AC 2011-1395: NSF STEP AWARD: THE COLLEGE OF ENGINEERING AT THE UNIVERSITY OF

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Dr. David Jones earned a BS and MS from Texas A&M University and a PhD from Oklahoma State University. He joined the Biological Systems Engineering Department at UNL in 1989 where he holds the rank of Professor. He also holds a courtesy appointment in the Department of Food Science and Technology.

He has been working in the fields of modeling, process analysis, and risk assessment. He has made contributions in the areas of processing alternative crops, thermochemical conversions, modeling heat and mass transfer within complex systems, and developing models for risk based decision making. In addition, Jones developed methods to use fuzzy set theory and soft computing techniques to capture information about complex systems.

The educational aspects and the students of the BSE department have been a focus for Dr. Jones. He was instrumental in developing the BSE curriculum. Dr. Jones is a leader in presenting the department to recruits, the public, and the university at large. He has developed a number of courses at all levels of the curriculum. His most lasting contribution has been the development of a junior level course in heat and mass transport that incorporates particular considerations for biological systems. Further, he has developed and maintained a productive senior capstone design course that provides hands-on engineering training to graduating seniors. He serves as the academic advisor for incoming freshman and transfer students and has served as faculty advisor for a number of student organizations.

He is active professionally and recently served as the national secretary for the Institute of Biological Engineering (IBE), a member of the American Society for Engineering Education (ASEE) and serves many roles for the American Society of Agricultural and Biological Engineering (ASABE). He has published over 100 papers and book chapters and supervised and advised numerous graduate students.

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NSF STEP Award: The College of Engineering at the University of Nebraska-Lincoln

As graduation rates in science, technology, engineering and mathematics (STEM) disciplines decrease and the STEM workforce ages, the need to attract and train future engineers and scientists is of great significance[1]. The ability of the United States to solve its most challenging problems and to remain globally competitive relies heavily on its capacity to develop future scientists and engineers. According to the National Science Foundation (NSF), "growth in science and engineering jobs will outpace job growth in other fields, with projected increases by 2012 of 26% and 15%, respectively"[2]. Fulfilling this need remains at the hands of institutions of higher education. Their challenge is to recruit and educate a population whose interest in the STEM disciplines has steadily declined over the years.

There are two ways institutions of higher education can keep up with the demand for more engineers. One solution lies in the recruitment and retention of women and students of color; populations that have been largely underrepresented in science and engineering related fields [2, 3, 4, 5, 6, 7, 8, 9]. In the year 2000 minorities represented approximately 17 % of all scientists and engineers in the United States [5]. Couple this with the rapid growth of science and engineering related jobs, it is apparent that in order to meet the demand, "the nation will need to produce more minority scientists and engineers…and to address the underrepresentation of minorities in these fields" [5].

Another solution is the development and implementation of transfer partnerships between community colleges (CC) and four-year institutions. Anderson-Rowland and Grierson [10]

promoted the CC as a viable option in the development of students as they pursue math and science careers. They state that,

> As the need for more engineers in the United States is becoming critical, the CC is becoming more important as a place to begin the nurture of more students who will choose engineering or computer science as a career (para. 1).

In response to the call for the development of more underrepresented scientists and engineers, a resolution is the creation of transfer partnerships between CC and four-year institutions that draw on the talent available at the CC. We suggest that the aforementioned solutions, aligned together, could have significant implications for alleviating the STEM Dilemma. The objective should be to develop and institutionalize an effective pathway that enables underrepresented CC students to transfer seamlessly into a four-year institution and pursue a baccalaureate degree in one of the STEM disciplines.

One such collaboration is UNL-STEP an NSF Science, Technology, Engineering, and Mathematics Talent Expansion Program at the University of Nebraska-Lincoln (UNL). The purpose of this paper is to provide an overview of the development and implementation of the Strengthening Transitions into Engineering Program (STEP) at the UNL College of Engineering (COE). It will also address the challenges and successes from the past four years of implementation. Finally, it will offer areas to consider when executing a collaborative project between CC and four-year academic institutions.

UNL-STEP

Students who begin their academic career at CCs often transfer to four-year institutions to complete their degree. This phenomenon occurs more frequently among first generation and underrepresented minority students than with their majority counterparts. However, there is a significant gap between the number of students who enter two-year colleges with the intention of transferring to four-year institutions, students who apply to transfer to four-year institutions, and the number who actually transfer. Only 52 % of degree-seeking transfer applicants who applied for admission at UNL actually enrolled [11].

Additionally, there are several barriers to successful transfer and transition from two-year to four-year institutions. These factors are exacerbated for students interested in engineering and for underrepresented students [12, 13, 14]. Studies have found that students in mathematics and sciences, as well as underrepresented students in general, have higher attrition rates and academic failure/dismissal rates than other transfer students [15]. Furthermore, research has demonstrated that retention of underrepresented minority students and women can be improved through retention initiatives that allow students to reach their academic and social potential [16], [17, 18]. Initiatives such as institutional commitment, removal of barriers to student success, internships, pre-college development, summer bridge programs, and attention to early success were mentioned by administrators at institutions who demonstrated success in retaining this population [16, 17, 18].

