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A Chemical Engineering Success Course for Transfer Students

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A Chemical Engineering Success Course for Transfer Students

Our department has developed a one-credit course, which is designed to assist in the successful transition of transfer students from their previous community college or university to our institution. It focusses on developing and understanding the skills needed and the academic expectation to achieve success at an Honors University. This course is taken by transfer students, simultaneously with our material & energy balance course. Prior to the development of this course, our department identified that most of our transfer students did not have the required computing skills, which are needed to be successful in our upper-level courses; therefore, some of the classes/assignments of the success course focus on MATLAB programming. The transfer success course has been taught for the last four years by the same faculty member who teaches the material and energy balance course. This paper will describe the success course structure, content and assessment. In addition, the graduation and retention rates will be presented for transfer students who have and have not taken the success course.

Introduction

Engineering and computing professionals are an essential ingredient for securing our nation's future economic success [1-4]. The availability of a diverse, highly skilled, and well-educated technology workforce is a must for meeting workforce demands and for solving the complex social, environmental, health, and security challenges of the 21st century. Nationally, progress in attracting, retaining, and graduating diverse populations to each of the STEM areas has varied by underrepresented group and by STEM discipline [3,5]. Only 2.4% of college bound African Americans and 1% of Hispanics indicated that they would study computer science in 2008[6]. The percentages of underrepresented minorities intending to study engineering are higher—16.7% of African Americans and approximately 17% of Hispanics[7]. Once in the major, their numbers shrink due to higher attrition rates than for white male students [8]. In 2008, 17.5% of all bachelor's degrees in computer science and 17.5% of bachelor's degrees in engineering were awarded to women. During this same period, 18.4% of computer science and 12.3% of engineering bachelor's degrees were awarded to underrepresented minorities. The percentages of underrepresented minority females awarded computer science and engineering bachelor's degrees remain extremely low—approximately 5% and 3% respectively[9].

Community colleges are a starting point in the higher education for a disproportionate percentage of underrepresented minorities. Approximately 40% of underrepresented women were enrolled in two-year public institutions, as compared to only 33.5% of white women. The same is true for men. During this same period 42% of underrepresented men were enrolled in two-year public colleges as compared to 33% of white men[9]. The National Science Foundation estimates that 44% of science and engineering graduates have attended a community college[10]. The estimate is higher for underrepresented minorities, up to 52%, but low transfer rates for these populations make the recruitment of community college students into STEM majors at universities challenging[11].

Beginning at a community college can negatively affect bachelor's degree attainment. This is due to the realities of high levels of attrition among community college students, difficulties associated with transferring, and attrition after transferring[12]. Once at the university, transfer students face multiple challenges associated with adjusting to the new academic and social environment. Women of color in STEM fields who transfer from community colleges face unique challenges related to the intersection of gender and race—also referred to as the "double bind". Women of color in STEM face "isolation, invisibility, discrimination, not belonging and disconnects for external social and cultural networks"[11, p. 244]. Unfortunately, one of the major leaks of talent in the STEM pipeline occurs between community colleges and universities. Programs are needed that effectively recruit, transition, retain, and graduate talented transfer students, especially underrepresented minorities and women.

