AC 2011-1024: ITASCA CC ENGINEERING BLOCK SCHEDULING MODEL

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Itasca CC Engineering Block Scheduling Model

Abstract

Itasca's engineering program has developed a successful and creative model of engineering education to provide students with the opportunity to complete their bachelor's degrees in engineering within four years regardless of the point at which they enter the engineering math course sequence. In 2002, Itasca Community College's Engineering program migrated from a traditional 16-week semester, first to a "block scheduling" format in which classes were taught "one-at-a-time" in four weeks, and then in the Spring of 2005, to a "two-at-a-time" format with classes completed in eight weeks. These block schedules offer the students the ability to navigate through the pre-calculus and calculus sequences at different pace, allowing them to complete their engineering degree in four years. This paper describes the analysis of four cohorts of students who started Itasca's program between the Fall of 2002 through the Fall of 2005 and who then transferred to a four-year institution to complete their bachelor's degrees in engineering:

- 4-Week Block Group – Students who started in the Fall of 2002 and Fall of 2003 and had a majority of their STEM classes taught in a four-week block format
- 8-Week Block Group – Students who started in the Fall of 2004 and Fall of 2005 and had a majority of their STEM classes taught in an eight-week block format

The most striking result of the Itasca model is that students who start their engineering education at Itasca in the block scheduling format average 8.7 semesters to completion of a bachelor's degree in engineering. In addition, there appears to be no significant statistical difference in their semesters to graduation between students whether they start their math sequence in calculus 1 or pre-calculus. Student graduation rates are also comparable to or higher than the institutions Itasca students transfer to and for institutions across the nation. Based on these results, adopting Itasca's model of block scheduling could improve the student time to graduation and graduation rates at institutions across the nation.

Introduction

According to the U.S. Congress, building a larger and more diverse workforce educated in science, technology, engineering, and mathematics is a critical national imperative for the twenty-first century[1]. Increasing the number of engineers will first require increasing the number of engineering students, and one way to do that is to "tap into the pool of students pursuing engineering science studies at community colleges, who could then transfer to four-year institutions, where they could pursue baccalaureate or advanced degrees"[2]. Another source identified by Sheila Tobias[3] and Richard Felder[4] in the 1990's are "second tier" engineering students. Tobias[3] defines first tier engineering students as those who have intentions and ability to earn science degrees and do so. Second tier are students who have the initial intention and ability but instead switch to nonscientific fields. For many engineering students who start at community colleges or are a "second tier" student, the calculus math sequence is a key factor in their decision to complete an engineering degree and then their time to graduation. This is due in part to the math prerequisites required for engineering and physics courses. To finish an engineering degree in four years, a student needs to start in calculus 1 in the fall of the first year and successfully complete all of the required math and other STEM courses on the first attempt and in a specified order. If any of these conditions are not met, the students face a one-semester or one-year delay in starting and/or completing an engineering education. This delay will certainly increase the time before they can enter the work force, but it is also more likely to discourage the students and can lead to non completion of the engineering programs.

One potential solution to this issue is the Itasca Community College model of block scheduling which utilizes condensed courses to provide all students with a pathway to completing a degree in four years. Itasca implemented its block scheduling model to increase student success rates and reduce time to graduation regardless of the starting math course. This paper will explain Itasca's model for block scheduling and evaluate if the model creates an equitable time to graduation for students and the model's impact on graduation rates.

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. ICC primarily serves students located in the northern third of the state and 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 along with a few early engineering courses such as 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'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 Itasca's 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. This difference in math preparation causes problems in terms of students finishing their degrees within four years and feeling motivated to complete their degree at all. Starting in 2002, Itasca started a block format to address these issues.

Itasca's Condensed Course Model

While the majority of classes at Itasca are the traditional 16-week semester courses, classes in Itasca's engineering program (engineering, math, chemistry, and physics courses) are currently delivered in a "two classes at a time" eight-week block format with two eight-week blocks per semester. 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 two hours per day, five 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. This scheduling format provides the key attributes of a(n):

- Focus on two engineering, math, or science courses at a time
- Flexible two hour class setting to create an interactive and student-led learning environment
- Ability to complete more than one math or physics course in a semester

Anecdotal feedback from a majority of students and faculty involved with the block classes is that they prefer learning in this format to the traditional 16-week course format. Student opinions appear to only be reinforced after they transfer and experience the traditional 16-week course approach in the final two years of their engineering education.