Given the CCs expanded role in academic transfer education, putting in place an aggressive recruitment and retention strategy to encourage more students, particularly

underrepresented students, to pursue education in engineering was imperative. To meet this demand, UNL, in partnership with the state's six CCs sought to increase the number of students successfully pursuing and obtaining baccalaureate degrees in engineering. As the state's only land-grant university with a mission of learning, discovery, and engagement, UNL's partnership with the state's six CCs fit within the scope of the institution's overall purpose. Furthermore, the partnership fulfills each institution's mission of providing educational excellence for all students, economic and cultural development through research and outreach, and a commitment to diversity and intellectual rigor.

The participating CCs are: Central Community College (CCC), a multi-campus CC with three main campuses and three educational centers; Metropolitan Community College (MCC), a full-service public CC with three urban campuses in the state's largest city and two educational centers in neighboring counties; Mid-Plains Community College (MPCC), which serves an 18-county region consisting of three rural campuses; Northeast Community College (NECC), which serves a 20-county region; Southeast Community College (SCC), located in the state's capital along with more than 20 off-campus sites in 15 counties; and Western Nebraska Community College (WNCC) which serves 12 counties with one main campus and two educational centers serving various sites throughout the area.

Implementation of UNL-STEP

To remove many of the aforementioned barriers to transfer, UNL-STEP sought to develop and institutionalize an effective pathway for CC students to complete select freshman and sophomore engineering courses and transfer seamlessly into the UNL-COE. Academic and

social support is provided to ensure retention and encourage completion of a baccalaureate engineering degree in the traditional time frame. Specific objectives of this project are to: (1) increase the number of students transferring into engineering at UNL such that by the end of the project, the percentage of transfer students choosing engineering is equal to the COE's percentage of total students enrolled, (2) increase the number of underrepresented minority students transferring into the COE, (3) increase the number of women transferring into the COE during each year of the grant period, and (4) increase retention and graduation rates of STEP transfer students.

To accomplish these goals the proposed action plan was to implement program activities through three strategies. The first strategy was to develop, implement, and institutionalize four introductory engineering courses at the six CCs that would be accepted for credit at the UNL-COE. The second strategy was to develop a set of student support activities that included academic, financial, and social components that would facilitate mentoring, community building and retention. Finally, internship opportunities were to be developed to enhance career development and post-graduate career preparation.

Management Team

UNL serves as the lead institution and fiscal agent for UNL-STEP. Two co- Principal Investigators (PIs) from UNL are responsible for program oversight, management and policy direction. One graduate assistant, who serves as the program coordinator, is responsible for the daily programmatic, administrative, and communicative functions for the program. Community college Chief Instructional Officers (CIOs) and key administrators are responsible for the

coordination and implementation of the program's activities on their representative campuses; in addition to the recruitment of potential transfer students. The CCs employ instructors who develop, teach, and evaluate one or more of the four engineering courses. Additionally, they are in part responsible for the recruitment and retention of transfer students into the program.

Although not identified as part of the formal management team, several internal relationships at UNL have proved to be influential in the development and implementation of UNL-STEP. Executing the goals of the program has allowed improved and informed relationships with the UNL Office of Admissions and the UNL Academic Transfer Coordinator. Both have been willing partners by providing support in recruiting STEP students to UNL and by providing exceptional counsel to the STEP management team. What's more, the Academic Transfer Coordinator has helped to foster and shepherd the establishment of course articulation agreements within the UNL system. These agreements are discussed further in the section on engineering courses. Partnerships have also been enhanced between STEP and key faculty from the COE. Although CC faculty are responsible for the delivery and evaluation of the courses, key UNL faculty, identified in Table 1, are available to assist CC faculty in their delivery, evaluation and revision of the courses. Partnering with UNL faculty has made them more aware of the needs of transfer students and the value of developing relationships with the CCs.

In addition to enhanced relationships with UNL partners, the relationship between UNL-STEP and its sponsoring department, the COE Dean's Office has been valuable. Due to the objectives of the program, the COE processes and procedures for advising transfer students have been further developed and clarified across the department. The influx of transfer students

into the COE requires organized advising of these students. The COE Dean's Office has reviewed and refined their processes for transfer students. Prior to transferring, students entering the COE have their credits evaluated, receive initial advising assistance through New Student Enrollment or by key COE staff, and are assigned an adviser appropriate for their chosen major. The integration of UNL resources and interaction across the COE has been of great benefit to faculty and transfer students. It is energizing to experience the system being proactive, responsive and receptive to the needs of STEP transfer students and transfer students in general.

