Undergraduate Engineering Retention and Enrichment through Implementation of an NSF IUSE Project in an Underrepresented Hispanic Serving Institution

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Abstract

Through the support of an NSF IUSE grant project, the College of Engineering and Technology (CET) at Northern New Mexico College (NNMC) has implemented a comprehensive strategy and work-plan to increase the retention rate and eventually the graduation rate of severely underprepared aspiring Engineering majors. The institute serves underrepresented minority student population; nearly two-thirds of whom rely on Pell grants and more than 50% of them are first-generation college students. The institution's struggle to retain general student population is evident from the following data: 78% retention from first to second semester, 66% retention from second to third semester, and the retention rate drops to 50% by the fourth semester.

The major goals of the project include: 1) Improve Engineering learning and learning environments: improve the knowledge base for defining, identifying, and innovating effective undergraduate engineering education using evidence-based resources and pedagogies; 2) Broaden participation for Engineering learning: increase the number of students recruited and retained in the Engineering program; 3) Build the professional Engineering workforce for future: improve the preparation of undergraduates so they succeed as productive members of the future engineering workforce and be engaged in STEM-literate society. To achieve the goals, the CET has taken the following measures over the last two years: 1) Re-envision and redesign the freshman level Engineering Physics and Math courses and curriculum to facilitate accelerated Math and Science remediation. This includes development of a total of five Engineering Math and Physics courses in proper sequence following contextualized delivery, active learning approach, and student support structure such as peer tutoring and mentoring; 2) Providing upper-division students with paid Undergraduate Research Experience (URE) and also peer-tutoring/mentoring opportunities; 3) Preparing Engineering students for the future workforce through on-job trainings by providing internship opportunities. The project focuses on evaluating the effectiveness of active versus theoretical learning in early Engineering Physics and Math classes among Engineering majors.

The paper describes the specifics of the project implementation; including the curriculum changes along with the sequence adopted, content delivery methods, the student support structure, etc. It also discusses the specific outcomes and effectiveness of the project so far in relation to the project goals, such as student enrollment, retention, performance, persistence, and also, student engagement in research and workforce trainings.

Introduction

Our institute's rural service area is home to a unique ethnic distribution; 71% of the population comes from a centuries-old Hispanic community (versus 16.7% nationally [1]), and another 9% are Native Americans. The community struggles with endemic poverty, a dearth of employment opportunities, and a marked underrepresentation in baccalaureate degree attainment (16.4% in the Rio Arriba county, compared to 28.8% nationally [1]).

58% of the institute's students are first generation, and 77% of the students are an underrepresented minority. The institute suffers from a large gap in college readiness, which is primarily due to poorly performing public schools (87% of K-12 regional schools failed to meet the 2011 NCLB AYP). As a consequence, the second year retention of first-time freshman students for the institute (59% in average for the last five years) is considerably lower as compared to the main three research universities in the state (77%, 73%, and 79% in average for the last five years [2]).

The CET was awarded an NSF-IUSE grant internally named EDUCERE in 2016 to implement a comprehensive work-plan to improve student learning and retention through improved and effective curriculum redesign, extensive student support system and continuing engagement in subject matter through undergraduate research and on-job trainings. This current paper describes the project initiatives and some of the significant results so far.

Work-plan and Implementation

I) Redesigning Engineering Physics and Math Curriculum

In Fall 2016, the CET re-envisioned the entire Physics curriculum for the Engineering program and redesigned three Physics courses (in sequence). The Engineering faculty had been experiencing severe challenges to teach many core courses in the program as they felt the majority of our underprepared student population failed to grasp the physics concepts through traditional instruction methods. Although previous Engineering Physics I and II courses had some lab components, they were disjointed and separate lab activities, and the courses were taught by non-engineers. Also, the prerequisite to those old Physics courses was Calculus-another roadblock for many aspiring students. A lot of our engineering students were becoming frustrated with all remedial Math courses and then having to take the Calculus courses before they could enter in any physics or core engineering courses. The retention of these students was a big challenge; these traditional Engineering Physics classes often had fewer than 10 students, and the student failure rates were high, sometimes as high as 50%.

