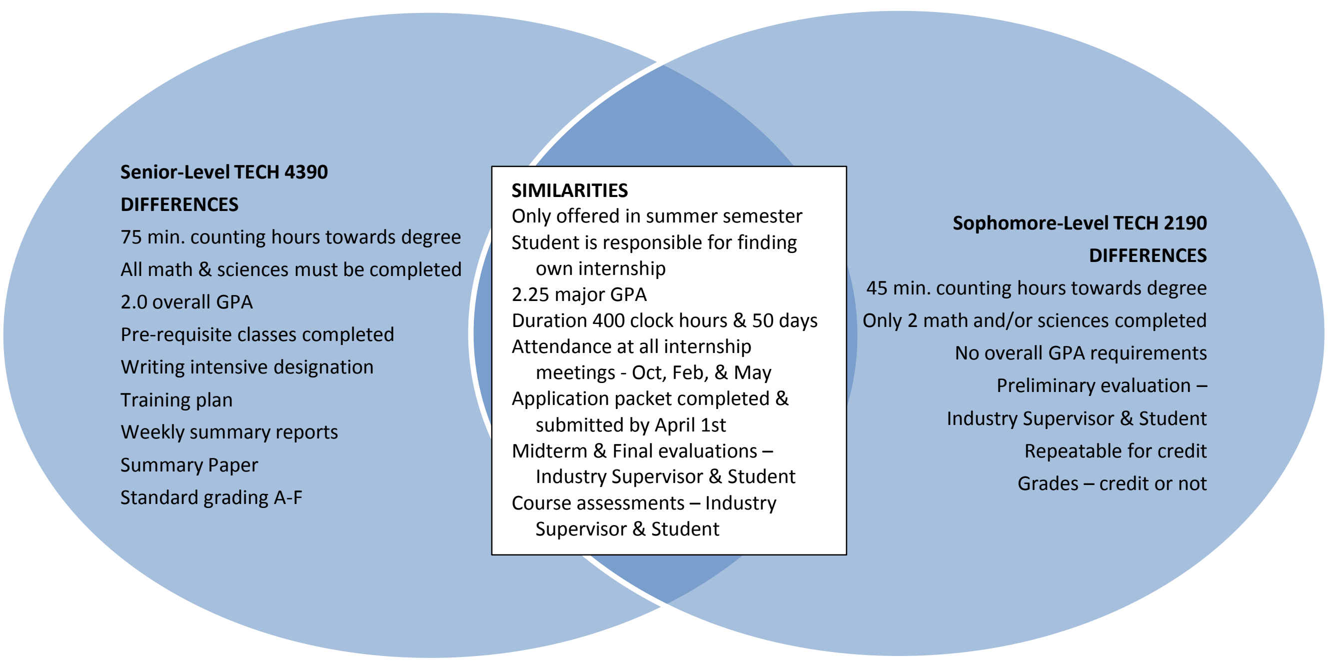


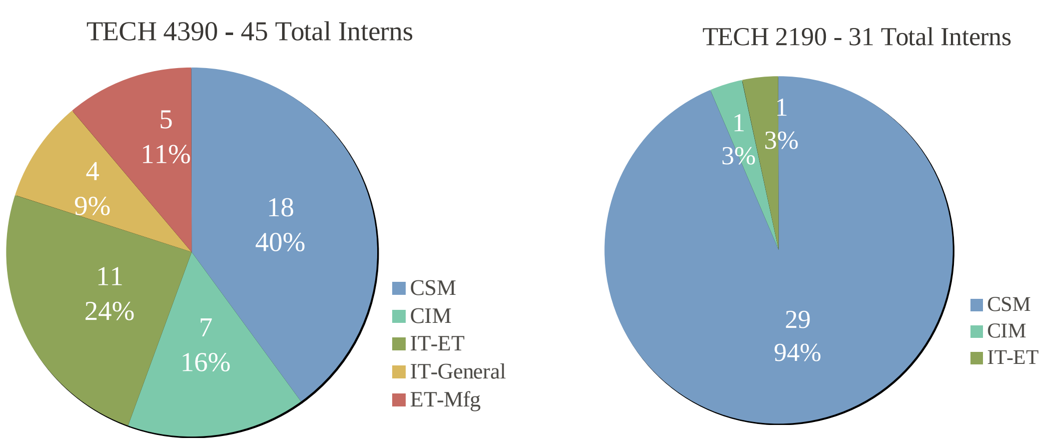
Figure 5: Venn diagram of TECH 4390 and 2190 Similarities and Differences

B. Communication with Students

The meeting sign-up sheets gather the list of students considering participating in the internship in the upcoming summer. This information is used to create an online site, through the university’s course management software, where students can receive important updates, job postings, meeting notices, and information from the Internship Coordinator. This site streamlines the communication process and reduces the email burden on the coordinator. While this site is used for communication, the departmental website is still the location of all the forms required for the course which helps with errors and redundancy.