UNL-STEP Pathway

Engineering Courses

UNL-STEP is best described by understanding the courses developed for the CCs. The overarching goal of the four engineering courses is to have a core set of courses taught at the CCs that are accepted for credit in the COE's degree programs. Furthermore, the courses would expose CC students to the engineering discipline enabling them to make informed educational and career choices. The intent was to also design the courses in such a way that students can ideally complete their first two years of education at a CC and then transfer with junior standing to the UNL-COE. An analysis by the co-PIs revealed considerable overlap in the objectives of the engineering and technical courses required in the first two years of the curricula of COE degree programs. The following observations summarize this overlap: 1) the primary objectives of the first freshman level course are to introduce students to the discipline to provide context and motivation for further study and to problem solving and critical thinking skills; 2) most disciplines require a course in scientific computer programming that teaches structured programming in a high-level computer language and the use of that language to solve

engineering problems; and 3) most disciplines either require, or allow as a technical elective, a course in basic circuits and electronics or a course in statics. These observations led to the development of the four core STEP courses. Table 1 provides a list of the courses, course descriptions, and course instructors and faculty support.

Course Articulation Agreements

A significant success of UNL-STEP was the establishment of articulation agreements for two of the four aforementioned courses. Articulation are formal agreements that are put in place between institutions that put in place the necessary institutional commitments to allow for seamless transfer of courses from one institution to another. Articulation agreements were established for ENGR 1020 MATLAB Programming and Problem Solving and ENGR 2010 Introduction to Circuits and Electronics. UNL-COE does not have a freshman course that is uniform across all majors. As such it was deemed to be impractical to establish an articulation agreement with each of the courses. Therefore, informal agreements exist for the ENGR 1010 introductory course; an adequate substitute for major specific freshman courses. No articulation agreement has been established for ENGR 2020 Statics. In lieu of an articulation agreement, students are subject to a 'Mechanics Readiness Exam.' This exam allows a student to demonstrate sufficient mastery of statics in order to pursue subsequent courses. Upon successful completion of the exam, credit is awarded for the course equivalent Engineering Management 223.

Student Support Activities

One of the intended goals of UNL-STEP is to build a community for STEP transfer students on the CC campuses which would then be actualized on the UNL campus upon transfer. It was anticipated that the creation of this community would occur through various student support activities such as the Summer Transfer Enrichment Program, Parent Orientation Program, and a peer mentoring program. The UNL-STEP team has found it challenging to create a STEP identity and (subsequently) a STEP community at UNL which has resulted in a selection of student support activities becoming non-operational.

It is not clear why students do not have an understanding of or a connection to STEP once they transfer to UNL. However, it can be assumed that students who transfer to UNL via the STEP pathway continue to experience the same hindrances to obtaining a baccalaureate degree as transfer students in general. Barriers to success for transfer students include acclamation to new settings, academic systems and teaching styles. Additionally, these students who are often non-traditional, experience inadequate financial resources and academic preparation, or are often juggling additional responsibilities associated with finances, family, or both [19, 20]. Although UNL-STEP communicates consistent messages attempting to prepare students for such a transition and has attempted to implement strategies to elevate these hindrances, barriers still persist.

Table 1
Course Descriptions

Course Name	CC & Number of Instructors	UNL Support Faculty
ENGR 1010 *Introduction to Engineering Design* 3-credit hour	▪ CCC - 1 ▪ MPCC - 1 ▪ MCC - 1 ▪ NECC - 1 ▪ SCC - 1 ▪ WNCC - 2	*Professor* *Biological Systems Engineering*
Description: One-semester course introducing students to a variety of engineering disciplines and the engineering design process. Working in multidisciplinary teams, students solve open-ended design problems in the context of energy systems and technology. This is an introductory course to Engineering and should be taken by all students interested in the engineering profession.		
ENGR 1020 *MATLAB Programming and Problem Solving* 3-credit hour	▪ CCC - 3 ▪ MPCC - 1 ▪ NECC - 1 ▪ SCC - 1 ▪ WNCC - 1	*Assistant Professor* *Computer Science & Engineering*
Description: One-semester computer programming course that teaches structured programming and problem solving using computers. The course consists of a sequence of programming assignments requiring students to write MATLAB programs to solve engineering problems.		
ENGR 2010 *Introduction to Circuits and Electronics* 3-credit hour	▪ CCC - 1 ▪ MPCC - 1 ▪ MCC - 1 ▪ NECC - 1 ▪ SCC - 1 ▪ WNCC - 1	*Sr. Lecturer* *Electrical Engineering*
Description: Basic circuit analysis including direct and alternating currents and operational amplifiers. Digital signals and circuits.		
ENGR 2020 *Engineering Statics* 3-credit hour	▪ CCC - 1 ▪ MPCC - 1 ▪ MCC - 1 ▪ NECC - 1 ▪ SCC - 1 ▪ WNCC - 1	*Associate Professor* *Engineering Mechanics*
Description: Action of forces on engineering structures and machines. Force systems, static equilibrium of frames and machines. Friction, center of gravity, moment of inertia, vector algebra.		