Thirty years of research and numerous models explain the factors associated with undergraduate persistence in higher education[1,4,5,13-16]. There is also a robust body of research about the causes of the gender disparity in STEM majors and career fields. The factors that have been studied fall into three broad categories: individual attributes[17-20], environmental conditions[7,21-28], and learning pedagogy[19,23,25,29-31]. The academic and career experience for women in STEM has been characterized by isolation, a lack of mentors, and a shortage of role models[26]. Faculty and peer interactions have substantial influence on the satisfaction and retention of students[2,3,32]. Specific faculty influences include the frequency of interaction with faculty, the quality of teaching by faculty and TAs, and the availability of female faculty and TA role models. Peer interactions affect the classroom climate and influence women's confidence and sense of belonging[29]. Peer interactions also influence participation in study groups and other peer support networks[19,29,30]. The content and characteristics of the curriculum have a substantial effect on the retention and progression of students in STEM majors, particularly for women and other underrepresented minorities[24,26,28]. The existence of a collaborative rather than "ordeal" style learning environment[25], the relevance of assignments, and opportunities to participate in applied learning experiences, such as internships and research[31], all influence success and retention in technical fields for women. All of these issues can be exacerbated for STEM transfer students who are often coming from supportive, science-friendly community college environments[32]. The success of transfer students is related to their academic skills and self-efficacy, college commitment, and personal and career motivations[8]. Transfer students can encounter difficulties with registration and advising processes, housing, and financial aid. They already have experience at college and often avoid or are resistant to orientation programs that seem irrelevant to their needs. At times, transfer students encounter or perceive negative attitudes toward them within their new college or university[33]. Students experience "transfer shock"; those who earned A's at the community college find themselves earning C's[34]. Transfer student who are ethnic minorities may face other barriers such as poor academic preparation, lack of family support, financial difficulties, and challenges of the campus racial climate[8].

Extensive research about the transfer student experience has shown that the challenges of the transfer process can be eased by orientation and other programs targeted toward transfer students that facilitate academic and social integration into the university[33,35,36]. The reality is that four-year institutions dedicate much more time and resources to first-year programs for freshmen[36]. First-year seminars, welcome activities, and other transition services are designed to meet the needs of younger students with no college experience. Due to various external funding initiatives (NSF, Bill and Melinda Gates Foundation, State initiatives, etc.), our university has experienced a larger number of transfer students over the last seven years. Based upon our experiences, we put in place student programming specifically designed for transfer students, to help them be more aware of courses to take for transfer and the financial aid process. In addition, programs[36] are provided to community college faculty, advisors, and students with current information about the four-year institution and its expectations. The programs are tailored to address the academic and social transition issues associated with the demographics (gender, ethnicity, socio-economic variables) of specific populations of transfer students[37]. For example, women of color who transfer from community colleges and enroll in STEM majors are often from first-generation families and struggle to balance family and cultural expectations. Effectively managing family and community responsibilities and relationships is critical for successful academic adjustment[11]. Research has clearly demonstrated that undergraduate success and persistence in STEM is enhanced by highly structured programs that combine multiple interventions such as financial support, intrusive advising, mandatory study groups, faculty mentoring, and community-building activities[19,24,35]. Although much of the STEM research and many of the programmatic interventions that have been implemented and studied have focused on first-time, full-time, underrepresented students, there is a general acceptance of the notion that what works for women and underrepresented minorities is also beneficial to all students in STEM[1], and as such increase the retention and academic success of transfer students. In addition to programming, a Transfer Success Seminar (TRS) course has been developed to assist in the successful transition of transfer students from their previous community college or university experience to our institution. The course focusses on developing and understanding the skills needed and the academic expectations to achieve success at an Honors University. The material covered compliments the work that is being done in upper-level courses in the major and contains academic material selected by the department that has been identified as a barrier to the success of transfer students in that particular major.

Transfer Student Success Course in Chemical Engineering

The Transfer Success Seminar course content parallels that of the Introduction to an Honors University (IHU) seminar[38]. The course is connected to a core introductory course (the Material and Energy Balance course (ENCH 215/215H) – which is not offered at any local community colleges in our area), and this course is usually the first chemical engineering course that transfer students will take in our curriculum. Connecting the seminar course to a core course, resulted in a cost effective option for expanding our First-Year Experience opportunities, which have been shown to be effective in improving the success of our students and in retaining them. Since the course was tied to a core course, it had the added benefit that the transfer students developed relationships with others in their major, and provided opportunities to develop critical thinking skills and learn material that has been identified as a barrier to the success of transfer students in our major (MATLAB programming).

