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The CASCADE Experience: An Innovative Cascaded Peer-Mentoring Project

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The CASCADE Experience:
An Innovative Cascaded Peer-Mentoring Project

Abstract

The CASCaded Mentoring and Design Experiences (CASCADE) program at Texas A&M University-Kingsville aims at increasing the quantity, quality, and diversity of TAMUK students who successfully earn an engineering baccalaureate degree. This goal is achieved through engaging engineering students in design exercises and experiences throughout their academic undergraduate careers. The CASCADE project provides student support in an innovative configuration of cascaded peer-mentoring. This program exposes freshman students to the engineering design process with vertically aligned design experiences through the sophomore and junior years. Cascading vertically, undergraduate seniors mentor juniors, juniors mentor sophomores, and sophomores mentor freshmen. The objectives of the CASCADE project are to: 1) infuse concepts of the design process across all four levels of the engineering undergraduate curriculum (i.e., freshman through senior), 2) increase first-year, second-year, and third-year retention of engineering undergraduate students to 78%, 68%, 62%, respectively, and 3) raise the 6-year engineering undergraduate graduation rate to 54%. This STEP 1-B project funded by the National Science Foundation has been piloted in three undergraduate engineering programs at TAMUK, particularly in the baccalaureate programs of mechanical, civil, and environmental engineering. The incorporation of engineering design experiences across the undergraduate curriculum has contributed to increased student retention and persistence to graduation within 6 years. The CASCADE project has been implemented in three freshman courses (UNIV 1101, AEEN 1310, MEEN 1310), four sophomore courses (CEEN 2301, MEEN 2302, EVEN 2371, AEEN 1320), and five junior courses (CEEN 3311, CEEN 3145, MEEN 3348, CEEN 3392, and MEEN 3392). The average first-year, second-year, and third-year retention percentages of undergraduate students in the above courses were 79% (range of 63-94%), 73% (47-91%), and 62% (47-76%), respectively. These values exceed the expected values and the actual retention rates for the corresponding engineering departments. The average six-year graduation rate for the targeted courses was 85.6% which is about 1.6 times larger than the expected six-year graduation rate. It is expected that this cascading peer mentoring program will serve as a model to benefit other engineering programs. Involvement of engineering faculty members has helped connect research to undergraduate education and theory to relevant design experiences linked to industry problems. Moreover, the broader impact of this program will help in advancing discovery on retention of underrepresented engineering students, while promoting teaching, training, and learning. National dissemination will help in the implementation of similar programs by other minority serving campuses.

Keywords: Cascaded Mentoring, Design Project, Engineering Education

Introduction

Many national reports have been calling for a significant strategic increase in engineering graduates in order to maintain US economic competitiveness and national prosperity [1, 2]. In response to these calls, multiple efforts, led by governmental investment and resources, have been directed towards improving engineering education, recruiting, and support, within the fields of Science, Technology, Engineering, and Math (STEM). These efforts produced many programs targeting Pre-college (K-12) students to improve recruiting, with some focusing on minorities [3].

Also, some programs aimed at improving K-12 math and science teachers' education, and enhancing engineering undergraduates with leadership skills, as methods to increase recruiting and retention simultaneously [4 – 6]. The impact of these programs has been positive on K-12 students' perceptions of engineering and among K-12 teachers who tended to include more engineering examples and career information in their classes [7]. Consequently, this positive effect trickled into STEM college majors, like engineering and computer science, where enrollment has actually increased. However, this increase in enrollment was not paralleled by improvement in retention rates in these areas, presenting another opportunity for more effort to be invested in taking these experiences and programs to the next level [8, 9].

As part of the body of efforts to increase Engineering graduates nationally, numerous studies were conducted to identify challenges and opportunities associated with retention of engineering students. Among the different challenges identified by these studies were the following two major opportunities:

1. Increasing diversity among engineering students in terms of minorities and women
2. Increasing retention rates particularly at the first and second years in engineering.

One example demonstrating the first opportunity can be seen in the fact that the Hispanic population of the US has a high growing rate especially in the college-age group. However, they are underrepresented in engineering in a highly disproportionate ratio [1, 10]. The second opportunity is based on decades of statistical data showing that retention rates of engineering students are the worst within the first two years of studying engineering in college. Those are: the freshman to sophomore cohort, and the sophomore to junior cohort [11, 12].

Literature reports show a growth in programs aiming at broadening participation of underrepresented groups in engineering such as women, Hispanic, and African American populations [13, 14]. Literature also shows that certain cognitive and pedagogical methods seem to be more effective than others in engaging students, and accordingly, increasing retention in engineering, particularly among female and underrepresented minority students. Example of these include: Project Based Learning (PBL), collaborative active learning exercises (like design and build), and community or team building in the classroom, or within a cohort, among other methods [15 – 18]. In other words, hands-on activities employing technical knowledge seem to be the most successful in engaging and retaining engineering students [19]. This is supported by research findings indicating that students' comprehension of pre-requisite material came only after applying the material [20]. Integration of such research results into programs targeting retention improvement among minorities presented an opportunity upon which the "Cascaded Mentoring and Design Experience (CASCADE)" project was based. This project is carried out by engineering faculty members at TAMUK, which is a Hispanic Serving Institute (HSI), as part of the NSF Science, Technology, Engineering, and Mathematics, Talent Expansion Program (STEP). Data regarding the programs offered by TAMUK and the composition of its student population are provided in appendix A.