C. The Student Application Review Procedures

Receiving 116 applications for both the Senior-level and the Sophomore-level courses this past summer required diligence in organizing the documents. The documents were submitted to the main office and placed in individual folders with the student's name, student number, and specific internship course requirement listed on the label. As in the past, the internship coordinator then created a spreadsheet to organize the data for both courses. For each course, the information was entered from the forms and supplemental information provided by the student into the spreadsheet. The requirements, as listed in Figure 5, were used as the spreadsheet headings. The process was straightforward, albeit labor intensive with attendant risks of data entry error. Once approved, each student was contacted with the approval/disapproval decision and a reminder of the final meeting. Figure 6 presents the breakdown of the students that were approved to take the two internship courses last summer and their respective majors. For reference, the following majors participated in this internship program during the summer of 2015: Construction Science and Management (CSM), Concrete Industry Management (CIM), Industrial Technology-Electronics Technology (IT-ET), Industrial Technology-General Technology (IT-General), and Engineering Technology-Manufacturing Engineering Technology (ET-Mfg).



TECH 4390 – 56 Applications Reviewed TECH 2190 – 60 Applications Reviewed

Figure 6: Participation by Major in TECH 4390 and 2190 Summer 2015 (n=76)

Results from the Pilot Implementation

Faculty Supervisor Feedback

The documents used during the internship include preliminary (1st week), midterm (5th week), and final (10th week) evaluations by both the Industry Supervisor and the student. The use of these forms during the implementation resulted in the following feedback:

1. The online forms were given in both Adobe pdf and Microsoft Word options, but many students and Industry Supervisors had trouble with the formats. Software familiarity and availability, internet access, as well as computer literacy of end users remains an issue that needs to be resolved.
2. The Likert-scale format was popular with the Industry Supervisors, but the comments portions of each Likert-scale item was overlooked in the majority of cases eliminating the possibility of collection data for future qualitative analysis.
3. The extent of critical analysis employed by Industry Supervisors of the students in assessing how far the students met expectations exhibited considerable variability. Half of the Likert-scale results were the highest ratings. Does this response rate actually represent the excellence of the students or the lack of critical analysis on the part of the Industry Supervisors who found checking the highest rating to be expedient?
4. The grading of the student evaluations proved challenging for baseline grading. The complexity of varied students, industries, and open-ended qualitative questions required consideration on the part of the faculty supervisor as to the student meeting the minimum day and hourly requirements, written page requirements, timely submission, and depth of written response. The elimination of daily logs reduces the faculty's ability to verify that the hourly/day requirement has been met, but the Industry Supervisor's final evaluation asks for verification about these requirements. There was some confusion by a few in the way these requirements were to be reported on the evaluation form.
5. Students requested a reminder email about upcoming evaluations as they discovered it was too easy to be absorbed in the industry environment and forget the academic deadlines of the course. The faculty supervisor easily accommodated this request through the course site.

Industry Supervisor Feedback

Figure 7 represents the Likert-scale feedback on the Industry Supervisor's final evaluation form for the students that participated in TECH 2190 in the Summer 2015 semester. This form is collected at the end of the 10-week session when Industry Supervisors were asked to rate the student in meeting the following expectations. The legend for the scale used is as follows: 5 = consistently exceeds expectations, 4 = sometimes exceeds expectations, 3 = meets expectations, 2 = rarely meets expectations, and 1 = does not meet expectations.