The course was taught by the faculty member who also taught the material and energy balance course; in addition, a peer mentor teaching fellow (a senior chemical engineering transfer student who had taken the transfer success course when they took the material and energy balance course) also helps with the course. This one credit course met once a week for 75 minutes. Course content included:

- Clarification academic expectations (which include the understanding of the value of a liberal arts education and academic integrity) and develop in the student the essential

academic skills (time management, problem solving, communication, library skills, etc.) for success at our institution
- Facilitate student's involvement as active members of the university community
- Maximize students' personal development and self-awareness for major/career decision making and life-long learning
- Resume and cover letter writing and mock interviews to assist in attaining a summer internship
- Homework assignments to supplement the material and energy balance course (which included homework assignments requiring the students to complete practice exams, MATLAB programming, etc.)
- Computer project and oral presentation
- Working additional material and energy balance problems (in class) to supplement the course material in a much smaller setting.

The responsibilities of the peer mentor included:
- Support the goals, expectations, and mission statement of the Office of Undergraduate Education
- Help students become familiar with university resources; advise and refer students to appropriate university resources, as the need arises
- Work with university staff and faculty to create a supportive, inclusive environment for new transfer students
- Maintain two consistent hours of time per week when available to students in the Transfer Seminar course
- Inform and update the course instructor of any important occurrences and of students with possible concerns
- Function as a positive role model at all times, including activities that occur on University property and in the local community
- Prepare and deliver course content in an effective manner as asked by the instructor
- Identify, support and attend 1-2 extra-curricular opportunities for your transfer student seminar class (may include academic, athletic, cultural, SEB, or other campus events)
- Other responsibilities as discussed with TRS Peer Supervisor or Class Instructor
- Attend class once per week for 75 minutes for the full 16 weeks of the semester
- Meet with the TRS Peer supervisor/Class Instructor once every 3 weeks
- Complete four (1 per month) journals chronicling their peer experience.

The peer mentors received a $250 book stipend and Service Learning transcript notation for completion of PRAC096 (zero credit, pass/fail course).

Transfer Student Seminar Assessment

The chemical engineering transfer student seminar course has been taught for the last four years and the qualitative and quantitative assessment data has been very similar over the first three years and the data has been combine and presented in the tables (1-4). (The fourth year data is not yet available, but will be added and presented at the conference). The data was collected, complied and analyzed by the Office of Undergraduate Education. In Table 1, the correlation of pre- and post-assessment expected grade point average was $r = 0.53$ ($p<0.001$), which suggest that for many students, the ‘predictions’ of their academic performance was fairly accurate (and was verified by looking up their post assessment GPA’s). In comparison, the correlation of pre- and post- assessment expected GPA for IHU students was r = 0.37.) Some students supplied a range of values (between 3.5 and 4.0), in which case the mid-range value was recorded for their expected GPA. Other students listed ‘at least 3.0’, which was recorded as 3.0. The data for the TRS-Chemical Engineering Skills was collected pre- and post- of the course and consisted of paired data and resulted in statistically significant improvements in each of the skills over the course of the class. Table 3 provides a comparison of skills and study habits at the beginning and the end of each semester of the course. An example of how the questions/statements were posed to the students is provided at the top of the table. Individual student ratings of the beginning and ending skills were very similar (statistically significant correlations), but positive change over time was also indicated. The second part of Table 3, highlighted the usefulness of the TRS instruction/activities and how often the strategies learned in the TRS are being used. The results indicate that if the students believed the instruction in the TRS to be useful, they were inclined to use what they learned (statistically significant correlations). Finally, Table 4, provides feedback for the specific instructor and course, which is followed by the qualitative open-ended responses for the ‘most valuable part of the course’.