There are a multitude of scenarios for math course sequences for a student based on a student's starting point in math, performance in a particular course, and potential scheduling issues (for example, full semester courses can cause a delay in the completion of a STEM degree). The ability to take more than one math or physics course in a semester 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 1: Sample Math Course Sequences in Traditional 16-Week 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 2: Sample Math Course Sequences Eight-Week Block Format

Tables 1 and 2 show the impact that block scheduling has on the ability of students to complete the calculus/differential equation sequence in their first two years and stay on a path to graduating in four years regardless of where they start in math or if they need to repeat a course. The impact was similar in the four-week block format used prior to the eight-week block format. In the four-week block, students learned in one STEM class at a time with a total of nine STEM courses in a year. The class schedule changed to an eight-week format in 2005 to address potential concerns with scheduling, illness issues, and classroom utilization.

The scheduling itself only provides the opportunity for students to complete their degree in four years or eight semesters. The question remains, how effective is Itasca's model of block scheduling in creating an equitable time to graduation for students regardless of starting point in the math sequence.

Data

To determine the effectiveness of the model, students who entered Itasca's program starting in the Fall of 2002 through the Fall of 2005 were tracked through their time at their four-year transfer institution. For the 242 students who started at Itasca in the Fall of 2002 through Fall of 2005, the following data was collected:

- Starting Math Course at Itasca
- Successful Completion of Calculus 1
- Successful Completion of Physics 1
- Transfer Institution
- Degree Obtained at Transfer Institution
- Total Semesters for Completion of Bachelor's Degree in Engineering

Data collection was conducted through transcript review and follow-up contacts with each of the students. The data was then compiled to evaluate average semesters to graduation and 4, 5, & 6 years graduations rates.

Starting Semester	Block Format	# of Students	% Degree 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	4-Week	60	60%	73%	8.7	8.5	9.1	No
Fall 2003	4-Week	39	56%	69%	8.7	8.9	8.7	No
Fall 2004	8-Week	75	39%	58%	9.0	8.8	9.1	No
Fall 2005	8-Week	68	46%	70%	8.5	8.5	8.6	No
Overall		242	49%	67%	8.7	8.7	8.9	

Table 3: Four Degree Completion Rate and Average Semester to Graduation

The results of the study show that there is no significant statistical difference in semesters to degree completion between a student who starts the math sequence with Calculus 1 or with Pre-Calculus. Both groups are completing their bachelor's degree in less than nine semesters, which is an impressive figure for students who start at a community college and then transfer to a four-year institution to complete their degree. This shows that the model is successful in providing an equitable time to graduation for students regardless of the starting point in math. The next questions raised are, can students learn as well and do they have degree completion rates comparable to programs that utilize only the traditional 16-week courses?

For degree completion rates, Itasca students were evaluated based upon two starting points:

- 49% degree completion for students who started introduction to engineering – this represents the typical community college students with a wide variety of math skills and actual interest in engineering and who 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; these students would be considered "ready and able" to start an engineering education

Itasca's 49% and 67% degree completion rates compare well with the degree completion rates 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.

The graduation rate comparison with these other studies suggests that the Itasca model is successful in providing the opportunity for an equitable time to graduation for students regardless of starting math course and a high degree of student success in completing their four-year engineering degree. The success of the model can also be demonstrated through a comparison of 4, 5, & 6 year graduation rates with some of the institutions and studies as shown in Table 4 and Figure 1.

	4 Year Graduation Rate	5 Year Graduation Rate	6 Year Graduation Rate
Itasca Overall	26.4%	43.8%	44.2%
Itasca - Calculus 1, First Math Class	45.3%	61.6%	69.8%
Itasca - Pre-Calculus, First Math Class	20.6%	38.1%	38.1%
SUCCEED Fall 1996 Class - Male Population	1.8%	24.0%	45.0%
Michigan Technological University	24.0%	65.0%	69.0%