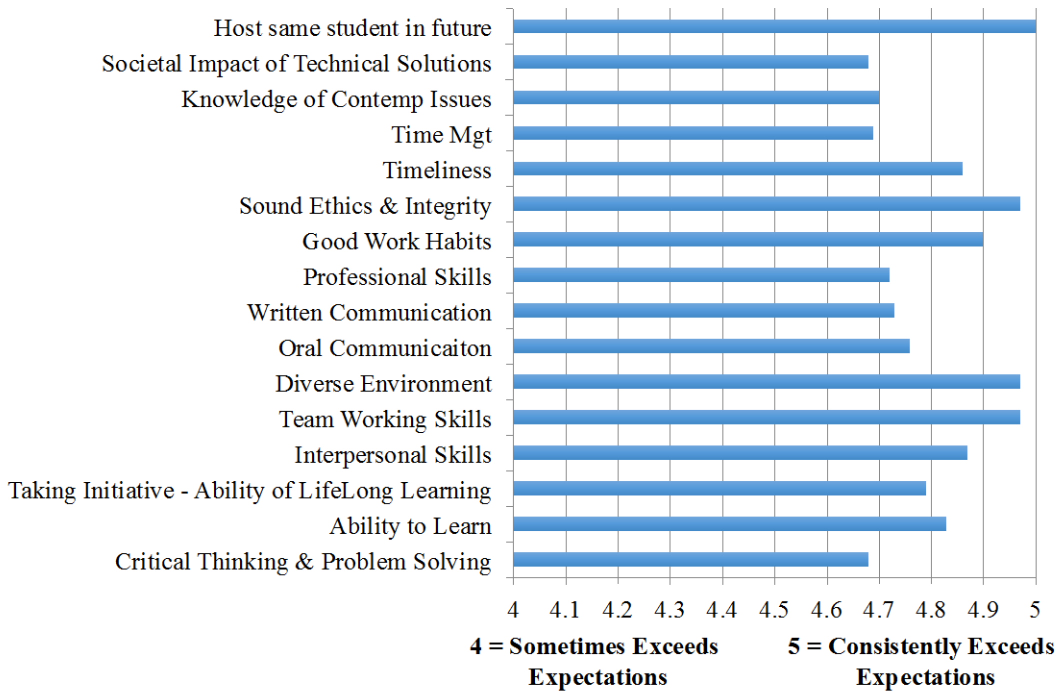


Figure 7: Industry Supervisor's Outcomes Evaluations of TECH 2190 for Summer 2015

The Industry Supervisor's evaluations suggest that the new internship program is currently functioning effectively and does not reveal any major issues that need immediate corrective response. However, as pointed out earlier, the scores on all student attributes range from 4.68-5.0 on a scale of 1-5. This result is somewhat suspect and may reveal a lack of critical analysis of student performance before the scores were assigned. This issue will be addressed in the revision of the evaluation forms for next iteration of the new internship program. The validity of the instrument will be evaluated by analyzing the clarity of the questions, the Likert scale number of levels and descriptions, and the length of the survey.

Some of the other feedback from the industry partners in this initial offering were: 1) that students appeared more "green" than past interns. This is in keeping with the change from the past senior-level to new sophomore-level of students; 2) The Industry Supervisor's evaluations included "Comments" sections that were disregarded in many cases in filling out the forms. Plans are to rework the forms to emphasize these important means of feedback while improving the ease of filling out the forms.

Conclusion and Future Work

Based on extensive research on demographics and retention data and theories of retention and learning, several intervention measures were instituted at Texas State University to facilitate the retention of second year STEM majors. Early internships were identified as one of the intervention measures. Accordingly, an early internship program was implemented for the first time in Summer 2015 in the Department of Engineering Technology at Texas State University. Early immersion in the industry and improved retention and persistence to graduation were amongst the desirable outcomes that served as the driving forces for changing the traditional capstone-oriented internship as detailed in this paper. Literature reveals a recent interest in early internships on the part of the industry and many professional programs of study on account of its beneficial impact on student retention. Based on the pilot run of the sophomore-level internship program and on the feedback received from the Industry Supervisors, the experiential learning program is performing as intended. However, an analysis of the assessment instruments and a review of sustained evaluations over a two-year period are necessary to assess the impact of the early internship on student learning in the academia in the post-internship years, as well as their retention and persistence to graduation.

The future work that will be conducted will include:

1) The Industry Supervisor evaluation forms will include a detailed rubric to assist the supervisors in conducting a critical analysis of student performance;
2) The application process can be streamlined in data gathering by implementing the online toolkit software used by the university. This software can be organized to simplify the data gathering and have it organize the preliminary spreadsheet for decision-making. This will eliminate the need for paper copies and separate data entry;
3) Students that completed TECH 2190 will be invited to an additional research study and requested to complete a final questionnaire before graduation where they will be asked to reflect on how the internship has impacted their remaining studies and their outlook on their future professional career. A comparative analysis of the qualitative student responses gathered during the internship and this final questionnaire will be completed; and
4) A spreadsheet will be maintained by the internship supervisor that would track the progress of students who have completed internships in the third and final years of study at the university. Information such as GPA, persistence in major, persistence to degree, etc. will be monitored to determine the effects of the early internship on students in the post internship period. The findings that result from such extended studies will be disseminated in future conferences and journal publications.