Through this project we have designed Physics for Engineers I (ENGR 215, 2 credits), Physics for Engineers II (ENGR 216, 3 credits) and Physics for Engineers III (ENGR 217, 3 credits) courses which are currently being taught in parallel with two Math courses following the just-in-time, and project-based learning approach. These two Math courses, Introductory Math for Engineering Applications I and II (2 credits each) are redesigned as well, to prepare the students with the required Math for these entry-level Physics courses and are offered in a sequence that is more meaningful for the engineering students. All Engineering majors are required to take these five Engineering Math and Physics courses (with the exception of one program that does not require Physics II). Although the students still require Calculus courses for the degree requirement, they are no longer prerequisites for the new Physics courses.

The Physics courses, and also, the two Introductory Math courses are now being taught by Engineering faculty and are modeled after the success experienced by Wright State University's introductory project-based Math course with active learning activities, specifically targeting Math-related attrition in their engineering programs. In their longitudinal study, Klingbeil and Bourne reported that the 'Wright State Model' program reduced impediments due to under-preparedness in Math, and helped in increasing the graduation rate of the enrolled students by a factor of more than two [3]. Following the 'Wright State Model', at CET we redesigned both Introductory Engineering Math and Physics curriculum for our Engineering programs. Here is a flowchart of the sequence of courses explaining relations of these courses with other core Engineering courses (Figure 1):

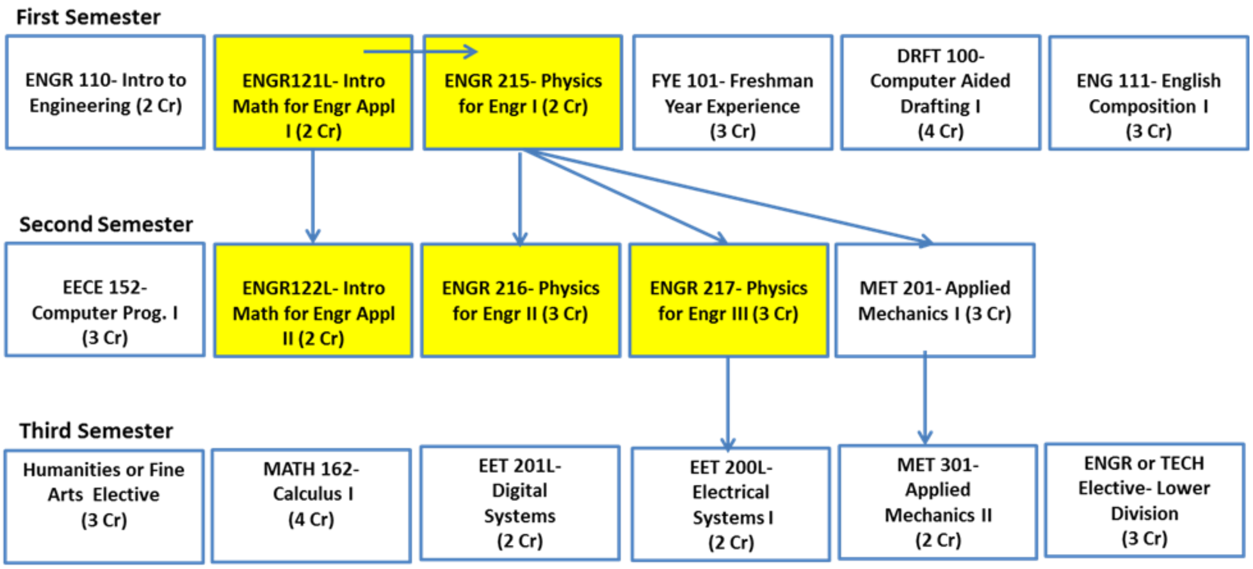

Figure 1: Flowchart of courses with the newly designed Physics and Engineering Math courses (highlighted in yellow) along with their relations with some core Engineering courses. The arrows show the prerequisite structure.

In the first semester, a declared Engineering major is advised to register for Introductory Math for Engineering Applications I (ENGR 121L) and Physics for Engineers I (ENGR 215) courses along with other Freshman Engineering and General Education courses. ENGR 121L is offered as an eight-week course during the first half of the semester and serves as a prerequisite for the ENGR 215 course, which is offered during the second eight week of the semester. In ENGR121L students are introduced to fundamental Math concepts ranging from Arithmetic to Algebra to Trigonometry through application; they are introduced to a practical problem first, and then through analysis and reasoning, the relevant Math concepts are presented to the students. This approach is followed throughout the Engineering Math and Physics sequence, as it appears to be more effective in student engagement and learning and eventually in retaining underprepared Engineering student population, as described later in this paper. In ENGR 215, Mechanics concepts are introduced, with the main emphasis on Statics problems, which can be handled with the Math skills provided in the ENGR 121L course. Having two eight-week-long courses in Engineering Math and Physics allowed us to cover just enough material to move students to Applied Mechanics course sequence as early as in their second semester (MET 201, Applied Mechanics I).