For instance, many students transitioning to the UNL-COE are unable to predict or handle the work load imposed upon them. Their schedules are filled with technical and engineering courses without the usual accompanying 'softer' course as a compensator. Their learning styles are slow to adapt to instructors that are more content centric rather than student centric. Furthermore, transfer students from CCs usually do not have a solid awareness of the engineering profession and the requirements for performing in that field. This is evidenced by the focus on very few engineering majors (e.g., Mechanical, Civil, and Electrical Engineering). Students seemed surprised to find the number of engineering majors offered at the UNL-COE. All of these factors are indications of the low level of preparation of CC transfer students. In theory, the proposed student support activities were designed to eliminate these hindrances. However, after planning multiple activities for students to participate in, attendance was poor. It was determined by the UNL-STEP team that because of the unique challenges faced by these students attending these activities were not a priority. In response, the UNL- STEP team questioned which format would best fit the needs of the students, taking into consideration their school, work and familial responsibilities while still exposing them to the importance of community building and career development.

In response, the UNL-STEP team in partnership with the COE Dean's Office, made the decision to develop and implement an Engineering Transfer Seminar Course (ENGR 030) for all new transfer students not only for STEP students. This seminar collectively executes the original strategy that attempted to provide student support activities in the form of orientation and enrichment programs, career development workshops, internships, and other community building activities. ENGR 030 is a required pass/no pass, seven week, zero-credit hour course designed to

provide transfer students with a variety of tools and resources needed to have a successful transition to the COE. Students transferring to the COE with 65 or more credits are required to register for and complete this course. Completion of the course is a COE requirement for graduation. Through learning to self-lead and understand the UNL-COE system, transfer students will be better prepared to learn and work with others at UNL and the college to be outstanding engineering students. Through diverse teaching strategies such as lecture, group discussion, individual assignments, and team learning, students are exposed to the following topics: (a) academic accountability, (b) introduction to UNL academic online systems, (c) developing relationships with advisers and faculty, (d) ensuring transfer of credits, (e) career development strategies and goals, (f) campus involvement activities, (g) graduate school and research opportunities, (f) study abroad and international internships, (g) introduction to transfer shock, and (h) development and implementation of long and short-term undergraduate goals.

CC Instructor Preparation

During the summer of 2007, 2009 and 2010 CC instructors of UNL-STEP engineering courses were invited to attend a Summer Learning Institute (SLI) on the UNL campus. This experience was designed with the intent of enhancing teaching methods and curriculum, fostering the exchange of ideas, and providing networking opportunities. The debut SLI concentrated on topics like educational theory, the nature of engineering, effective teaching and learning strategies, and technological and presentation skills. Subsequent SLI's have included topics such as the design and implementation of course objectives and outcomes, transferring students successfully, identifying and recruiting students, collaborative technologies, engineering design, senior capstone projects, and STEP administrative and evaluation updates. Participants

were also given the opportunity to tour research laboratories and to interact with UNL faculty and staff.

The SLI participants were asked to complete end-of-session evaluation forms at the end of both SLIs. The results from the nine 2007 participant respondents and the six 2009 participant respondents are presented in Table 2 and reveal ratings increased dramatically from 2007 to 2009. Ratings were highest in 2009 for *overall clarity of the information presented* and the largest increase occurred for the item *usefulness of information for your teaching*.

Table 2

Participant Ratings of the Quality of the SLIs

	2007		2009	
Indicator of Quality	*N*	Mean	*N*	Mean
Overall quality of course	9	3.67	6	4.16
Preparation of the instructor(s)	9	3.78	6	4.33
Level of participant engagement in the session	9	3.89	6	4.33
Time for participants to ask questions and/or share comments	9	4.00	6	4.16
Usefulness of information for your teaching	9	2.89	6	4.33
Overall clarity of the information presented	9	3.56	6	4.50
How well the instructors reached the stated goals of the Institute	9	3.11	6	4.00

Note. Responses were rated on a 5-point scale where 1 = Poor, 2 = Below Average, 3 = Average, 4 = Above Average, and 5 = Excellent.

During the 2009 SLI, faculty were asked to rate their level of agreement regarding the instruction provided using a 4-point scale where 1 = strongly disagree and 4 = strongly agree. The results are displayed in Figure 1. Faculty reported ratings of *agree* or *strongly agree* for seven of the nine statements. The statements *the new content and/or strategies I learned are compatible with my institution's culture, my department/institution will be supportive of me as I*

implement what I learned, and *I feel confident that I can apply what I learned to my teacher* were rated the highest. Only two statements were rated less than agree, *I think it will be easy to apply what I learned to my teaching* and *I had opportunities within this training to practice applying new content and/or teaching strategies*.

Participants were also given a series of open response questions regarding the aspects of the training they liked best and what they would change to improve the training. The participants liked the productive, open discussion with other instructors. Ideas for improving the institute included having more time for each discussion, being more hands-on with creating units for the engineering courses, and presenting a clearer picture of UNL's requirements.

