AC 2011-1029: THE ITASCA CC ENGINEERING LEARNING COMMUNITY

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The Itasca CC Engineering Learning Community

Abstract

The engineering program at Itasca Community College in northern Minnesota has developed a successful and unique learning community model for engineering education. The model is highly effective in attracting a wide variety of students into the field of engineering. It has proven successful in developing the student's ability to complete a four-year engineering degree and enter the workforce in a timely fashion. The success of the model is based on a comprehensive learning community approach that is defined by 1) strong K-12 relationships, 2) two-year "across the curriculum" engineering and professional development (EPD) course sequence, 3) active faculty and student life, 4) block scheduling of courses, 5) active student learning strategies, and 6) strong articulation agreements with regional four-year institutions. This paper will explore these six elements that define the Itasca engineering learning community model. Student graduation rates will be used to compare the success of the model with other programs in the region and across the nation.

Introduction

The value of learning communities within higher education is now well documented[1]. Such evidence has thrust this concept into curricular redesign efforts across the United States. Numerous publications and the demand for information is so high that a peer-reviewed journal on the subject now exists*, The Journal of Learning Communities Research.* Engineering education has also embraced this new paradigm and "Engineering Learning Communities" are now featured at nearly every major engineering program in the country, from the top-ranked research institutions to private liberal arts colleges. Examples include MIT, Auburn University, Georgia Tech, Texas A&M, Harvey Mudd College, Olin College, Rose-Hulman IT, Union College, and Purdue University.

The values of learning communities are nicely summarized by a Purdue University Engineer: "Research results here and at programs across the United States show that students who take part in a learning community (LCs) earn higher grades, make friends faster, and graduate at higher or faster rates than students who don't participate. As a consequence LC's are a core component of Purdue's first year experience. Each college has learning community options for students to choose from[2]." "From 1999 to 2008 Purdue Engineering program has gone from four communities and 246 students to 48 communities and 1611 students. They have measured success in student retention and performance in all demographics[3]."

The driving force behind this transition in engineering education is the research results that demonstrate learning communities lead to measurable changes in student learning and retention. Anecdotal reports also show that students are *simply enjoying* the process more. Lardner and Malnarich[4] state, "Learning communities can have powerful consequences for everyone involved. To become an educational reform, though, this transformative power needs to be focused on the critical issue of student achievement on campuses. That means involving and creating wider campus conversations and providing opportunities for faculty to develop working relations with each other that are tenable and practical. Until we shift our collective attention to the students whose time with us is brief indeed, learning communities will continue to serve the fortunate few, while the many drift away— and so too the promise of this educational innovation to become a means for educational equity."

This paper highlights the Itasca Community College engineering learning community model and the elements that make it successful.

Background

Itasca Community College (ICC) is a small (1000 FYE), rural, two-year college located in Grand Rapids, in northern Minnesota, approximately 80 miles northwest of Duluth, Minnesota. It was founded in 1922 and has held accreditation with the North Central Association Higher Learning Commission since the mid-1970's. The institution primarily serves students located in the northern third of the state. ICC is a member of the Minnesota State Colleges and Universities system (MnSCU) as well as a member of the Northeast Minnesota Higher Education District (NHED). The college offers a number of two-year transfer and terminal programs and is exceptionally known (regionally and nationally) for its associate of science engineering transfer program. Students who complete Itasca's engineering program transfer to four-year institutions across the nation to complete their STEM degrees. A majority of the students transfer to the regional ABET-accredited institutions with which Itasca has strong partnerships and articulation agreements:

- Bemidji State University
- Michigan Technological University
- Minnesota State University, Mankato – Main Campus
- Minnesota State University, Mankato – Iron Range Engineering Campus
- North Dakota State University
- University of Minnesota – Duluth
- University of Minnesota – Twin Cities
- University of North Dakota
- St. Cloud State University

Prior to 1993, Itasca had a typical rural community college pre-engineering program with less than a dozen students per year taking basic math, science, and general education courses, in addition to a few early engineering courses (static mechanics and engineering circuits). Between 1993 and 2010, the program grew from 10 students to 150 students through purposeful efforts to increase the engineering education opportunities for students in northern Minnesota[5]. The program growth has come as the quality of the learning community model has improved. The program's faculty now consists of six engineering/physics instructors, two math instructors, and a position and a half of chemistry instructors.

As an open admission institution, students who start the engineering program come with a wide range of socioeconomic factors and math preparation factors that can impact their success. 72% of students at Itasca are first generation college students and 76% qualify for financial aid. In math preparation terms, approximately one third of the students start their math sequences with calculus 1, one third with pre-calculus, and one third with a math course below pre-calculus.