Table1: Participant Descriptives

Male	17 (52%)		**Type of prior college**	
Female	16 (48%)		Community college	24 (73%)
Live on campus	6 (16%)		Four-year college	9 (27%)
Commute	27 (84%)			
Minority	24 (73%)			
High school grade point average			**Prior college grade point average**	
2.0 - 2.5	2 (6%)		2.0 – 2.5	5 (14%)
2.6 – 3.0	9 (27%)		2.6 – 3.0	9 (27%)
3.1 – 3.5	12 (36%)		3.1 – 3.5	12 (36%)
3.6 – 4.0	7 (21%)		3.6 – 4.0	5 (14%)
>4.0	1 (3%)			
Unspecified	2 (6%)		**Expected grade point average**	
			Pre-assessment M=3.43	Median=3.50
Paid employment			Post-assessment M=3.19	Median=3.0
None	15 (45%)			
<10 hours per week	4 (12%)			
10-20 hours per week	8 (24%)			
20-30 hours per week	5 (15%)			
>30 hours per week	1 (3%)			
Reasons for enrolling in the TRS				
Advisor/instructor recommended	16 (49%)			
Helpful, specific skill-building	17 (51%)			

Table 2: TRS-Chemical Engineering Skills

N=33	Pre-assessment Mean/SD/Median	Post-assessment Mean/SD/Median
Convert quantities from one set of units to another	3.73 (.90) 4.00	4.60 (.52) 5.00
Define, calculate, estimate properties of process materials…	2.91 (1.45) 3.00	4.10 (.57) 4.00
Draw and label process flowcharts…	2.00 (1.26) 2.00	4.20 (.79) 4.00
Carry out degree-of-freedom analyses	1.91 (1.14) 1.00	3.70 (1.06) 3.50
Write and solve material and energy balance equations…	2.18 (1.54) 1.00	3.70 (.95) 3.00
Perform pressure-volume-temperature calculations…	3.18 (1.25) 3.00	3.80 (.92) 3.50
Perform vapor-liquid equilibrium calculations…	2.00 (1.26) 2.00	3.50 (.71) 3.00
Develop computer program - solve thermodynamic problem	1.73 (1.27) 1.00	3.00 (.47) 3.00

*Response scale (1-5, low to high self-reported knowledge/skill)

Composite of all (8) chemical engineering items:

	Mean/SD	Median	Min-Max
Pre-assessment	2.45 (1.01)	2.12	1.25 – 4.63
Post-assessment	3.82 (.56)	3.69	3.13 – 4.75

Table 3: Pre- Post-assessment Items

Comparison of skills and study habits at the beginning and end of semester; Example: Overall, my time management skills at the beginning of the semester were/now are). Response scale (1-5): Very Poor, Poor, Fair, Good, and Very Good.

N=33	Skills were Mean/SD/Median	Skills now are Mean/SD/Median	Correlation
Time management	2.90 (1.10) 3.00	3.67 (.75) 4.00	*r* =.37, p<.01
Organization	3.15 (1.04) 3.00	3.80 (.80) 4.00	*r* =.49, p<.001
Procrastination	2.62 (1.33) 2.50	3.43 (.94) 3.00	*r* =.66, p<.001
Study skills	2.98 (1.03) 3.00	3.65 (.88) 4.00	*r* =.40, p<.01
Motivation	3.48 (1.08) 4.00	3.75 (.95) 4.00	*r* =.45, p<.001
Class participation	3.33 (.99) 3.00	3.72 (.82) 4.00	*r* =.66, p<.001
Social	3.35 (1.04) 3.00	3.72 (.92) 4.00	*r* =.62, p<.001
Writing	3.68 (.77) 4.00	3.87 (.79) 4.00	*r* =.74, p<.001

<u>Usefulness of TRS instruction/activities, how often strategies learned in the TRS is being used</u>.