Project Description

The overall goal of CASCADE is to increase the quantity, quality, and diversity of TAMUK students who successfully earn an engineering baccalaureate degree. CASCADE engages engineering students in design exercises and experiences throughout their academic undergraduate careers, and provides student support in an innovative configuration of cascaded peer-mentoring. In addition, the project incorporates engineering design experiences across the undergraduate curriculum with linkages to the university's engineering innovation laboratory for access to industry projects. This contributes to increased student retention and persistence to graduation. CASCADE uses research proven practices to create a retention program based on integrated curriculum, peer-mentoring, learning communities, and efforts that build innovation and creativity into the engineering curriculum. The design efforts introduced by this project vertically align PBL that is fused with design components to form a thread covering every year of the undergraduate engineering curriculum. To achieve these goals, CASCADE works with the existing TAMUK Javelina Engineering Student Success Center (JESSC) to build continuous engineering learning communities for students through cohort experiences in their majors. Peer-mentoring includes pairing junior- and senior-level engineering students from the Javelina Innovation Laboratory (JIL) with students in the first- and second-year targeted courses. The most remarkable part about CASCADE is that it offers a fundamental freshman exposure to the design process that continues with them through their years as undergraduates, until the senior capstone design experience fused with industry interaction and peer mentoring. Cascading vertically, undergraduate seniors mentor juniors, juniors mentor sophomores, and sophomores mentor freshmen. This STEP project is being piloted in four undergraduate engineering programs at TAMUK College of Engineering which are: mechanical, civil, chemical, and environmental engineering. The CASCADE objectives are:

1. Infuse concepts of the design process across all four levels of the engineering undergraduate curriculum (i.e., freshman through senior)
2. Increase first-year, second-year, and third-year retention of engineering undergraduate students to 78%, 68%, 62%, respectively, and
3. Raise the 6-year engineering undergraduate graduation rate to 54%.

Strategies to achieve these objectives include:

1. Incorporation of a freshman design experience into existing introductory engineering courses and a sophomore, as well as a junior design experience, into targeted engineering courses.
2. Creation of an innovative cascaded mentoring program designed to maintain consistent access to peer mentors, thus providing continuous support for mentees as they progress through the engineering program, and
3. Linkage to the TAMUK Javelina Innovation Laboratory (JIL), which will provide access to authentic design projects for curricular requirements as well as other venues for student design experiences.

CASCADE links to TAMUK student-focused innovation center, (JESSC), which ties to South Texas industry and business to allow for project ideas and sponsorships of paid student internships. This allows students to develop innovative solutions to scientific and technical problems posed by these South Texan industries, governmental, and nongovernmental agencies, and to pursue their own innovations.

Project Implementation

Initially, CASCADE curriculum implementation was piloted in the civil engineering (CEEN) and mechanical engineering (MEEN) departments, and subsequently expanded to include the chemical (CHNG) and environmental (EVEN) engineering departments. Figure 1 depicts the different parts of the project graphically. Table 1 shows the details of the implementation plan with the associated timeline and courses hosting the design project to formulate the thread of design in the curriculum. Table 2 provides a listing of the different courses hosting the design project as part of the CASCADE project.

As shown by table 1, implementation of the CASCADE project started in the academic year of 2012 – 2013 and continued through the following years [21]. Currently the project is still ongoing with minor changes of logistics and participating faculty depending on availability of faculty and the changes in their assignments. Nevertheless, the general plan and objectives are still the same with activities and participation expanding every year. Two departments participated in the project at its inception in 2013. In the following years, two additional departments joined and multiple courses were selected from the different departments to host the design component in the curriculum, as part of this project. Currently there are eight courses hosting design projects as part of CASCADE which are spread between the first three years of engineering. Each cohort taking on design projects in a course is supported by a mentoring layer of students from the class right above it (i.e. seniors mentoring juniors, juniors mentoring sophomores, and sophomores mentoring freshman). Each team working on a design project had a design-mentor assigned to them who met with the team during lecture or lab time, as well as at least once outside these times. Course instructors and design mentors coordinated efforts to guide teams and closely monitor implementation of the steps of the engineering design process. Each team reported on their progress to both their instructor and their design mentor.

Project teams had 5 – 6 students and worked with their instructor, mentor, and an industrial partner (industry, faculty research, or government labs) for projects with industrial sponsors, and the JESSC center director. Table 3 shows the baseline and milestones for infusing design experiences into the engineering curriculum for the four targeted TAMUK departments. A