Acknowledgments

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References

1. PCAST (2012) Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics, Washington, DC.

2. National Science Foundation (2012). *Science and Engineering Indicators, 2012.* Available: http://www.nsf.gov/statistics/seind12/c2/c2s2.htm. Arlington, VA.

3. Bureau of Labor Statistics (2014). *STEM 101: Intro to tomorrow's jobs.* Retrieved in April, 2014 from: http://www.bls.gov/careeroutlook/subject/stem.htm

4. U.S. Department of Commerce and the National Economic Council (2012) *Competitiveness and Innovative Capacity of the United States Report.* Washington, D.C. Published by The U.S. Department of Commerce.

5. Texas Comptroller of Public Accounts (2014). The Texas Economy- Economic Outlook. Retrieved May 2013 from: http://thetexaseconomy.org/economic-outlook/

6. Pew Research Center, (2014). *In 2014, Latinos will surpass whites as largest racial/ethnic group in California.* Retrieved on January,2014 from: http://www.pewresearch.org/fact-tank/2014/01/24/in-2014-latinos-will-surpass-whites-as-largest-racialethnic-group-in-california/

7. U.S. Census Bureau (2013). United States Population Projections: 2000 to 2050- The 2009 National Population Projections. Retrieved on May 1, 2013 from: http://www.census.gov/population/projections/files/analytical-document09.pdf

8. Tinto, V. (1975). Dropout from higher education: a theoretical synthesis of recent research. Review of Educational Research in Higher Education 45(1), 89-125.

9. Tinto, V. (1987). Leaving college: Rethinking the causes and cures of student attrition (1st Ed.). Chicago, IL: University of Chicago Press.

10. Tinto, V. (1993). Leaving college: Rethinking the causes and cures of student attrition (2nd Ed.). Chicago, IL: University of Chicago Press.

11. Astin, A. (1975). Preventing students from dropping out. San Francisco, CA: Jossey-Bass.

12. Astin, A. (1977). What matters most in college: Four critical years. San Francisco, CA: Jossey-Bass.

13. Bandura, A. (1989) Human Agency in Social Cognitive Theory, *American Psychologist*, Vol. 44, No. 9.

14. Graham, M.J., Frederick, J., Byars-Winston, A., and Hunter, A. (2013) Increasing Persistence of College Students in STEM, *Science*, Vol. 341.

15. U.S. Department of Education (2000) Entry and Persistence of Women and Minorities in College Science and Engineering Education, Office of Educational Research and Improvement, NCES 2000-601.

16. Pearson, J.C., and West, R. (1991) An Initial Investigation of the Effects of Gender on Student Questions in the Classroom: Developing a Descriptive Base, *Communication Education,* 40, 22-32.

17. Ortiz, A., Talley, K., Novoa, C., Eleanor, C., Guirguis, M., Morey, M., Feakes, D., Sriraman, V. and Huling, L. (2014) Texas State STEM Rising Stars, Proposal submitted to National Science Foundation IUSE Program, January 2014 (funded).

18. Intel Corporation (2015) Intel's Early Internships for Software Engineering. Retrieved from: http://www.intel.com/content/www/us/en/jobs/locations/united-states/students/internships/intel-early-internship-software-engineering.html

19. Northrop Grumman Corporation (2015) Northrop Grumman High School Involvement Partnership Program (HIP). Retrieved from: http://www.northropgrumman.com/Careers/StudentsAndNewGrads/Pages/GettingStartedEarly.aspx.

20. GE Corporation (2015) GE Early Identification (EID) Program. Retrieved from: http: //*site.**ge**-energy.com/about/careers/.../index.html.*

21. Khraishi, T. and Denman, K. (2015) How Do Mentoring, Internships and Conferences affect Retention and Graduation? Experience from a NSF STEP Project, Proceedings of the 2015 ASEE Gulf-Southwest Annual Conference, San Antonio, TX.

22. Safavi, M, (2008) Impact of Internship Programs within Construction Education, 2008 ASC Region V Proceedings.

23. Seevers, M., Knowlton, W., Pyke, P., Schrader, C., and Gardner, J. (2006) Improving Engineering Undergraduate Retention via Research and Internships, Proceedings of 2006 ASEE Annual Conference, Chicago, IL.

24. Batey, A. (2012) Minutes of the Special Meeting of Industrial Advisory Boards on Internship, Department of Engineering Technology, Texas State University, San Marcos, TX.