- Usefulness scale (1-5): not at all useful, slightly useful, moderately useful, very useful, extremely useful
- How often used (1-5): almost never, infrequently, occasionally, frequently, almost always

	Usefulness Mean/SD/Median	How often use Mean/SD/Median	Correlation*
Time management n=33	3.84 (.90) 4.00	3.76 (.95) 4.00	*r* =.51, p<.001
Organization n=33	3.86 (.87) 4.00	3.67 (.99) 4.00	*r* =.73, p<.001
Procrastination n=31	3.78 (.98) 4.00	3.59 (.93) 4.00	*r* =.76, p>.001
Study skills n=33	4.00 (.87) 4.00	3.81 (1.02) 4.00	*r* =.72, p<.001
Motivation n=33	3.94 (.96) 4.00	3.78 (1.07) 4.00	*r* =.64, p<.001
Class participation n=32	4.32 (1.10) 5.00	3.85 (1.12) 4.00	*r* =.58, p<.001
Social n=32	3.74 (1.08) 4.00	3.58 (1.18) 4.00	*r* =.86, p<.001
Writing n=33	3.82 (1.10) 4.00	3.78 (1.20) 4.00	*r* =.79, p<.001

Table 4: Feedback about Instructor and Course:

N=33	Mean/SD
TRS instructor open and responsive to questions	4.92 (.28)
TRS instructor respectful of students opinions &concerns	4.87 (.43)
Class activities typically interesting and engaging	4.67 (.57)
Class activities contributed to understanding of content material	4.70 (.53)
Instructor clear about learning outcomes	4.77 (.50)
Assignments contributed to learning in TRS	4.73 (.55)
Grading criteria were clear	4.80 (.48)
Peer contributed in meaningful ways (n=32)	4.65 (.63)
Peer interacted positively with students (n=32)	4.77 (.43)
Instructor and peer worked well together	4.85 (.37)
I feel more prepared for the university academic expectations	4.50 (.79)
Recommend a first-year experience (like TRS) for new students	4.75 (.70)

Response scale (1-5) *median score was 5.00 for all items

Qualitative data

The most valuable part of the TRS 201 was:

1. Small group setting
   "the small-group setting, which is hard to come by in college sometimes"
   "working in groups with other students who were in my situation"
   "Now I have someone I know better and can work better with…valuable asset for me"

2. Extra content help

   "The teacher and peer mentor were great at explaining things in a simple matter", "help with practice problems", "simplify the difficult topics at lecture", review sessions; "Extra problems and exploring different approaches to problems was very helpful"; small group work on problems; "having additional time with the faculty member in a smaller setting – very helpful in providing explanation of difficult concepts"

3. Career planning, goals, resume, advice

4. Learning about campus and its resources, developing better study habits, time management, organization

Transfer Student Seminar Outcomes:

Over the last five years, our material and energy balance course has been made up of 30-50% transfer students. In addition, our program student population is 30-45% minority students and about the same percentage female. Students who have taken the student success course, have earned ABC grades with similar percentages as the freshman admits (this ratio is anywhere from 2 to 1 to 7 to 1 ratios), however the transfer students without the transfer success course are almost twice as likely to earn DFW grades (versus ABC grades) in the material and energy balance course (Table 5). As expected, success in the material and energy balance course correlates directly with our graduation and retention rates in our program (Tables 6-8). As supported by the literature, it is believed that the success in the material and energy balance course has less to do with the content of the transfer success course, but has more to do with the sense of community[39-42] that these transfer students experience with their peers, the course instructor and peer mentor.

Table 5: ENCH 215/215H Grades

	Freshman Admit			Transfer Students			
Semester	ABC Grade	DFW Grade	Number of Transfer Students (Percent of Total)	ABC Grade	DFW Grade	ABC Grade With TRS course	DFW Grade With TRS course
Fall 2010	35	8	27 (38.6 %)	16	11		
Fall 2011	28	12	29 (42 %)	17	12		
Fall 2012	35	11	46 (50 %)	12	19	10	5
Fall 2013	43	14	27 (32.1 %)	5	10	9	3
Fall 2014	48	12	41 (40.6 %)	10	20	9	2
Fall 2015	66	10	36 (32.1 %)	13	15	7	1

Table 6: ENCH 215/215H Freshman Admit: Where are they now?