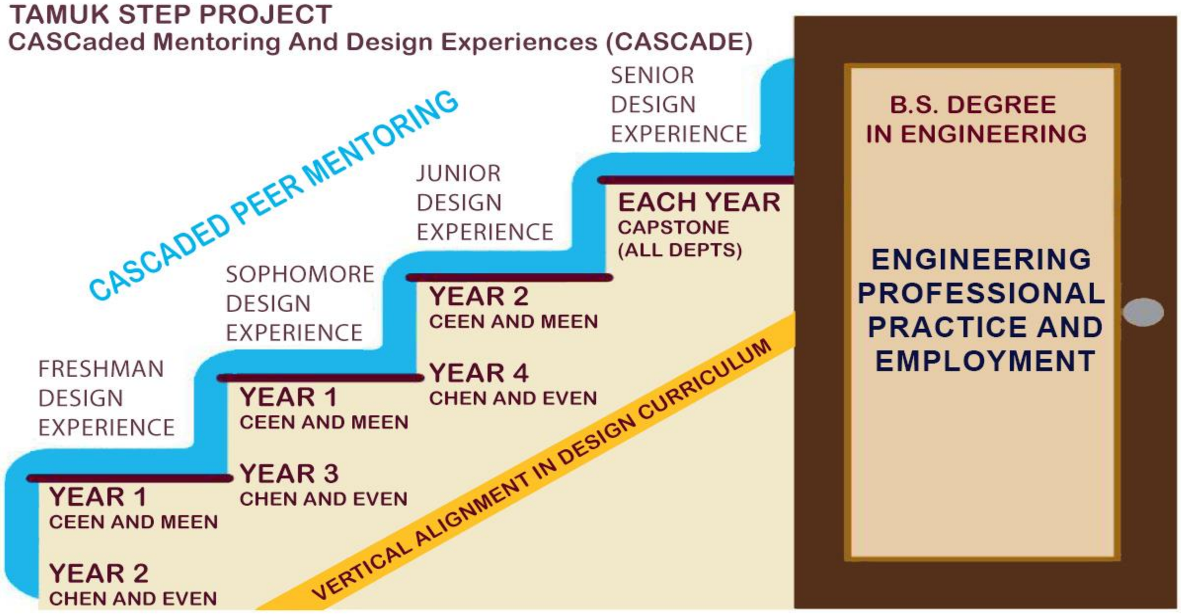

Figure 1: Overview of the CASCADE Project plan and timeline.

summary listing of the design projects implemented, per course, for the academic year 2015 – 2016 is provided in Appendix B.

Table 1: CASCADE project implementation timeline and courses forming the design project thread.

<table>
<tr><th>Level</th><th>Year 1
2012 – 2013</th><th>Year 2
2013 – 2014</th><th>Year 3
2014 – 2015</th><th>Year 4
2015 – 2016</th><th>Year 5
2016 – 2017</th></tr>
<tr><td rowspan="6">Freshmen</td><td rowspan="6">-</td><td rowspan="2">Learning Global Context UNIV 1101</td><td rowspan="6">No Activity</td><td rowspan="3">Computer graphics & app
AEEN 1310</td><td rowspan="3">Computer graphics & app
AEEN 1310</td></tr>
<tr></tr>
<tr><td rowspan="2">Computer graphics & app AEEN 1310</td></tr>
<tr><td rowspan="3">Engineering graphics 1
MEEN 1310</td><td rowspan="3">Engineering graphics 1
MEEN 1310</td></tr>
<tr><td rowspan="2">Engineering graphics 1
MEEN 1310</td></tr>
<tr></tr>
<tr><td rowspan="3">Sophomore</td><td rowspan="3">Mechanics I
Statics
CEEN 2301</td><td rowspan="3">Mechanics II
Dynamics
MEEN 2302</td><td rowspan="3">No Activity</td><td>Envi. Eng. in Global Society
EVEN 2372</td><td rowspan="3">Mechanics I
Statics
CEEN 2301</td></tr>
<tr><td>Mechanics II
Dynamics
MEEN 2302</td></tr>
<tr><td>Mechanics I
Statics CEEN 2301</td></tr>
<tr><td colspan="2" rowspan="6">Junior</td><td rowspan="3">Strength of Materials
CEEN 3311</td><td rowspan="6">No Activity</td><td rowspan="2">Strength of Materials
CEEN 3311</td><td rowspan="3">Fluid Mechanics
MEEN 3392</td></tr>
<tr></tr>
<tr><td rowspan="2">Construction Materials
CEEN 3145</td></tr>
<tr><td rowspan="3">Construction Materials
CEEN 3145</td><td rowspan="3">Hydraulics and Fluid Mechanics
CEEN 3392</td></tr>
<tr><td rowspan="2">Heat transfer
MEEN 3348</td></tr>
<tr></tr>
</table>

<u>Results and Discussion</u>

CASCADE is currently underway continuing through two more years to come. The data available comes from three years of implementation: 2012-2013, 2013-2014, and 2015-2016. During the year 2014-2015 activities were halted because of major administrative changes at TAMUK. An evaluation plan was established as part of the project implementation to measure the project success and provide feedback for modifications and corrections. The methodology of the plan constitutes the utilization of both quantitative and qualitative data using built-in assessment tasks with both direct and indirect assessment components through survey questions to all participants: students, mentors, and faculty. The quantitative data were analyzed using descriptive statistics as provided in the following sections.

Table 2: Listing of the courses hosting design projects and forming the design thread in the curriculum as part of the CASCADE project.