Along with success in program growth, the four-year degree graduation rate for students entering Itasca's program has been a success story as well.

Starting Semester	# of Students	% Completion for Students who Started: Introduction to Engineering	General Physics 1	Average Semesters to Graduation for: All Students	Calculus 1 as 1st Math Course	Pre-Calculus as 1st Math Course	Significant Difference at a "critical p-value" of 0.05?
Fall 2002	60	60%	73%	8.7	8.5	9.1	No
Fall 2003	39	56%	69%	8.7	8.9	8.7	No
Fall 2004	75	39%	58%	9.0	8.8	9.1	No
Fall 2005	68	46%	70%	8.5	8.5	8.6	No
Overall	242	49%	67%	8.7	8.7	8.9	

Table 1: Four Year Degree Completion Rate and Average Semester to Graduation

Two degree completion rates, shown in Table 1, serve to indicate student success:

- 49% degree completion for students who started introduction to engineering – this represents the typical community college 1st year students with a wide variety of math skills and actual interest in engineering and that individually may or may not be considered "ready and able" to start an engineering education
- 67% degree completion for students who started calculus-based physics 1 – this represents the students who have continued at Itasca to the point where most engineering students start their college experience with a calculus 1 math ability and a strong interest in engineering and would be considered "ready and able" to start an engineering education

Itasca's 49% and 67% four-year degree completion rates compare well with those of other institutions and studies:

- 40.8% national engineering/engineering technologies degree completion rate from a 2009 U.S. Department of education study, "Students Who Study Science, Technology, Engineering, and Mathematics (STEM) in Postsecondary Education"[6].
- 69% 6-year graduation rate for engineering students at Michigan Technological University[7]
- 56% 6-year graduation rate for incoming fall 2001 engineering students at the University of North Dakota School of Engineering and Mines[8]
- 45% male and 49% female graduation rates for incoming fall 1996 students in a 2005 study of the Southeastern University and College Coalition for Engineering Education (SUCCEED) Institutions[9]. SUCCEED institutions award over 1/12 of all U.S. engineering degrees and include the institutions of Clemson University, Florida A&M University, Florida State University, Georgia Institute of Technology, North Carolina A&T State University, North Carolina State University, University of Florida, University of North Carolina at Charlotte, and the Virginia Polytechnic Institute and State University at the time of the study.

In addition, Table 1 shows that the engineering learning program is also successful in providing an equitable time to completion of a four-year engineering degree regardless of whether the student starts the math course sequence with calculus 1 or pre-calculus.

The Itasca Engineering Learning Community Model

The success of the Itasca program's growth, student four-year degree completion rates, and average number of semesters to four-year degree completion are a direct result of the program's unique learning community. The key elements that define Itasca's learning community model are 1) strong K-12 relationships, 2) 2-year "across the curriculum" engineering and professional development (EPD) course sequence, 3) active faculty and student life, 4) block scheduling of courses, 5) active student learning strategies, and 6) strong articulation agreements with regional four-year institutions. These elements focus on student success in transitioning from high school to college, student success in engineering education at Itasca and the four-year transfer institution, and ultimately success in the engineering career. Funding for the six key elements of the program is a 50/50 combination of institutional money and grant and foundation support.