	ENCH 215/215H ABC Grade						ENCH 215/215H DFW Grade					
Semester	Graduated ChE	Graduated STEM	Current ChE	Current STEM	Other Major	Left University	Graduated CHE	Graduated STEM	Current ChE	Current STEM	Other Major	Left University
Fall 10	23	4	1	5	1	1	2	2	1	3		
Fall 11	22	3		1		2		5	2	2	1	2
Fall 12	12		11	5	3	3				4	3	4
Fall 13			37	4		2			6	5	2	1
Fall 14			44	2		2			3	5	3	1
Fall 15			61	5					2	7		1

Table 7: ENCH 215/215H Transfer Students: Where are they now?

	ENCH 215/215H ABC Grade						ENCH 215/215H DFW Grade					
Semester	Graduated ChE	Graduated STEM	Current ChE	Current STEM	Other Major	Left University	Graduated CHE	Graduated STEM	Current ChE	Current STEM	Other Major	Left University
Fall 10	8	1		2		5	1	1	1		1	7
Fall 11	12		2			3		1	1	3		7
Fall 12	6		4	1		1	1	3	1	3	1	10
Fall 13			4			1			2	4		4
Fall 14			10						7	5	3	5
Fall 15			11	2					2	9	1	3

Table 8: ENCH 215/215H WITH Success Course TRS 201 Students: Where are they now?

	ENCH 215/215H ABC Grade						ENCH 215/215H DFW Grade					
Semester	Graduated ChE	Graduated STEM	Current ChE	Current STEM	Other Major	Left University	Graduated CHE	Graduated STEM	Current ChE	Current STEM	Other Major	Left University
Fall 12	3		5	1		1	1	2	1			1
Fall 13			6	3					1			2
Fall 14			9						1			1
Fall 15			6	1			1					

Conclusions

The development of a one-credit transfer success course, which is specifically tied to our material and energy balance course, has resulted in the positive success (in the graduation and retention rates) of transfer students in our Chemical Engineering program. Even for the students who left our program after having the transfer success course had a much higher rate of retention in STEM fields and retention at the University. The cost of this program is minimal, especially in comparison to similar programs, which were supported by NSF STEP or S-STEM programs[43-45]. It is our belief, that this success in the material and energy balance course (and program) has less to do with the content of the transfer success course, but has more to do with the sense of community that these transfer students experienced with their peers, the course instructor and the peer mentor. This information was supported by the end of the semester free responses that were collected during the course/instructor evaluations.