Freshman Courses		**Sophomore Courses**		**Junior Courses**	
Course Code	**Course Title**	**Course Code**	**Course Title**	**Course Code**	**Course Title**
UNIV 1101	Learning Global context	**CEEN 2301**	Mechanics I Statics	**CEEN 3311**	Strength of Materials
AEEN 1310	Computer Graphics & App.	**MEEN 2302**	Mechanics II Dynamics	**MEEN 3347**	Thermodynamics
MEEN 1310	Engineering Graphics 1	**EVEN 2372**	Env. Eng. In a Global Society	**CEEN 3145**	Construction Materials
				MEEN 3348	Heat Transfer
				MEEN 3392	Fluid Mechanics
				CEEN 3392	Hydraulics & Fluid Mechanics

Table 3: Baseline and planned milestones for implementing the CASCADE project.

Level	**Baseline**	**2012-2013**	**2013-2014**	**2014-2015**	**2015-2016**	**2016-2017**
Freshman	Very limited	In 2 departments	In 4 departments	Institutionalization in progress	Institutionalization in progress	Institutionalized
Sophomore	None	In 2 departments	In 2 departments	In 4 departments	Institutionalization in progress	Institutionalized
Junior	None		In 2 departments	In 2 departments	In 4 departments	Institutionalized
Senior	Capstone	JIL-enhanced capstone	JIL-enhanced capstone	JIL-enhanced capstone	JIL-enhanced capstone	JIL-enhanced capstone

It is to be mentioned that although all student in each of the designated courses were required to participate in this project, the number of participating students used for this paper was taken from the survey responses which was voluntary. Students in the course were asked to go online and fill the surveys but were not obliged to that. This method carries with it an inherent non-response bias. Participant who chose not to answer surveys are not included in the results. In addition, allowing voluntary survey-taking produces a different total number of participation between pre-surveys and post-surveys, since the time between these two events is an entire semester.

Table 4: Demographics of participating students in the CASCADE project (ethnicity / race).

Demographics	Race from Pre-activity Surveys							Race from Post-activity Survey						
	Asian	African American	Hispanic	Native American	Native Hawaiian	White	Total (N)	Asian	African American	Hispanic	Native American	Native Hawaiian	White	Total (N)
2012-2013	2%	7%	59%	0%	0%	33%	20	-	-	-	-	-	-	11
2013-2014	3%	4%	68%	1%	0%	24%	76	2%	0%	76%	0%	0%	22%	49
2015-2016	3%	5%	66%	0%	1%	24%	211	5%	4%	62%	0%	3%	26%	147

Table 5: Demographics of participating students in the CASCADE project by gender.

Demographics	Gender Pre		Gender Post	
	Male	Female	Male	Female
2012-2013	83%	17%	-	-
2013-2014	86%	14%	78%	22%
2015-2016	81%	19%	80%	20%

Table 6: Demographics of participating mentors in the CASCADE project.

Demographics	Race from Pre-activity Surveys								Race from Post-activity Survey							
	Asian	African American	Hispanic	Native American	Native Hawaiian	White	Total (N)	Male / Female	Asian	African American	Hispanic	Native American	Native Hawaiian	White	Total (N)	Male / Female
2012 - 2013	20 %	0 %	60 %	0 %	0 %	20 %	5	4/1	0 %	0 %	66 %	0 %	0 %	-	6	5/1
2013 - 2014	20 %	0 %	70 %	0 %	0 %	10 %	10	7/3	0 %	0 %	92 %	0 %	0 %	8 %	13	8/5
2015 - 2016	5 %	8 %	82 %	0 %	0 %	5 %	26	19/7	9 %	9 %	77 %	0 %	0 %	5 %	21	14/7

Assessment and evaluation targets were: retention, mentoring experience, and students' experience. Following are the categories of results obtained from the assessment data:

A. Diversity in students and mentors:

The demographics of the participants in the CASCADE project through its life are presented in table 4 for ethnicity and race, and in table 5 for gender. Descriptive statistics were used to analyze this data. These demographics provide a true sample representing the student population, in terms of gender and ethnic diversity, at TAMUK College of Engineering, as shown in appendix A. This is one of the main reasons that made this university a fertile ground that is ready to implement CASCADE.

Meanwhile, the demographics of the mentors show higher percentages of female and minority participants, considering the fact that mentors are also a sub group of the student body. This is a very encouraging observation indicating that minority students were not just individually engaged, but continue to be more involved at deeper levels in their engineering education after experiencing the CASCADE design projects. In fact, this group of mentors was willing and ready to teach and spread their knowledge and excitement about engineering among peers. This is an ultimate goal of such projects that seems to have been achieved by the CASCADE project. Table 6 shows the demographic data for mentors. Notice that each mentor worked with more than one group of students and across more than one course.

The diversity factor from pre to post design projects for both the students and the mentors seems to be stable with minor changes. The representation of disciplines within the students and the mentors also seems to be stable with minor variations. Note that cohorts of students are formed through the common classes taken by a generation (sophomore, junior, etc.). Each generation goes through the same set of classes and gets exposure to this project together with very few exceptions which come naturally in every university.