In our two passes (currently, the project is in year 3) so far at our redesign of Engineering Physics together with its two Engineering Math support courses, we have found it, via formal and informal class assessments and concept maps, to be advantageous to limit the number of concepts covered in our 8-week preparatory course and to constantly foreshadow the role that these key concepts play in our subsequent 8-week Physics I course. On this limited, but sound, foundation we then explore a much broader array of concepts in the following semester's three courses; Introductory Math for Engineering Applications II (ENGR 122L), Physics for Engineers II (ENGR 216L) and Physics for Engineers III (ENGR 217L). In ENGR 122L course fundamental Calculus concepts of derivatives and Integrals are developed, again through applications- the concepts that are used and applied in parallel Physics courses (Mechanics and Fluid-Thermal Sciences in ENGR 216L and Electromagnetism in ENGR 217L) without the requirement of the rigorous Calculus courses yet. Please note that the students are still required to take Calculus courses as their degree requirement, but not as a prerequisite to any of the new Physics courses (Figure 1). This fact has allowed us to advance students in their Engineering path without having to wait several semesters to complete all their Math requirements and has substantially helped in retaining students. Subsequent to Physics II students can take the Thermodynamics course, and following Physics III students can enter Circuits courses (Electrical Systems I and II).

Several hands-on activities (sometime before or in parallel to the theoretical learning), lab experiments, and simulation tools to visualize physical and mathematical concepts are being incorporated in the classroom. We developed weekly labs for the first of our 5 foundational courses, ENGR 121L Introduction to Mathematics for Engineering Applications I. These labs attempted to illustrate linear functions via Ohm's Law and Gain Laws for operational amplifiers, quadratic functions via Torricelli's fluid Law, and trigonometric functions via joint angles in multi-armed robots- to provide some examples. While students proved adept at understanding the physical apparatus and in collecting data, they were not that successful in illustrating that the data confirmed or refuted the relevant physical law. This shifted our thinking to platforms for hands-on activities that permitted greater emphasis on the underlying mathematics. This led us to use the interactive features of Python to illustrate mathematical formulas in a way that facilitates rapid exploration and direct comparison with simulated and/or experimental data. We introduced Python as a graphing calculator that we then used consistently, and at increasing levels of depth in our subsequent foundation courses in Engineering Math and Physics courses.

On the foundation of Engineering Math I and Physics I, we then, in Engineering Math II, develop key concepts of calculus while foreshadowing their importance to one subject of near-universal significance to engineering. In particular, we establish derivatives and integrals of trigonometric functions and explore (by hand, software, and hardware) the capacity to develop arbitrary signals using Fourier Series. By hand, they achieve confidence in manipulating the mathematical objects, but they are limited to fairly artificial problems. With hardware, namely a microphone for sound, and a student-built cell-phone mounted spectrometer for light, they were able to capture signals of importance to them that were then analyzed by the Fourier and graphical tools of Python.

On the Engineering Physics side, we offer Physics II and Physics III in parallel with each other, only requiring Engineering Physics I as a prerequisite. In these courses, we continue our less-is-more strategy by focusing on concepts that will find immediate use in their subsequent Mechanics, Fluid-thermal Engineering, and Circuits courses. In both courses, several contextualized labs/ hands-on experiments are incorporated, which are often delivered in parallel to the lectures. In each of these Physics courses, we go beyond using Python as a fancy graphing calculator to using it to explore phase planes in vibration problems (Physics II) and to simulate complex, three-dimensional combinations of forces and distribution of charges (Physics III). As all 5 of these introductory courses are taught by the Engineering faculty, the integration of mathematics, computation, and experiment in an engineering context is readily achieved.