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REFERENCES

1. Bean, J.P. and Metzner, B.S., *A conceptual model of nontraditional undergraduate student attrition.* Review of Educational Research, 1985. 55: p. 485-540.
2. Bettinger, E. and Long, B.T., *Do faculty serve as role models? The impace of instructor gender on female students.* American Economic Review, 2005. 95(3): p. 152-157.
3. Bjorklund, S.A., Parente, J.M., and Sathianathan, D., *Effects of faculty interaction and feedback on gains in student skills.* Journal of Engineering Education, 2004. 93(2): p. 153-160.
4. Braxton, J.M., Hirschy, A.S., and McClendon, S.A., *Understanding and reducing college student departure.* ASHE-ERIC Education Report, 2004. 30(3).
5. Cabrera, A.F., Nora, A., and Castaneda, M.B., *College persistence: Structural equations modeling test of an integrated model of student retention.* Journal of Higher Education, 1993. 64(2): p. 123-139.
6. Higher Education Research Institute (HERI), *Survey of American freshman: National norms*. 2009, University of California Los Angeles.
7. Hill, C., Corbett, C., and St. Rose, A., *Why so few? Women in science, technology, engineering and mathematics*. 2010, AAUW: Washington, DC.
8. Dennis, J.M., Calvillo, E., and Gonzalez, A., *The Role of psychosocial variables in understanding the acheivement and retention of transfer students at an ethnically diverse urban university.* Journal of College Student Development, 2008. 49(6): p. 535-550.
9. National Science Foundation Division of Science Resources. *Women, Minorities, and Persons with Disabilities in Science and Engineering. Special Report NSF 11-309*. 2011 [cited 2011 July 20]; Available from: http://www.nsf.gov/statistics/wmpd/.
10. Tsapogas, J., *The role of community colleges in the education of recent science and engineering graduate (Info Brief)*. 2004, National Science Foundation: Washinton, DC.
11. Reyes, M.-E., *Unique challenges for women of color in STEM transferring form community colleges to universities.* Harvard Educational Review, 2011. 81(2 Summer 2011): p. 241-261.
12. Dougherty, K., *The effects of community colleges: Aid or hinderance to socioeconomic attainment?* Sociology of Education, 1987. 60: p. 86-103.
13. Pascarella, E.T. and Terenzini, P.T., *How college affects students: A third decade of research*. 2005, San Francisco, CA: Jossey-Bass.
14. Reason, R.D., *An examination of persistence research through the lens of a comprehensive conceptual framework.* Journal of College Student Development, 2009. 50(6): p. 659-682.
15. Tinto, V., *Leaving college: Rethinking the causes and cures of student attrition*. 2nd ed. 1993, Chicago: Univerity of Chicago Press.
16. Torres, V., *A mixed method study testing data-model fit of a retention model for Latino/a students at urban universities.* Journal of College Student Development, 2006. 47(3): p. 299-318.
17. Good, C., Aronson, J., and Harder, J.A., *Problems in the pipeline: Stereotype threat and women's achievement in high-level math courses.* Journal of Applied Dvelopmental Psychology, 2008. 29(1): p. 17-28.
18. Margolis, J. and Fisher, A., *Caring about connections: Gender and computing*. 2002, Carnegie Mellon University, School of Computer Science: Pittsburgh, PA.
19. Ingram, S. and Parker, A., *Gender and collaboration: Communication styles in the engineering classroom*. 2002: Fernwood Publishers.
20. Marra, R.M., Rodgers, K.A., Shen, D., and Bogue, B., *Women engineering students and self-efficacy: A multi-year, multi-institution study on women engineering student self-efficacy.* Journal of Engineering Education, 2009. 98(1): p. 27-38.
21. Astin, A.W. and H., A., *Undergraduate science education: The impact of different college environments on the educational pipeline in the sciences*. 1993, University of California, Graduate School of Education, Higher Education Research Institute: Los Angeles.
22. Barker, L.J., McDowell, C., and Kalahar, K., *Exploring factors that influence computer science introductory course students to persist in the major.* ACM SIGCSE Bulletin, 2009. 41(2): p. 282-286.
23. Harper, S.R. and Quay, S.J., *Beyond sameness, with engagement and outcomes for all: An introduction*, in *Student engagement in higher education*. 2009, Routledge: New York, NY. p. 1-15.
24. Kahveci, A., Southerland, S.A., and Gilmer, P.J., *Retaining undergraduate women in science, mathematics, and engineering.* Journal of College Science Teaching, 2006. 36(3): p. 34-38.