B. <u>Retention:</u>

The majority of the participating students and courses were from Mechanical Engineering (MEEN), Architectural Engineering (AEEN) which resides jointly with the department of Civil Engineering as one department for both disciplines, and Civil Engineering (CEEN). Figure 2 shows the retention data for these disciplines over three years: 2012 – 2013 which is the year CASCADE started, so it can be used as a baseline, 2013-2014, and 2015-2016, which are the following two years of implementation. MEEN data shows a slightly increasing trend compared to both CEEN and AEEN data, which is showing increase in the year following the implementation of the CASCADE project, and then a decrease, but not below the baseline levels. The sudden jump in the middle year for these two disciplines can be explained by the fact that transfer-in students from community colleges, or from the pre-engineering levels, happen in the sophomore and junior years. Therefore, it is not unusual to see sudden enrollment increases in these two years in any engineering discipline at TAMUK due to these factors. Accordingly, retention rates would show sudden jumps as they are calculated from enrollment data.

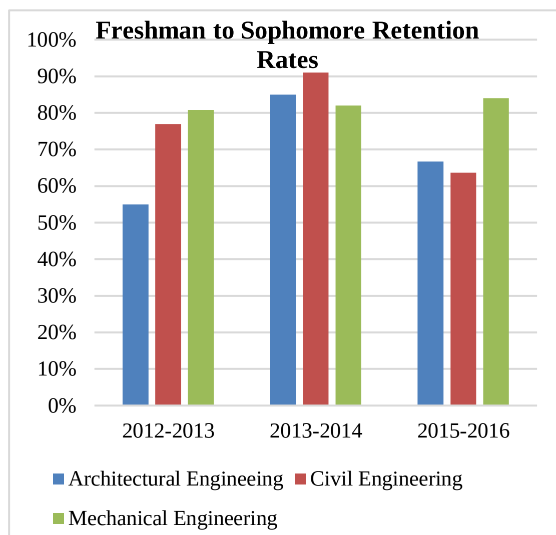

Figure 2: Freshman to sophomore retention rates in Mechanical Engineering (MEEN), Architectural Engineering (AEEN), and Civil Engineering (CEEN), which constitute the maiority of the CASCADE

Retention data by discipline, from the two main participating departments (MEEN and CEEN) are presented in figure 3. The data shows a general increasing trend of retention during the time of implementing the CASCADE project compared to the trend before the project in the baseline year of 2012-2013. It is to be noted that junior to senior retention relies on the enrollment data of seniors and juniors, which usually does not include students staying beyond senior for their last course or to finish. The same set of students could cause a spike in the data and a dip in the adjacent year depending on when an entire cohort is entered in the calculation. This is also an indicator that students are willing to persist with their studies for a degree even if it takes up to 6 years and still graduate successfully.

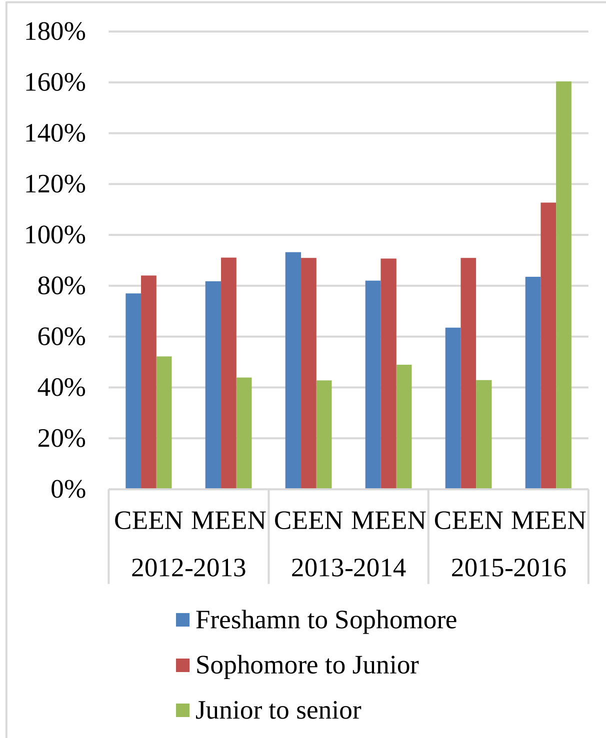

Figure 3: Retention rate for three levels in MEEN and CEEN during three different years.

Among the collected information were answers for a direct question on whether participating students were motivated to remain in engineering or not, using the Likert scale. Results related to this question are presented by figure 4. The cohorts in year 2013-2014 showed a stronger shift in answers towards a stronger motivation to stay in engineering between the pre and post survey of being exposed to the CASCADE experience, compared to the cohort in 2015-2016. To probe further for the reason behind these observations, an extra question was posed to the participants on whether they have thought of transferring to a different engineering discipline or not. Results for this question are shown in figure 5 where before the CASCADE experience the majority of the cohort was leaning towards staying in the same engineering discipline. However, post the CASCADE experience the answers shifted slightly towards the extreme ends of either stay in the same discipline, or just decided already to transfer to a different discipline. Linking the observations from figures 4 and figure 5 leads to the hypothesis that exposure to a hands-on design project, which is interdisciplinary by nature, might have created a side effect. This side effect