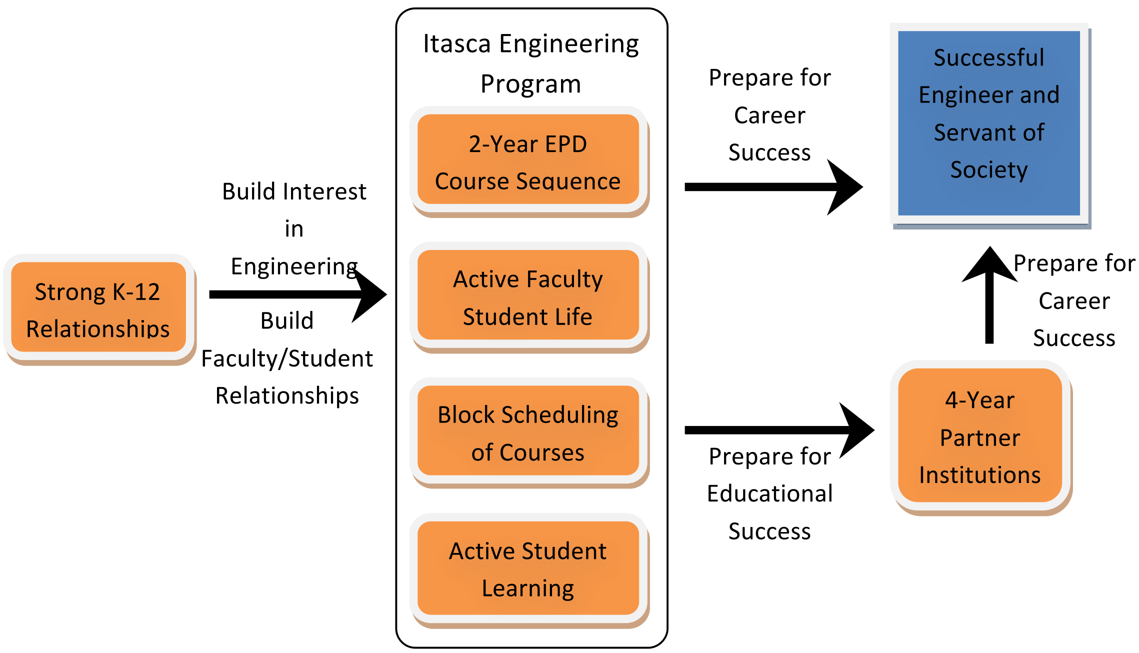

Figure 1: Elements of Itasca Engineering Learning Community

Strong K-12 relationships

Success in college depends on many factors grounded in the high school experience. One often overlooked factor is the identification of college major and career aspirations during the high school years[10]. Not only is it important for learning communities to develop these aspirations in K-12 students, but according to the 2005 National Academy report[11] "Enhancing the Community College Pathway to Engineering Careers", "Community colleges are in the best position to undertake outreach programs to K–12 teachers and students in their communities" to build student aspirations for engineering.

Itasca has a two-prong strategy to building strong relationships with regional K-12 students, teachers, and schools. The first prong is to build overall student interest in the field of engineering through high school visits and hosting regional engineering events. Faculty and former engineering program graduates make weekly visits to area high school science and math classes to inform students about and get them interested in the field of engineering. This outreach is done through engineers acting as guest speakers, engineering faculty mentoring high school Project Lead the Way classes, single class period engineering competitions, enthusiastic presentation of the types of careers available in engineering, and descriptions of how to become an engineer, etc. Additionally, several regional events are hosted each year at the college where students come and spend a day involved in an engineering activity. Examples include Women in Engineering Day, Engineering Day, hosting JETS competition, regional FIRST robotics training and practice competitions, elementary school renewable energy activities, Project Lead the Way events, engineering summer camps, College for Kids, etc. These examples align with the effective recruitment strategies identified in the National Academies report[11].

The second prong is to *develop personal connections* with students from these high schools before the start of their college academic career. These connections begin with high school visits and student participation in events at Itasca. They continue to develop through telephone calls, letters, the ICC Engineering holiday card, the ICC Engineering Valentine's card, ICC Engineering t-shirts, and invitations to a multitude of on-campus events: student/parent open houses, summer engineering camp, summer bash for rising seniors, spring dinner for applicants, and more. By the time a student enters their first year courses on campus, they are very likely recognized by name, face, and personality by the engineering faculty.

The connections made between faculty and future students involved in these K-12 activities builds the aspiration for the engineering degree and career. Perhaps more importantly, these connections build a trusting and cooperative relationship between students and their future teachers that carries into their first semester course. This is the foundation for student success that goes on with the students to the four-year transfer institution.

2-year "Across the Curriculum" Engineering and Professional Development Course Sequence
Itasca has utilizes a two-year engineering and professional development (EPD) course sequence to continue the development of the students to succeed in engineering education and ultimately their career. The EPD sequence, in place since 2002, starts with Introduction to Engineering in the fall of the students 1st year and then continues with "Engineering and Professional Development (EPD) 2, EPD 3, & EPD 4 sequentially in each of the remaining three semesters the student is at Itasca. This course sequence is focused on developing the individual as a better student, engineer, professional, and citizen.

Student Development - Each semester students learn and practice the skills needed to be successful as a student such as time management, study methods, stress management, personal health, personal finance, and fitness. This increases the level of student efficacy and is positively related to student academic success and adjustment during the 1st year of college[12].