25. O'Neal, J.B., *Engineering education as an ordeal and its relationship to women in engineering*, in *American Society for Engineering Education Annual Conference Proceedings*. 1994. p. 1008-1011.
26. Rypisi, C., Malcolm, L.E., and Kim, H.S., *Environmental and developmental approaches to supporting women's success in STEM fields*, in *Student engagement in higher education*, S.R. Harper and Quay, S.J., Editors. 2009, Routledge: New York, NY. p. 117-135.
27. Sax, L., Bryant, A.N., and Harper, C.E., *The differential effects of student-faculty interaction on college outcomes for men and women.* Journal of College Student Development, 2005. 46(6): p. 642-659.
28. Zhao, C., Carini, R.M., and Kuh, G.D., *Searching for the peach blossom Shangri-La: Student engagement of men and women SMET majors.* Review of Higher Education, 2006. 28(4): p. 503-25.
29. Amellink, C.T. and Creamer, E.G., *Gender differences in elements of the undergraduate experience that influence satisfaction with the engineering major and the intent to pursue.* Journal of Engineering Education, 2010. 98(1): p. 27-38.
30. Hirschy, A.S. and Wilson, M.E., *The sociology of the classroom and its influence on student learning.* Peabody Journal of Education, 2002. 77(3): p. 85-100.
31. Sheppard, S., Macatangay, K., Colby, A., and Sullivan, W., *Educating engineers: Designing for the future of the field*. 2009: Jossey-Bass.
32. Campbell, T. and Campbell, D., *Faculty-student mentor program: Effects on academic performance and retention.* Research in Higher Education, 1997. 38: p. 727-742.
33. Silverman, S.C., Sarvenaz, A., and Stiles, M.R., *Meeting the needs of commuter, part-time, transfer, and returning students*, in *Student engagement in higher education: Theoretical perspectives and practical approaches for diverse populations*, S.R. Harper and Quaye, S.J., Editors. 2009, Routledge: New York. p. 223-241.
34. Hills, J., *Transfer shock: The academic performance of the junior college transfer.* Journal of Experimental Education, 1965. 33(3): p. 201-216.
35. Laanan, F.S., *Studying transfer students: Part II: Dimensions of transfer students' adjustment.* Community College Journal of Research and Practice, 2007. 31: p. 37-59.
36. Roberts, K.G., T. Bowles and J.P. Lavelle, "Building a Better Transfer Community: Improving Engagement and Advising of Prospective Transfer Students," Proceedings of the 2015 Annual Conference & Exposition, ASEE (2015).
37. Townsend, B.K. and Wilson, K.B., *"A hand hold for a little bit": Factors facilitating the success of community college transfer students to a large research university.* Journal of College Student Development, 2006. 47(4): p. 439-456.
38. Bayles, T.M., *Improving the Freshman Engineering Experience*, Proceedings of the 2004 Annual Conference & Exposition, ASEE (2004).
39. Sheppard, S., S. Gilmartin, H.L. Chen, K. Donaldson, G. Lichtenstein, O. Eris, M. Lande and G. Toye, *"Exploring the Engineering Student Experience: Findings from the Academic Pathways of People Learning Engineering Surveys (APPLES),"* Center for the Advancement of Engineering Education, Technical Report CAEE-TR-10-01, (2010).
40. Wu, P., *"Increasing College Opportunity for Low-Income Students,"* https://www.whitehouse.gov/sites/default/files/docs/white_house_report_on_increasing_college_opportunity_for_low-income_students.pdf
41. Yoder, B.L, *"Going the Distance Best Practices and Strategies for Retaining Engineering, Engineering Technology and Computing Students,"* https://www.asee.org/retention-project, ASEE (2012).
42. Corbett, C. and C. Hill, *"Solving the Equation The Variables for Women's Success in Engineering and Computing,"* http://www.aauw.org/research/solving-the-equation/, AAUW (2015).
43. Anderson-Rowland, M.R, Rodriguez, A.A. and A. Grierson, "Motivated Engeineering Transfer Students/STEP after Six Years," Proceedings of the 2015 Annual Conference & Exposition, ASEE (2015).
44. Laier, J. and S.J. Steadman, "Inproving Transfer Student Success," Proceedings of the 2014 Annual Conference & Exposition, ASEE (2014).
45. Ford, D.M., Rees, P. and K.G. Rubin, "The Impact of Federally Funded Scholarship Programs on the Success of Transfer Students at a Public Engineering College," Proceedings of the 2015 Annual Conference & Exposition, ASEE (2015).