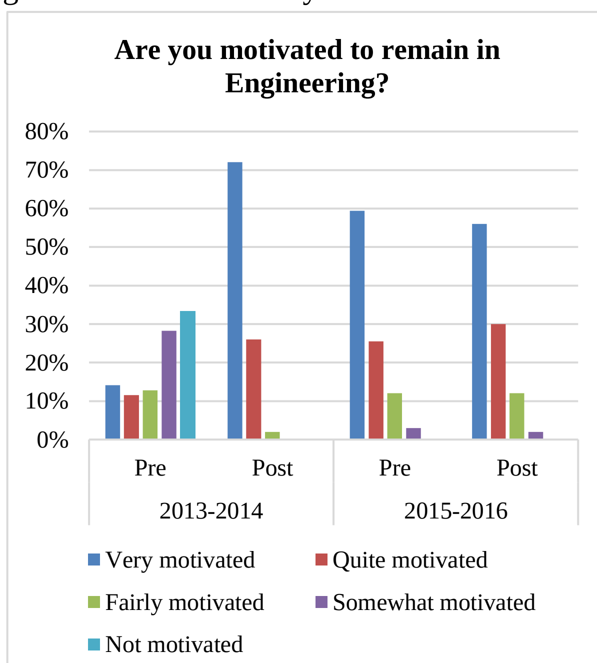

Figure 4: Answers to the question on desire to stay in engineering from two different cohorts, pre and post CASCADE experience.

could be a confusion regarding which discipline really matches the students' interests and passion, which has increased by going through the CASCADE experience. Moreover, in this small sub group of students, the element of confusion might have even led to the answers in figure 5 where a bit of a doubt about staying in engineering altogether started to surface. Considering that the changes between pre and post surveys for the two figures are within a 2% or less level, it is still useful in guiding the managers of the CASCADE projects to ensure that importance of the CASCADE experience message being crystal clear and that the practices and implementation actions are done appropriately. These observations could also lead to another type of future study that was not even explored before.

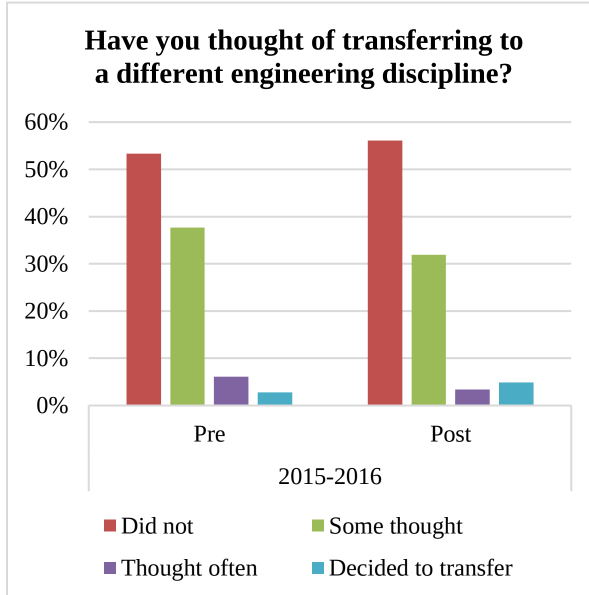

Figure 5: Answers to the question on thoughts of transferring to another engineering discipline, cohort of 2015-2016, pre and post the CASCADE experience.

C. Knowledge of design project

Participating students and mentors were asked about their knowledge of project design before and after they went through the CASCADE project experience. This was designed to measure their level of knowledge, not just if they had knowledge or not. Figure 6 shows a summary of this direct assessment information over two years of the project. The data shows a clear shift in the knowledge level about design project between the pre and post-tests, for these years of the project. This observation was confirmed by performing ANOVA test which showed F-test results at $\alpha = 0.05$ leading to the rejection of the null hypothesis. In other words: the two means of the pre and post-project implementation results for each of the years under investigation are different. The answers were through direct assessment which indicates also that the level of confidence the students developed regarding their engineering skills and identity has increased. From the mentors' side, during the year 2015-2016 there were 26 mentors involved with CASCADE projects. Majority of the mentors (81%) had previous experience with design projects in their courses as students. This was a gain of 11% compared to the data from the academic year of 2013-2014. This year the mentors appeared to have had a more varied set of positive experiences with design project.

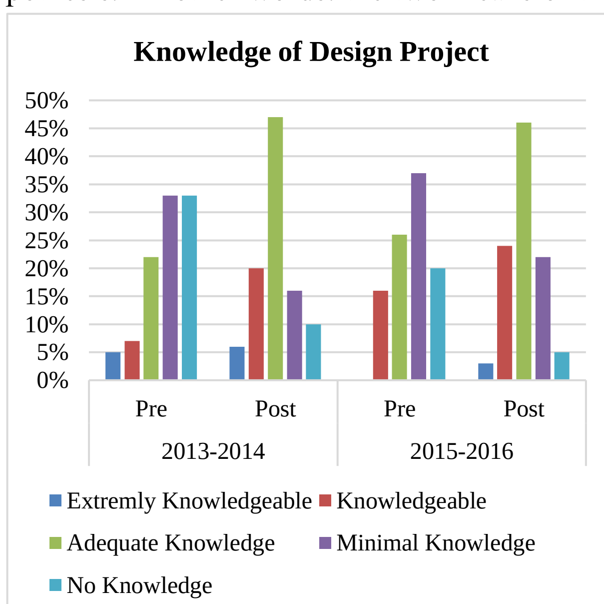

Figure 6: Answers to the question on knowledge of design projects, pre and post the CASCADE experience, two different cohorts.