II) Peer-led tutoring/mentoring

A substantial body of research has demonstrated improvements in student learning and positive impacts on lower-division student success and retention in STEM courses with a student support model, referred to as Peer-Led Team Learning (PLTL). This nationally recognized model of teaching and learning, developed originally for a Chemistry class at the City College of New York, has been adapted to many institutions nationwide across all STEM disciplines with noted success. In PLTL, upper-division students who have done well in a course or subject serve as peer leaders to lower division students taking the same course, and facilitate small-group learning.

Following the PLTL model, the project has created peer mentoring and tutoring opportunities for Engineering students for the new Physics for Engineering and Introductory Math for Engineering Applications courses. The peer tutors/mentors are working with the freshmen engineering students in these classes, side-by-side of the faculty instructor as “teaching assistants”, to facilitate student engagement, problem-solving and active learning inside the classroom. They are also holding tutoring and study hours (3- 5 hours per week) outside of the actual class hours and helping students solve their assignments etc. Because these Peer Team Leaders have recently completed the coursework being taught, they can ‘lead’ the younger students through the learning process, as they are close to the material and to the students’ point of view. These peer tutors/mentors are selected by the PI and Co-PI with the input from other Engineering faculty and are mentored by the PI and Co-PI. From the inception of this grant project, every semester one or two peer tutors/mentors are working to help the students in these introductory Math and Physics classes. So far five different students have benefited from these mentoring/tutoring opportunities, not only in terms of financial gain (paid positions) but also in terms of their mentoring and teaching skills.

A significant fraction of our students also take part in mentoring opportunities and training through another NSF grant project led by one of the Co-PIs of the current project. These students mentor both K12 students and teachers in schools, libraries, and community learning centers. They receive training (in a semester-long course) in how other communities have closed the learning gap plaguing underrepresented populations.

III) Undergraduate Research and Internships

Finally, in support of maintaining a culture of innovation, creative ideas, and diverse approaches to problem-solving, through the project support, the CET faculty is working to create opportunities to foster analytical and problem solving abilities among its upper division engineering students. CET seeks to provide Junior and Senior-level students with undergraduate research and industry workforce experiences to better prepare them for graduate programs and for highly evolving and technology-based labor market. The literature has reported for more than three decades the substantial benefits for underrepresented minorities (URM) when engaging in URE. A myriad of recent publications substantiates the importance of URE including increased confidence in research and professional skills, enhanced preparation for graduate school, and greater clarity on future career pathways [4], [5]. Using grant-funded equipment and other existing facilities, CET faculty are mentoring Junior or Senior-level Engineering students during the regular semester and also during the summer. Another aspect of the research/project work using laboratory equipment is to involve the freshmen Engineering students with their senior counterpart in some of the experiments and/or demo to excite them about the field and to reinforce their theoretical knowledge through these hands-on experiments. These paid research opportunities are helping our students from the poor community in reducing their regular work hours from low-paid non-technical jobs, and also in honing their professional skills.

Through the support of the grant project, the CET faculty was also able to create several paid (a one-time stipend incentive is provided to the student interns) summer training and/or internship opportunities, mainly through collaboration with the nearby Los Alamos National Lab. This is proving to be a wonderful opportunity for many of our future aspiring Engineers and professionals to work under the supervision of top-notch researchers and professionals.

Project Effectiveness Indicators and Results

The effectiveness indicators for important specific objectives under each project goals (as given in the abstract section) and the current level of attainment are described below:

I) Specific Objectives for Goal 1:

a) Analyze the active/applied learning activities to determine if they correlate with increases in later success in Engineering courses.

In an attempt to determine the effectiveness of the applied/active learning activities and to see if they correlate with an increase in later success in Engineering courses, we analyzed student performance in the Applied Mechanics I class. The current prerequisite to the Applied Mechanics I class is Physics for Engineers I. Before the redesign of Physics curriculum the prerequisite was PHYS 215, Engineering Physics I, which was a traditional Physics class. It was heavily oriented towards theory and the lab components were rather disjointed with the theoretical learning activities. We compared the Applied Mechanics I class final grade point average (which reflects all assignment grades, including homework, quizzes, and a total of three exams) as a measure of the performance level of different cohorts. We chose this course, as it has been offered consistently every fall semester by the same faculty, and the assignments are either the same or functionally equivalent. We compared four semester’s data: Fall 2014, Fall 2015, Fall 2016, and Fall 2017. Fall 2017 class is the only class where students took the new prerequisite Physics class (newly designed) and prior semester students have the old (traditional) Physics prerequisite. The results are shown in tabular form below in Table 1.