Engineering Development – Students complete three engineering/design projects in their Introduction to Engineering and then one semester-long project in each of the following EPD courses. These projects increase in complexity and significance each semester as students learn the project management and teamwork skills needed to successfully integrate their engineering knowledge with practical application. Example projects include city bicycle path planning, carbon footprint studies for city traffic routes, energy analysis and efficiency improvement plans for low income houses, initial project assessments for local municipality projects, and EPICs projects. In addition to applying their technical knowledge, students gain valuable experience into how to be an engineer before their first internship or co-op experience. These projects also keep students interested in the field of engineering as their course work gets more difficult and they start to question their interest in engineering and their chances of success in completing the engineering degree. This four semester design experience allows students to make the connections to their technical learning and involves students in the kind of thinking that engineers use in professional practice[15].

Professional Development – Student development in ethics, etiquette, interviewing, presentations, "dress for success", and interpersonal skills is an integral part of the EPD sequence. Graduates of the program frequently refer to the positive impact the professional development activities had on their experiences as interns and ultimately in the careers.

Citizen Development – Students learn that engineers are servants to society through presentations, reading activities, and a minimum of 70 of hours of community service that they complete while at Itasca. Examples of the activities include road-side clean-ups, recreational trail maintenance, local elementary science and engineering activities, and volunteering at the local food-shelf, Habitat for Humanity, animal shelter, and homeless shelter. Through these experiences Itasca fosters a culture that develops future engineers that make an active difference in the communities that they live in.

This four-course EPD sequence provides students with the professional practice needed to prepare them as future engineers "who are both competent and attuned to the full range of demands and possibilities inherent in the professional practice of engineering[13]".

Active Faculty and Student Life

Itasca has developed a very active faculty and student life element in its learning community. Through these activities students and faculty develop strong working relationships that enhance the student learning in the class room and improve student retention rates[14]. The program is a family of learners – students, faculty, and staff – who recreate together, socialize, learn, compete, and interact on a 24/7 basis. The elements of the program include many different student/staff/faculty sub-communities within the larger community:

- ~100 engineering students live in the engineering facilities. This living community incorporates weekly events and additional mentoring experiences. Pike, Schroeder, and Berry[15] related persistence to success in residential learning communities.
- Several learning community events place faculty and students together in a setting outside of the classroom. Events such as camping trips, engineering Olympics, Itasca engineering triathlon, Pi run, and hotdog roasts at faculty members' homes are a key element of the relationship building that makes Itasca unique.
- The learning community supports interest in specific clubs with significant student and faculty participation: science café, outdoor adventure club, chess club, engineering modern dance club, engineering acting, curling club, a basketball league, etc.

- At any time during the year there is a planned engineering learning community-wide event being executed. Examples include: aluminum foil canoe contest, cribbage tournament, fishing contest, spaghetti feed, Yahtzee tournament, cross-country skiing, and much more.
- Several times per year organized transfer trips are taken via motor coaches where students and faculty visit the engineering programs at the regional engineering universities.
- There are multiple "plant-trips" per year that bring students to industry settings where they learn more about the different disciplines of engineering.

All of these activities build relationships and the quality of interaction between students and faculty. Braxton[16] and Tinto[14] related persistence to completion and quality of student-faculty interactions. The level of student-faculty interactions and the student connection to the engineering learning community at Itasca improves the quality of student learning and increases the level of student success in completion of a four-year degree.

Block Scheduling of Courses

Math, science, and engineering courses are taught "two-at-a-time" in eight-week block class format instead of the traditional 16-week semester format. Students generally take two engineering, math, or science classes per block while completing one or two semester long general education courses. Each block class is scheduled for 2 hours per day, 5 days a week with flexibility for the instructor to provide a "float" or non-contact day each week for student work days or engineering program events. A major advantage of this model is that it minimizes "competition" between classes for a student's attention and results in fewer time management crises in their schedule.

There are a multitude of scenarios for math course sequences, which can cause a delay in the completion of a STEM degree in four years, such as a student's starting math course, performance in a particular course, and potential scheduling issues such as full courses. Table 2 shows some of the possible scenarios in the traditional 16-week schedule format. Table 3 shows the opportunity for students to take more than one math or physics course in a semester in the eight-week block format. This format provides students with the opportunity to "catch up" to their "calculus 1 ready" peers in their STEM courses and stay on track to complete their degree in four years.