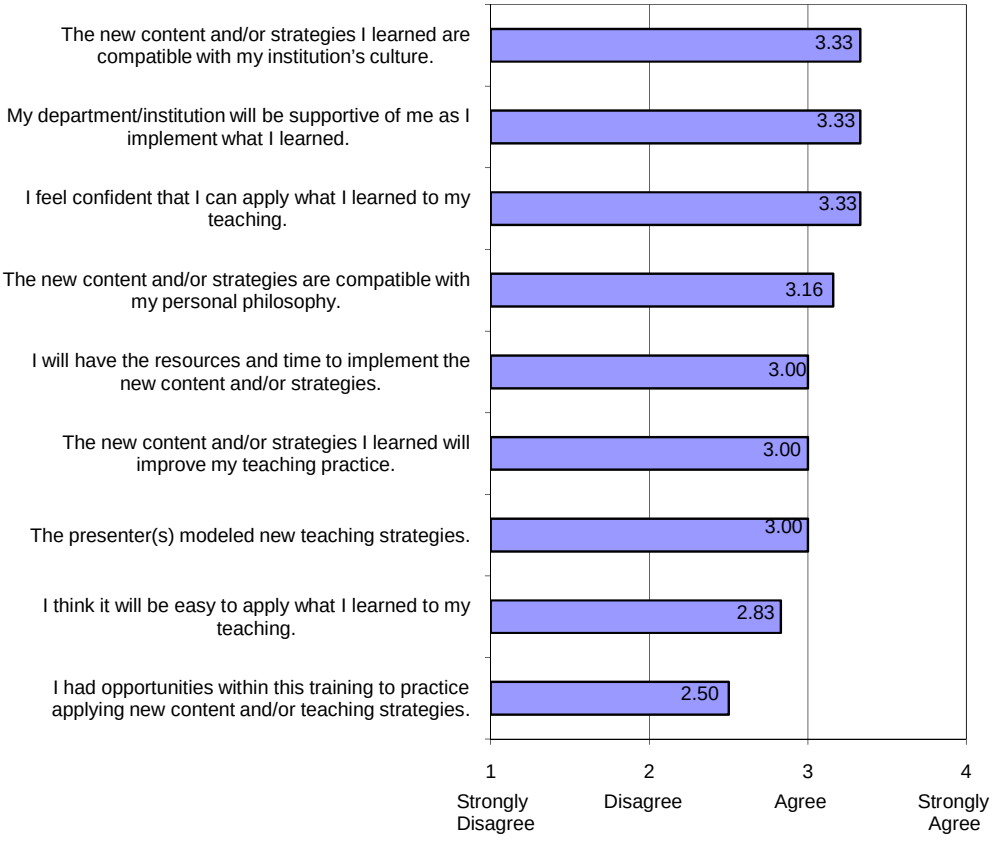

Figure 1. **Levels of Agreement on Instruction Provided (*N=6*)**

Participants were also asked to describe the impact the training would have on their students and to explain what additional support might be necessary to implement the ideas of the institute. The most common responses regarding the impact on students involved helping the students to be more prepared for transferring to UNL and being able to improve their teaching to motivate the students. The most common support needs included continued discussions and sharing of ideas and technology needs for engineering students at the community colleges.

Observations, Focus Groups, and Interviews

Observations of both SLIs were conducted and revealed the majority of trainees were male. The main sessions were held in a mini-lecture hall in the Engineering building on the main UNL campus, with presentations projected using a whiteboard and projector. There were visits to other campus locations during the SLI, including an orientation to the use of Googledocs at one of the technology laboratories on the main campus. All participants had access to hardware/software that was used, and the main meeting space was set up for wireless networking. Content specific instruction was delivered by lecture format, modeling and demonstrating, and through collaborative learning. Teaching styles that were observed included structured instruction, inclusion style, guided discovery, and convergent discovery. Instructional strategies that were used extensively were collaborative learning and hands-on learning. Occasionally independent work, lecture, simulations/demonstrations, and integration of technology were used.

A focus group was conducted with CC faculty participating during the 2009 SLI . The group consisted of CC faculty from various departments, including business, math, engineering,

and other sciences. Their time at their institution ranged from 2 years to 33 years, with a mean of 14 years. Some mentioned that there had been some efforts to increase the number of women and minorities entering the science, math, and technology fields at their respective institutions. This was accomplished by presentations at high schools, including job fairs and career days.

When focus group participants were asked to evaluate the quality of the training they received for the STEP project, overall they felt that the quality and value were high; however, the participants did offer some suggestions. They indicated the amount of information being presented was too much for the limited time in the sessions. They suggested they would like a clearer vision of what needs to be accomplished as part of the STEP program at their respective institutions and would like more timely feedback to help them determine if they are working toward that vision. Additionally, they would like updates on Blackboard along with more support, trainings, and resources to better meet program goals and objectives. Several participants said they felt the training had increased their knowledge of engineering, indicating that their instruction now has more focus, substance, and content, they have gained experience in course development, and are still working on integrating STEP into their courses.

When asked about student impacts, the focus group participants shared that students from their respective CCs reported having difficulty with certain UNL professors recognizing and accepting for transfer their CC STEP classes. The focus group participants also noted the importance of ensuring that the CC students considering a transfer to UNL know about and are included in the STEP process at UNL. When focus group participants were asked if the STEP project had contributed to a greater collaboration between their college and UNL, the overall

consensus was that it worked best if the STEP director and/or the CC instructor are involved. They stated it has been better this year than last, and the people at UNL they are working with have good discussions and ideas.