Table 1: Comparison of Applied Mechanics I class grades for Fall 2014, Fall 2015, Fall 2016, and Fall 2017

	Traditional Physics Prerequisite			New Physics Prerequisite
	Fall 2014	Fall 2015	Fall 2016	Fall 2017
Number of students	6	3	3	13
Class average grade point	2.778	2.11	0.667	3.332
Standard deviation	1.081	0.311	0.942	0.977

Although the number of students in these classes is rather small, we see a significantly higher class grade point average for the MET 201 class in Fall 2017, as compared to all other semesters, which is indicative of the high effectiveness of the applied/active learning approach adopted in the new Physics curriculum. We will continue to measure student performance in later Engineering classes to determine the effectiveness of the new Physics curriculum.

During the first two years of the project implementation, student's perception of learning in the Physics courses was assessed through anonymous surveys in Physics for Engineers II and Physics for Engineers III during Spring 2017 and Spring 2018 semesters. The results of these anonymous surveys are as follows:

Physics for Engineers II

In the two semesters together, there were a total of 23 students enrolled in the course and 17 of them completed the survey. When asked "mark the aspect(s) of the course that helped you the most in learning the concepts", 14 (82%) students marked Theory and/or lectures, while 13 (76%) students marked Hands-on activities/ demos. Also, out of these 17 students, 15 (88%) students agreed or strongly agreed to the statement that the hands-on activities/demos/simulations supplemented the lectures appropriately in the learning process. When asked "which approach to learning Physics concepts do you think is more appropriate for your learning style?" 9 (53%) students responded, "theory first and then activity" whereas 8 (47%) students responded, "activity first and then theory".

Physics for Engineers III

In the two semesters together, there were 48 students enrolled in the course and 37 of them completed the survey. When asked "mark the aspect(s) of the course that helped you the most in learning the concepts", 30 (81%) students marked Theory and/or lectures, while 25 (68%) students marked Hands-on activities. Also, out of 37 students, 30 (81%) students agreed or strongly agreed to the statement that the hands-on activities/demos/simulations supplemented the lectures appropriately in the learning process. When asked "which approach to learning Physics concepts do you think is more appropriate for your learning style?" 25 (68%) students responded, "theory first and then activity" whereas 12 (32%) students responded, "activity first and then theory".

b) Analyze the effectiveness of upper division research projects and Internships on preparedness for graduate school and workforce success.

The effectiveness of upper division research projects and internships/on-job trainings are measured using the Student Undergraduate Research Experience (SURE) survey following the methodology used by Lopatto [6]. This study was motivated by the following research questions: Is the educational experience of undergraduates seeking Engineering degrees at CET being enhanced by participation in research or internships? More specifically, what do students report about whether the research or internship experience changed their plans to continue in a STEM profession? Did the expectations of the research fit their experience? Did the research experience or internship affect student perceptions of their gains in knowledge and skills? Nine students experienced Undergraduate research or internships, and a modified SURE survey was administered to each one of them. Characteristics of the case study students were as follows: six male and three female; out of the nine, four reported as Hispanic and one Native American. The average age reported was 29.5. The results from the SURE survey are given below:

When asked the question how the research or internship experience influenced his/her plan for postgraduate education, one student stated that she had a plan for postgraduate education before she began the research and the plan has not changed. It can be noted that one of the students who were part of the URE has graduated and is currently pursuing a Ph.D. in Engineering. “My goal is to go to graduate school for a Ph.D. degree in the physical sciences (including engineering, math, and computer science)” was endorsed by two of the students, including the one currently pursuing that degree. Additionally, two SURE respondents noted that their goal is to go to school immediately after obtaining their Engineering B.S. for an M.S or a Ph.D. Five stated that first, they were planning to work, but all five planned afterward to seek a higher degree such as an M.S., Ph.D., or other professional degree in their field. Total respondents were 8, as one stated being undecided. In terms of whether the research experience had changed the student’s plans, four of the nine said, “I was considering postgraduate education and my research experience has confirmed that choice.”