Student's Starting Math Course	**Student's Math Courses by Academic Year and Semester**					
	1st Year		**2nd Year**		**3rd Year**	
	Fall Semester	Spring Semester	Fall Semester	Spring Semester	Fall Semester	Spring Semester
Calculus 1	Calculus 1	Calculus 2	Multi-Variable Calculus	Differential Equations		
Pre-Calculus	Pre-Calculus	Calculus 1	Calculus 2	Multi-Variable Calculus	Differential Equations	
Calculus 1 - with Calculus 1 repeated	Calculus 1	Calculus 1	Calculus 2	Multi-Variable Calculus	Differential Equations	
Intermediate Algebra	Intermediate Algebra	Pre-Calculus	Calculus 1	Calculus 2	Multi-Variable Calculus	Differential Equations

Table 2: Sample Math Course Sequences in Traditional Semester Model

	Student's Math Courses by Academic Year, Semester, and Block							
	1st Year				2nd Year			
	Fall Semester		Spring Semester		Fall Semester		Spring Semester	
Student's Starting Math Course	1st 8 Week Block	2nd 8 Week Block	1st 8 Week Block	2nd 8 Week Block	1st 8 Week Block	2nd 8 Week Block	1st 8 Week Block	2nd 8 Week Block
Calculus 1		Calculus 1	Calculus 2		Multi-Variable Calculus		Differential Equations	
Pre-Calculus	Pre-Calculus		Calculus 1	Calculus 2	Multi-Variable Calculus		Differential Equations	
Calculus 1 - with Calculus 1 repeated		Calculus 1	Calculus 1	Calculus 2	Multi-Variable Calculus		Differential Equations	
Intermediate Algebra	Intermediate Algebra	Pre-Calculus	Calculus 1	Calculus 2	Multi-Variable Calculus		Differential Equations	

Table 3: Sample Math Course Sequences in Eight-Week Block Format

Evidence from the study on Itasca's graduation rates demonstrates that this ability to stay on track with their peers is a significant contribution to student educational success. The flexible 5-day, 2-hour class format also creates a better setting to create an active student learning environment.

Active Student Learning Strategies

The engineering program's math, chemistry, physics, and engineering faculty are dedicated to meeting Educating the Engineer 2020's call for engineering education to "address how students learn as well as what they learn in order to ensure that student learning outcomes focus on the performance characteristics needed in future engineers[17]". The faculty have focused their efforts on studying and adapting the latest in the knowledge of engineering education with the group study of "How People Learn", Engineer 2020, Educating the Engineer of 2020, and Educating Engineers. This has led to further study and application of active student learning methods or problem based learning (PBL), project based learning (PjBL), lab-centered instruction, modeling eliciting activities (MEA's), legacy cycle, academic journaling, EPICs, TIDEE, etc. into their curriculum to help students attain the skills, experiences, and knowledge necessary for success in their engineering education and ultimately their engineering careers.

Strong Articulation Agreements with Regional four-year Institutions

Dimitriu and O'Connor[18] identified that one of the elements vital to "recruiting and retaining students in a community college engineering program and preparing them to be successful after transfer to a four year university" is to "increase coordination of curriculum between community colleges and four year universities by obtaining articulation agreements with surrounding area institutions". Itasca has developed strong working relationships and articulation agreements with the nine regional engineering programs listed in the background section.

Representatives from these programs recruit students on site, starting with all nine programs at Itasca's annual engineering college fair day, where they present to and interact with students. Following up, faculty and representatives from these programs come back several times during the year to build relationships with the students. The faculty from these programs have also served as guest lecturers in engineering courses. In addition, students travel with Itasca faculty on annual visits to each of the programs so that students can get a "feel" for each institution and obtain information specific to transferring from Itasca to each of these institutions. These activities help students select the best university to continue their engineering education while providing the students with the best chance for success. In return, the four-year programs gain students who will excel in and add value to their programs.

The Iron Range Engineering program is a unique example of Itasca faculty members initiating a new problem-based learning (PBL) engineering program in partnership with Minnesota State University – Mankato. Faculty from both institutions are developing and implementing a curriculum that is in direct response to forming the kind of advanced engineer professional called for in Engineer 2020[17]. Students enter this upper division program transfer having completed their lower division courses at a community college or another four-year institution, with many coming from Itasca's program.

Conclusion

Itasca Community College's model of an engineering learning community is an amalgamation of the best ideas in engineering education. The graduation rates of 67% for students who start physics 1 and 49% overall is exceptional. The model's completion rate from community college through the four-year engineering degree – an average of 8.9 semesters – is significant. This success is based on the Itasca model's 1) strong K-12 relationships, 2) 2-year "across the curriculum" engineering and professional development (EPD) course sequence, 3) active faculty and student life, 4) block scheduling of courses, 5) active student learning strategies, and 6) strong articulation agreements with regional four-year institutions. These elements represent an overall approach to developing high school student interest in engineering, developing these students to succeed in their engineering education at Itasca and their four-year transfer institution, and ultimately preparing them for success in their engineering careers. Adopting the proven components of the Itasca model has great potential to improve engineering education across the nation.

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