D. Interest in Design Project

Figure 7 shows direct assessment data for interest in project design by participating students, in three years, pre and post exposure to the CASCADE project. The data in the figure shows a shift between pre and post exposure to CASCADE towards building interest in project design. Cross examination of this data set with the data in Figures 2 and 3, a very close similarity in trend is observed between the two figures. This observation supports the idea that increase in knowledge is proportional to increase in interest, which leads to increase in retention of students in the engineering fields. It is to be noted that mentors interest in in engineering and motivation to continue was proped and the answers also showed a increase between pre and post CASCADE experience.

Indirect assessment:

Faculty instructing the courses where the CASCADE design projects were run provided their assessment and observations as well. The majority observed that the level of engagement and excitement among the participating students increased as a result of conducting the design project. In particular, the majority of the faculty noticed adequate increase in acceletation of learning, proficiency with design projects, and proficiency in general engineering concepts. Also, the same percentage of faculty observed improved team-work skills. However, when evaluating problem solving skills, which is a higher order thinking skill, the majority of faculty were confortable, but not as strongly confident, that it has adequately improved.

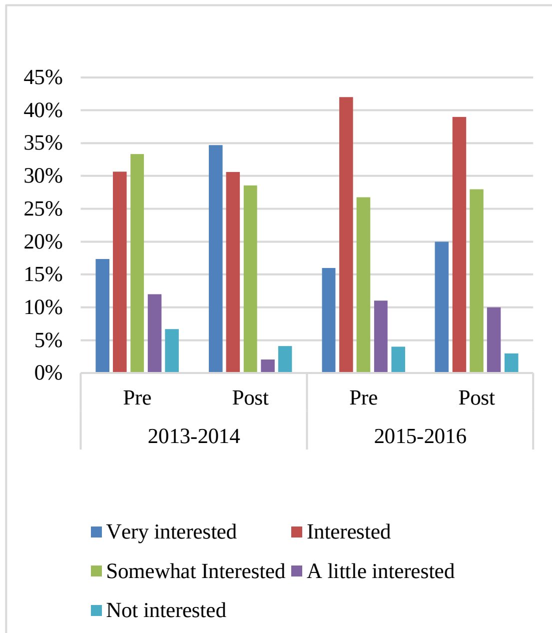

Figure 7: Answers to the question on interest in design projects, pre and post the CASCADE experience, two different cohorts.

Conclusion

The CASCADE project was implemented at TAMUK to improve quality and quantity of engineering students through a combination of two elements: 1) introducing a design project into selected courses, which form a thread in the curriculum in different departments, and 2) introducing mentors to the design teams from among students who have had the CASCADE experience before. One main objective of CASCADE was increasing minorities' numbers, among engineering graduates by increasing the level of engagement of students with the design experiences and by creating cohorts connected between the different levels in engineering through mentors from within the student body. As design project started showing in the different courses, direct and indirect assessment was being conducted in parallel to measure the effectiveness of the project implementation. Data was collected before and after students went through the CASCADE experience and results were presented and discussed above. Retention data, interest and motivation indicators, and engagement signs, were all in an improving trend. Some outliers in the data pointed at unusual events associated with high transfer-in numbers of students coming into the engineering programs in the second and third year, or an entire cohort delayed in graduation by one year. Since minorities constitute a significant part of the student body composition at TAMUK, it can be concluded that the project had a positive effect on retention among minorities at TAMUK. In addition, a comparison between these retention data and national trends shows that TAMUK retention is at a significantly higher level than the national average.

Finally, the data from the reported experience bring about some considerable questions regarding the clarity of the message delivered and the level of impact on the participating students, in terms of the information being overwhelming or confusing, to the point of confusing their ability to decide which engineering discipline to select in relation to their career goals, based on the experience they receive from engaging in these design projects.

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Appendix A: University and college data

Texas A&M University-Kingsville, a Hispanic-Serving Institution, is located in South Texas, with a population that is 81% Hispanic. Most of TAMUK's approximately 6,200 (2010-2011) total students (53% male, 47% female) are from REGION, and the student body reflects area demographics: 62% Hispanic, 27% white, and 5% African American. TAMUK is accredited by the South Texan Commission, and is listed in *Outlook* magazine's annual Top 100 institutions for bachelor's degrees awarded to Hispanics. CASCADE aligns with TAMUK's institutional mission to "develop well-rounded leaders and critical thinkers who can solve problems in an increasingly complex, dynamic and global society." The Frank H. Dotterweich College of Engineering (COE) at TAMUK offers programs in chemical, civil, mechanical, electrical, and architectural engineering that are accredited by the Engineering Accreditation Commission of ABET, as well as programs in environmental engineering, industrial engineering, natural gas engineering, computer science, industrial technology and industrial management. Institutional information provided by the TAMUK Office of Institutional Research, is provided in Tables 1-4. TAMUK FTE undergraduate enrollment data for Fall 2010 as well as the number of engineering bachelor's degrees awarded in the 2010-2011 academic year are provided in Table 1. Student demographic data for Fall 2010 are detailed in Table 2. Historical data on student retention and persistence in the CoE (Tables 3 and 4) provide baseline information for establishing project benchmarks and outcomes.