On campus interviews with a limited number of CC instructors were also conducted during the 2009-2010 school year. When asked to evaluate the training, CC instructors indicated that it was better this year than last, that it had found its direction, and that there was more interaction among participants and with UNL faculty than in the past. CC instructors did indicate, since some course materials were not fully available to all participants during training, access was an issue. CC instructors also stated that the STEP trainings prepared them better for course development and that they rethought how to approach courses. With this, they changed their instruction and now have students in their classes do more presentations, small group work, and learning the technologies that can be utilized. The CC instructors also mentioned that what has impacted the students is that they are gaining a more real perspective about engineering, rather than taking just a prerequisite course and gaining an idea of what an engineer does.

Program Evaluation

Since 2008 174 students have taken at *least* one STEP course at a participating CC. Of the 174 participants, 12% transferred successfully to the UNL-COE. Mechanical Engineering was the most represented major with 23% of all STEP transfer students majoring in this discipline. The number of STEP students who enrolled in and completed STEP courses at a participating CC was 246. ENGR 1010 was the highest represented course at 43% of students taking the course.

Meeting Student Enrollment Goals

Student enrollment data from UNL were examined to gain an overall feel for the effectiveness of UNL-STEP towards meeting the goal of increasing the number of females and minorities in the COE. As shown in Table 3, the percentage of female and minority students in the COE displayed a positive linear trend from spring 2007 until spring 2010.

Table 3

Percentage of Student Enrollment in COE at UNL

Student Category	Spring 2007 Percentage	Spring 2009 Percentage	Spring 2010 Percentage
Female Students (percentage of total female students enrolled in the College of Engineering at UNL)	11.32	11.65	12.35
Minority Students (percentage of total minority students enrolled in the College of Engineering at UNL)	6.97	7.48	7.84

Student enrollment data from UNL were also examined to determine progress towards meeting the goal of increasing the number of transfer students into the engineering department. Table 4 displays these percentages from fall 2007 until fall 2009. The results indicate that while enrollment in the COE has remained steady, the percentage of transfer students choosing engineering has steadily increased over the last 3 years.

Table 4

Percentage of Transfer Student Enrollment in COE at UNL

Student Category	Fall 2007 Percentage	Fall 2008 Percentage	Fall 2009 Percentage
Total students enrolled in College of Engineering (percentage of total UNL enrollment)	10.89	10.66	10.71
Total transfer students choosing the College of Engineering (percentage of total transfer students entering UNL)	10.74	12.23	13.99

Impact on Student Participants

UNL-STEP students who are enrolled in one of the four engineering courses are asked to complete a student survey. CC faculty teaching these courses are asked to assist in providing participating students with evaluation materials. The instructors distribute informed consent forms and information about how to access the online survey to their students. The survey includes measures of student demographic characteristics including gender and ethnicity. The survey also includes measures of the following outcomes based on Social Cognitive Career Theory (SCCT): Self-efficacy for engineering tasks, self-efficacy for engineering majors, outcome expectations, interest in engineering majors, intentions to pursue engineering goals, perceived support, and familiarity with engineering program requirements. Each of these seven constructs are measured on a 5-point Likert scale using anywhere from 5 to 19 items per construct.

Table 5 displays the number of STEP student respondents by year and by course in which they were enrolled. Each course is represented by student participants except for ENGR 2010 which typically has very low enrollment numbers. The table reveals that a total of 89 students have completed the online survey since spring semester of 2008.

Table 5

Course Enrollments of Student Respondents

Community College Course	2008		2009		2010	
	N	Percentage	*N*	Percentage	*N*	Percentage
ENGR 1010	2	3.0	20	40.8	0	0.0
ENGR 1020	29	97.0	23	46.9	9	100.0
ENGR 2010	0	0.0	0	0.0	0	0.0
ENGR 2020	0	0.0	6	20.7	0	0.0

Table 6 displays the characteristics of the 89 participating STEP students and reveals the majority of participants are male and White.

Table 6

Demographic Characteristics of CC STEP Participants

	N	Percentage
Gender:		
Male	79	88.8
Female	10	11.2
Ethnicity:		
White	75	84.3
African-American	3	7.9
Hispanic	7	2.2
Asian	2	3.4
Other	2	2.2

Survey Responses of UNL-STEP Students

To determine the impact of the UNL-STEP program on student attitudes and perceptions of pursuing a career in engineering, the seven subscales were examined. For general comparison over time, Table 7 displays the mean[1] and standard deviation[2] scores for each of the measures for the spring 2008, spring and fall 2009, and spring 2010 administrations.

[1] The mean or average value is a measure of central tendency computed by adding a set of values and dividing the sum by the total number of values.

The results indicate UNL-STEP students are reporting increased levels of support and familiarity with program requirements over time. Participants' intentions to pursue an engineering degree have also increased over time, but their interest in specific engineering majors has decreased. UNL STEP students reported increased levels of self-efficacy for engineering majors and engineering tasks over time. Student outcome expectations remained at a moderate level over time.