The students evaluated their research experience overall on a Likert scale (1-5) at a weighted average of 4.20. The top five aspects are listed below in descending order of importance (Table 2). The weighted average is reported. It is to be noted that learning laboratory techniques was the highest endorsed result, at a weighted average of 4.33. The students rated: “Overall, how much did you gain from this experience [SURE]” at a weighted average of 4.22, which made it the second most strongly endorsed item.

Table 2. Top five SURE responses to evaluate the Undergraduate Research or Internship Experience

Statement	**Evaluation**
Learning Laboratory techniques.	4.33
Overall gain from the experience.	4.22
Ability to analyze data (or information).	4.11
Ability to integrate theory and practice	4.00
Understanding that scientific assertions require supporting evidence	4.00

The least endorsed experience was “Skill in how to give an effective oral presentation”, weighted at 3.33. When asked to “Think about the expectations you had about the research/internship experience before the research/internship began. Which of the following best fits your experience?” The students responded as follows, five students thought “The experience met my expectations”, two endorsed this response, “This experience was a little better than I expected.” One student each were at the extremes, where one noted: “The experience was much better than I expected.” And one thought, “The experience was a little less than I expected.” All nine in the case study answered these items.

II) Specific Objectives for Goal 2:

a) In terms of the enrollment, the specific objective of the project was to increase the number of declared majors by 45% by 2019 (compared to Fall 2015, prior to the inception of the project).

The number of declared majors increased from 23 students in Fall 2015 to 41 in Fall 2016. The total number of declared majors in Fall 2017 was 43. Finally, the total number of declared majors in Fall 2018 was 36. In terms of absolute numbers, the enrollment has increased by 57%

from Fall 2015 to Fall 2018, which is significantly higher than the anticipated overall growth in declared majors.

One possible explanation of the slight decrease in total enrollment in the Fall 2018 semester, from the previous Fall 2017 semester is the expiration of a scholarship grant in May 2018. We believe, we were able to attract and recruit some students in the previous years because of the availability of the scholarships and with the expiration of the program we are observing a drop in the overall enrollment number in the current year.

b) In terms of the retention the specific objective was to increase the retention rate by 27% from year one to two (55% at the inception of the project, to 70%); and 79% from year one to three (28% at the inception of the project, to 50%) by 2019.

Student enrollment lists from Fall 2016, Fall 2017 and Fall 2018 are compared to obtain retention data. Out of 41 enrolled students in the program in Fall 2016, 29 were retained in Fall 2017, which corresponds to a retention rate of 70.73% (from year 1 to year 2). One student from this cohort graduated in Spring 2018, and two other students transferred to another institution but continued their study in the Engineering field. Thus discounting these three students, from this cohort of Fall 2016, out of 38 students, 18 were retained in Fall 2018. So, from year 1 to year 3, the retention rate is 47.37% for this cohort.

Out of 43 students that were enrolled in these programs in Fall 2017, one student graduated in Spring 2018. Thus discounting for this student, when compared to the students list from Fall 2017, we found that, out of the remaining 42 students in these programs, 26 students are continuing in Fall 2018. This corresponds to a retention rate of 61.9% (from year 1 to year 2). These data show that the retention rates have improved significantly and are close to the target, as given by the project goals. Although the retention rates have improved significantly compared to the years prior to the project, we see that the figures are somewhat lower for Fall 2017 cohort as compared to Fall 2016 cohort. Again, we suspect that the expiration of the scholarship grant could be the main reason behind this somewhat drop in the retention rates.

We also tracked students who were enrolled in ENGR 121L, Introductory Math for Engineering Applications I, and ENGR 215, Physics for Engineers I classes from Fall 2016 and Fall 2017 cohort, to compare the retention rates among the students who were impacted by the newly designed curriculum to the general engineering population and general college student population.

Table 3: Retention among Fall 2016 and Fall 2017 cohorts who were enrolled in newly redesigned Engineering Math I and Physics I classes

		% retained in subsequent semesters			
		Spring 2017	Fall 2017	Spring 2018	Fall 2018
Fall 2016 cohorts	ENGR 121L (N = 26)	87.5	75	65.22	60
	ENGR 215 (N = 29)	89.66	80	76	63.63
Fall 2017 cohorts	ENGR 121L (N = 25)			92	80
	ENGR 215 (N = 26)			96.15	80

Please refer to table 3 for the summary. Compare this data with the College's general student retention data: 78% retention from first to second semester, 66% retention from second to third semester, the retention rate drops to 50% by the fourth semester. The results evidently show significant improvement on retaining the Engineering cohorts (who were impacted by the new curriculum) as compared to the general Northern student population.