Table 1: Fall 2010 Enrollment and Engineering Degrees Awarded for TAMUK*

Undergraduate Enrollment (FTE)	Undergraduate Engineering Enrollment (FTE)	Undergraduate Engineering Degrees Awarded (2010-2011 academic year)
4824	853	167

Table 2: Demographic Data for TAMUK Undergraduate Students (Fall 2010)

	Undergraduate Enrollment	%Female	%Hispanic	%African American	%Asian	%International Students	%Other TAMUK
TAMUK	5291	46.2%	66.0%	6.7%	1.0%	1.8%	24.6%
TAMUK Engineering	888	16.6%	59.1%	4.3%	1.6%	4.84%	30.2%

Table 3: TAMUK First-time, Full-time Freshmen Retention Rates, Engineering Majors

First-time Engineering Freshmen Average		Average % Continuing to Second Year	Average % Continuing to Third Year	Average % Continuing to Fourth Year	Average 6-Year Graduation Rate
Mean	SD				
134	20.36	68%	58%	52%	44%

Table 4: Number of Engineering Graduates

Academic Year 2006-2007	Academic Year 2007-2008	Academic Year 2008-2009	Academic Year 2009-2010	Academic Year 2010-2011
137	123	139	149	167

Appendix B: Summary list of design projects used in designated courses to implement CASCADE during the academic year 2015 - 2016

Freshman Courses: Computer Graphics and Applications (AEEN 1310), Engineering Graphics 1 (MEEN 1310).

FALL 2015

AEEN 1310 (Computer Based Graphics and Design): Students of this class were divided into 9 groups and were involved in designing the following 2D Models in AUTOCAD:

1. **Sky scraper**
2. **Movie theatre**
3. **Parking**
4. **Swimming pool**
5. **Shopping mall**
6. **Residential houses**
7. **Recreation**
8. **Bank**
9. **Library**
   - Students had a great opportunity to improve their designing skills in Autocad under the guidance of the mentors.
   - 6 mentors were assigned to this course to assist the students.

MEEN 1310 (Engineering Graphics I): Students of this class were divided into 5 groups and were involved in designing the following 3d models in Solidworks:

1. **Bicycle**
2. **Piston Assembly**
3. **Pitman Steering**
4. **Robot**
5. **Rack/Pinion Steering**
   - Students learned the part design, assembly and mating in 3D Modeling software.
   - 5 mentors were assigned to help in designing the parts in Solidworks.

SPRING 2016

AEEN 1310 (Computer Based Graphics and Design): Students of this course were divided into 6 groups. The project was to designing the following 2D Models in Autocad:

1. **Movie theatre**
2. **Parking**
3. **Library**
4. **Residential houses**
5. **Recreation**
6. **Football and pool**
   - Students had a good learning experience to make the 2D design in Autocad.
   - 6 mentors were assigned to this course.

MEEN 1310 (Engineering Graphics I): Students of this course were divided into 4 groups. The objective of the project was to design 3 D Models of the following topics in Solidworks.

1. **Piston engine**

2. **Bicycle**
3. **Super charger**
4. **Robotic arm**

- The task was to design each part and assemble them.
- 4 mentors were assigned to this course.

Sophomore: Mechanics II, Dynamics (MEEN 2302), Environmental Engineering in a Global Society (EVEN 2372), Mechanics I, Statics (CEEN 2301)

FALL 2015

EVEN 2372 (Environmental Engineering in a Global society): Students of this course were divided into 3 groups. The project was to focus on current global environmental issues. This learning outcome was planned to improve the oral communication skills for their senior design problem. The following were the projects:

1. **Power plant emissions and trading**
2. **Water conservation**
    - 3 mentors were assigned to help students with the power point presentations.

CEEN 2301 (Mechanics I Statics): The class was divided into 6 groups. The topic of this project was ''Structural Analysis and Design of a Truss Structure using an Innovative Tool".

- 6 mentors were assigned to assist students to design the Truss structure.

SPRING 2016

MEEN 2302 (Mechanics II Dynamics): Students of this course were divided into 4 groups. The objective of the project was to design and model a cylinder, piston, crankshaft, flywheel arrangement of an internal combustion engine in Solidworks.

1. Students were involved in designing and calculating the center of mass of the final assembly.
    - 3 mentors were assigned to this course.

Junior: Strength of Materials (CEEN 3311), Construction Materials (CEEN 3145), Heat Transfer (MEEN 3348).

FALL 2015

CEEN 3311(Strength of Materials): Students of this course were divided into 5 groups. The topics for this project was:

1. **To determine stress and strain at a point in a beam.**
2. **Moment and deflection in beams.**
    - **5 mentors were assigned to this course.**

SPRING 2016

CEEN 3145 (Construction Materials): Students of this class were divided into 4 groups. The objective of the project was to give students knowledge of the behavior of materials used in civil engineering applications, helping them better understand the ''Design and construction of civil structures.''

- 4 mentors were assigned to this course.

MEEN 3348 (Heat Transfer): Students of this course were divided into 7 groups. The topics for the project were:

1. **Design a hot or cold liquid container.**
2. **Collecting a solar thermal energy by a vacuum collector in TOWN.**

3. **Heat transfer management in micro channel.**
4. **Design a water heater for house use.**
5. **Heat transfer in composite materials.**
6. **Design and selection of insulation materials for houses in REGION.**
7. **Design of Refrigerator.**
    - 3 mentors were assigned to this course.