Table 7

Mean Scores for Student Survey Constructs

	Spring 2008 (N = 31)		Spring 2009 (N = 20)		Fall 2009 (N = 29)		Spring 2010 (N = 9)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Familiarity with Engineering Program Requirements	2.78	0.87	2.87	0.72	2.90	0.85	3.34	0.48
Self-efficacy for Engineering Majors	3.76	1.00	3.25	0.78	3.57	0.67	3.82	1.06
Self-efficacy for Engineering Tasks	4.17	0.73	3.93	0.66	4.21	0.69	4.47	0.74
Interest in Engineering Majors	3.09	0.76	2.93	1.10	2.74	0.82	2.64	0.60
Outcome Expectations	3.76	0.45	3.61	0.85	3.43	0.46	3.65	0.37
Intentions to Pursue Engineering Goals	3.73	0.98	3.76	0.88	3.63	0.95	3.85	0.90
Perceived Support	3.56	0.67	3.41	0.90	3.35	0.96	3.86	1.07

Data from 8 UNL STEP students who transferred from one of the CCs into UNL COE were compared to data collected from all participating UNL STEP students during the 2009 and 2010 school years for the constructs of familiarity, self-efficacy, and interest. The results are

[2] The standard deviation (*SD*) is a measure of how spread out a set of values is. Higher standard deviations indicate greater variability in data across respondents.

presented in Table 8 and reveal the UNL STEP transfer students had higher levels of self-efficacy, interest, and familiarity than the average UNL STEP CC student.

Table 8

Student Survey Construct Comparison of UNL STEP Transfer Students to UNL STEP CC Students

	STEP Students Attending UNL (N = 8)		STEP Students at Community Colleges, 2009-2010 (N = 58)	
	Mean	*SD*	Mean	*SD*
Familiarity with Engineering Program Requirements	3.51	.61	2.96	.64
Self-efficacy for Engineering Majors	3.89	.51	3.50	.77
Self-efficacy for Engineering Tasks	4.37	.51	4.15	.69
Interest in Engineering Majors	3.08	.50	2.79	.88

Community College STEP Student Focus Group

A focus group was conducted with COE transfer students in the UNL STEP program. All were males and in the junior or senior class. When asked to evaluate the quality of their engineering classes at their CC, their responses were mixed. As with other courses, while some students felt their instructors knew the material and conveyed it well, others felt their instructors were not as knowledgeable regarding the subject matter and in some instances, were not able answer students' questions. The STEP students mentioned that they liked that they were able to transfer classes from the STEP program and that it was nice having someone available on the UNL campus to answer questions. They suggested promoting the STEP program in middle school, citing the rewards that could be gained from an engineering career so students would be on the right track in high school should they desire to pursue a career in engineering. The barriers in trying to earn an engineering degree at UNL, according to the students, were primarily

money for tuition and in some ways, the classes at UNL can be overwhelming. When asked what support they had pursuing an engineering degree at UNL, students stated that they received support from an online resource, from professors, and from self-organized study groups. Students were asked if they would participate in the STEP program if they had to do it over again. Some STEP students stated they would, but would have transferred earlier, while others indicated that they would have come straight to UNL, rather than attending CC. All of the students commented on how they felt misinformed on what courses transferred, that the curriculum transfer Web site at UNL didn't appear to reflect current courses, and whether specific courses would transfer was not clearly stated. The STEP students indicated that addressing this issue would improve the program. Other suggestions for improvement were setting up a scholarship for STEP participants and also providing assistance for STEP students to line up an internship.

Program Challenges

Recruitment

The CCs have an unresolved challenge in that it is difficult to recruit students to enter the STEP project. It should not be surprising that the CCs have a different challenge than UNL-COE, although it manifests itself a bit differently. Neither UNL-STEP nor the CCs have adequately investigated this difficulty; yet some observations and opinions have emerged. It is our view that students inclined toward engineering will preferentially select UNL (or another University offering engineering) prior to selecting a CC. Therefore the pool of students available to CCs is decreased by those entering UNL. Those remaining in the pool are either academically not prepared for engineering, often lacking the pre-requisite mathematics courses or otherwise

constrained. Regardless, recruiting these students to the CCs to pursue engineering is challenging. Even when successful, student success is not assured.

Beyond the general challenges associated with recruiting students, the budget allocated for the project did not include monies to recruit students to the CCs. This lack of allocation has minimized efforts at the CCs related to the STEP program. Recruiting efforts are realized through support for the delivery of courses and through augmentations of their existing recruiting activities. It should be pointed out that UNL-STEP has focused on recruiting students from the CCs, not to the CCs. For instance, to expose the CC students to life at UNL prior to transferring two unique COE recruitment and educational activities were made available to the STEP students while attending the CC. First, CC STEP students and faculty participated in the COE's E-Week Open House. Held each spring, the E-Week open house is where senior engineering students display their research projects, corporate representatives host booths to promote their companies, and prospective engineering students partake in information sessions and hands-on activities that highlight the benefits of becoming an engineer. E-Day is a similar event held each winter featuring the engineering majors available through the Department of Biological Systems Engineering and Agricultural Engineering. Through these activities students are exposed to life as an engineering student, the social and academic culture of UNL and the COE. To further aid in the recruitment of CC students to UNL and to develop a connection between the students and the university, the Co-PI and Program Coordinator visit each CC and provide a presentation about the goals and objectives of STEP to current STEP students and prospective STEP students.