III) Specific Objectives for Goal 3:

a) In terms of Undergraduate Research the specific objectives were:
   i) Between 4 and 8 upper-division students will engage in research activities during the academic year during years 2 and 3.
   ii) At least 4 upper-division students will engage in research activities over the summer during years 2 and 3.
   iii) At least 5 upper-division students will participate in a local, regional or national meeting/conference in engineering over a 3-year period.

So far 3 upper division Engineering students were engaged in URE during the regular academic year in year 2. They were mentored by the project PI in conducting aerodynamic research using a grant-funded subsonic wind tunnel. Two of these students presented their research findings in the form of a poster in the institute-wide annual research symposium in Spring 2018. In the summer of 2018 (year 2 of the project), another 2 upper division Engineering students performed research work, again under the supervision of the project PI. They are also scheduled to present their work in the annual research symposium in Spring 2019. Thus, the project so far is on target in terms of engaging students in faculty-mentored research activities.

Apart from UREs for Engineering majors, the project has also provided research opportunities for undergraduate students in Social Science majors. Throughout the course of the project, so far, 4 different Social Science undergraduate students were mentored in URE by one of the Co-PIs of the project. These student researchers, with the guidance from the mentor, administered several surveys in the abovementioned Physics and Math classes and conducted data collection and analysis (Math Anxiety, Self-construal, Research Experience surveys, focus groups etc. These findings will be presented in a separate paper). Their research has been presented in the college annual symposium in Spring 2017 and in Spring 2018.

b) In terms of Undergraduate Internships, the specific objective was to have at least 6 upper division students engaging in a workforce summer internship over a 3-year period.

In the first two years of the project, a total of five internship positions were offered by the nearby National Lab to four different students (one student received the position for two consecutive years) All these students were part of the newly designed Physics for Engineers classes within the last two years. As per the grant proposal, these students received an incentive stipend for working in a relevant technical field while pursuing their degree program. The project management team worked closely with the institute's outreach personnel to create these opportunities for the students, and to encourage them to apply for these positions. The project personnel and other faculty members are now constantly encouraging students to apply for these positions. As part of another NSF grant project at the CET, several brown bag meetings were organized and employers from the nearby National Lab were invited to deliver talks and organized workshops related to resume and cover letter writing, online job application process at the Lab, professional etiquettes, etc, which helped our students in their internship/job application. Mostly, being first-time college students, a majority of our students lacked the confidence to apply for an internship, but these recent success stories are starting to change the perception, and, in general, the students are more confident and motivated to pursue these positions.

Conclusion and Future Work:

This paper elaborates implementation of a comprehensive strategy to retain underprepared minority students in Engineering at a Hispanic Serving Institute in a rural setting and to provide them an enriching learning experience through undergraduate research and on-job training. Engineering Math and Physics curriculum were re-envisioned and redesigned to allow for in-class active learning with the support from peer-led tutors/mentors. The sequence and the content of the Engineering Math and Physics courses are carefully redesigned to allow for an effective and optimal path for aspiring Engineers to core Engineering courses, without having to go through the Calculus courses first, which was a major roadblock to many students. In the first two years of the project implementation, this strategy seems to increase the retention (and also the enrollment) among our Engineering majors. For the cohort who were enrolled in these newly developed courses, the retention among them are significantly higher (higher than the target as proposed in the grant project) compared the Engineering majors and general student population in the institute. The project has also proved to improve the learning experience of the undergraduate students through tutoring/mentoring, undergraduate research and internship opportunities. Although the number of students impacted through these experiences might seem small, it is still quite significant when considered the small Engineering student population. Also, the modified SURE survey results show that the participants in the research or internships perceive the experience as a positive enhancement to their educational experience and with that experience they are more likely to continue their study in postgraduate STEM or professional degree. In the final year of the project, we plan to continue offering student support services and opportunities, such as tutoring/mentoring, UREs, Internships, and assess the effectiveness of these activities. Moreover, students from the new Engineering Math and Physics cohorts will be tracked for their progress in terms of GPA, earned credits, success in upper division classes, degree attainment etc.

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