A stated outcome of the STEP project is to increase the number of underrepresented minorities attending the UNL-COE. The UNL-COE recorded slight increases in the number of transfer, female, and minority students from 2008 – 2009. While these numbers show positive increases, they are not traced directly to UNL-STEP participants. In our examination of the transfer student demographics, given the limited access to underrepresented groups in the communities that many of the CCs serve, this outcome has yet to be realized. The design of UNL-STEP parallels what research has found to be successful for underrepresented students who transfer and major STEM in stem disciplines. Supportive environments that include key constituents (e.g., faculty, advisers, peers), peer support, a clear pathway towards a baccalaureate degree, introductory courses, and communication and partnership between CC and four-year institutions were all found to increase the number of underrepresented students successfully completing a four-year STEM degree [21, 22]. These components are all part of UNL-STEP. This makes the lack of underrepresented students in the program more even more complex. Yet, it was previously mentioned that the budget did not allocate funds supporting a formal marketing and recruitment strategy. It could be argued that a lack of a formal recruitment plan has greatly impacted the ability for the CC to develop a recruitment plan that moves beyond brochures, and created specifically for the unique needs of underrepresented students. Feedback from CC faculty and transfer students alike reinforced the perceived need to reach out to middle school students, when they have an opportunity to change their preparation, to consider pursing an engineering degree and engineering as a profession.

Furthermore, research has demonstrated that barriers to participation in STEM for underrepresented groups are due largely to unavailable role models, particularly in the form of

instructors and practitioners [10, 4, 7, 8]. Few underrepresented role models are available at UNL and the CCs. For instance, at the UNL-COE non-traditional and underrepresented students are not the norm. The COE is the fourth largest college at UNL however it is one of the least diverse. According to the Institutional Research and Planning Trend Report [23], in fall 2009 7% of enrolled engineering students were ethnic minorities compared to 12% for the entire campus. Eighty-eight percent of enrolled students during the same time period were male compared to 53% for the entire campus population. The COE faculty demographics are even more troubling. Of the 157 faculty, 86% are male, 57% Caucasian, 43% Asian, and 2% are African American and Hispanic combined. The lack of available role models is largely outside of the scope of the STEP project, but should not go unobserved as a justification for the low number of underrepresented CC students interested in engineering at UNL.

Collecting Data & Monitoring Student Progress

Collecting, monitoring, and responding to information about students engaged in STEP is a continuing challenge. Information about students is derived from two branches. The first branch is from our external evaluation partner RMC Resource Corporation. Data collected by RMC are anonymous and are not the point of the present discussion. The data of interest in this discussion is that which originates from the CC instructors of each of the STEP courses. CC instructors of each of the STEP courses are asked to forward a roster of each class to the UNL-STEP team. The UNL-STEP team responds to this list by forwarding information cards to the instructor so that the instructor can distribute them to the students in their class. The students in the class complete the information cards and return them to the COE via mail (the cards are self-addressed and postage paid). The second attempt is to gain information by forwarding an email

to the CC instructors of each of the STEP courses. The email is intended to be forwarded to their students. The students are to use the email to access a web site where information is provided. In this way, the students have two opportunities to make themselves known and the project will have access to information about students engaged in STEP at the CCs. What remains a challenge is being able to track students that move from the CC to UNL, some other four-year college or university, or if they discontinue their education. Information gaps persist and it is assumed that students have not been identified and student tracking is incomplete.

Discussion

As UNL and other four-year universities attempt to serve a student body that originates at CCs, adjustments must be made. UNL's partnership with the state's six CCs is an example of collaboration that seeks to increase the number and success of students transitioning into rigorous academic settings.

The partnerships have produced courses delivered at the CCs that integrate into COE curriculums and support programs are delivered to students while in the COE. While these programs and partnerships are adding value to the student experience, efforts continue to monitor and evaluate their impact and sustainability. Further, durable accomplishments include a shared understanding of university and CC culture, understanding of internal processes and limitations, appreciating the contribution and value of CC students transferring into COE, and others.

The UNL STEP plan to implement these programs is a good one. However, having a sound plan of action is only a fraction of the implementation process. We offer four areas to

consider when implementing a collaborative project between CCs and a four-year academic institution. The four areas are: (1) properly identifying and tracking STEP prospects and students, (2) developing a collaborative relationship through trust, consistent communication, and formal networks, (3) understanding the developmental and educational needs of the CC student, and (4) negotiating the differing departmental views on the implementation and acceptance of the engineering transfer courses. We suggest that an awareness of these issues in addition to solutions will enhance understanding and collaboration between the institutions and will impact the effectiveness of the pathway for CC students to the four-year institution.

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