Table 4: 4, 5, & 6 Year Graduation Rate Comparison

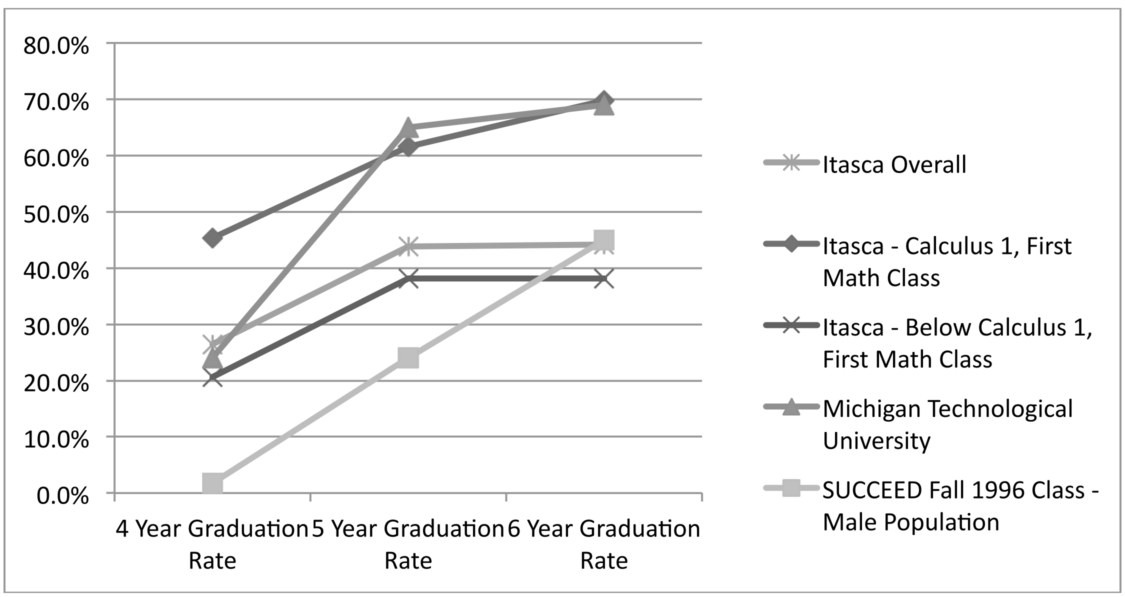

Figure 1: 4, 5, & 6 Year Graduation Rate Comparison

In comparison to these partner institutions and national studies, the Itasca engineering program model is highly successful in developing engineering students who complete their Bachelor's degree in engineering in a timely manner. The success is in spite of an open admissions policy, serving a majority of students who are below calculus 1 ready and who have other factors that would classify them as "at-risk" students (first-generation college students, low income, etc). In addition, the students who then transfer after their two years at Itasca, deal with the issues associated with transferring to a new institution, and yet remain successful.

Other key attributes of the Itasca model, in addition to the condensed class schedule, that contribute to student success include:

> Strong Learning Community – students and faculty develop strong working relationships through weekly activities outside of the classroom that enhance the student learning in the class room and improve student retention rates
>
> Active Student Learning – faculty have studied and implemented the use of project based learning (PjBL), lab-centered instruction, modeling eliciting activities (MEA's), legacy cycle, principles from "How People Learn", academic journaling, EPICs, TIDEE, etc. Itasca has developed some of its own methods of active student learning, such as a the two-year "across the curriculum" engineering design and professional development course sequence to build an engaging and active student learning environment
>
> Program Assessment – an annual program assessment process has been developed to provide feedback for improving student learning. The assessment process is comprised of an annual "FE" type comprehensive exam to assess the student learning in program courses and a student portfolio to demonstrate attainment of the programs "ABET-based" learning outcomes at the end of their second year

One of the noteworthy findings in the study is the decrease in degree completion rate as the engineering program transitioned from a four-week (Fall 2002 and 2003) to an eight-week (Fall 2004 and 2005) condensed course model. Possible reasons for this decrease include a decreased sense of focus on learning with multiple courses being taken at one time and a reduction in the very strong sense of community that existed in the "one class at a time" approach.

The Itasca model is transferable to other engineering institutions in its entirety or for select course sequences. Even the adoption of the model for just the math courses or some of the first two-year course sequences can be done successfully within the traditional 16-week semester, as is done at Itasca. Even a partial adoption has significant potential to reduce student time to graduation and increase class offering efficiencies as demonstrated by this study. The class efficiency opportunities emerge as more students completing sequential courses on time so that fewer trailer or follow-up sections of classes need to be offered. The block format would also work well for students in cooperative education programs. It would allow them to get ahead or catch up on key courses in their major before or after each of their co-op sessions.

Future Work

This study provides findings that are encouraging for the Itasca model of block scheduling. There is a need to expand the study of degree completion rates at more four-year partner and national institutions with a focus on start points for math sequences and a correlation of student success to ACT scores. Progressive math models, such as the Wright State University STEM math model, should be investigated for an inclusion into the Itasca block schedule format. In addition, a pilot study of the block scheduling, especially with starting math courses, at one of the regional universities would provide valuable information on the transferability of the model to four-year universities.

The reduction in graduation rates from the four-week to eight-week format is currently being evaluated by Itasca faculty. Initial findings indicate a need to incorporate a stronger "small cohort experience" into the current eight-week model that existed in the "one class at a time" four-week model. Identifying the impact of the compounding factors associated with the other program components needs to be evaluated to determine to what degree they influence the findings of this study.

The graduation rates were a composite for all universities that students transferred to for completion of their four-year degree. Further study is needed to see if there were differences in student success based upon the institution they transferred to as well as identifying potential additional measures of student readiness that would predict their success at a four-year institution.

Conclusion

The condensed course format of the Itasca engineering model is very successful in creating an equitable framework for students' time to graduation regardless of starting points in the math sequence. In addition, the graduation rates of the typical community college students entering Itasca's program are equal to or greater than those of some of Itasca's partner and other national four-year engineering institutions in this study. The Itasca model is transferable to other institutions and has great potential to improve engineering education across the nation.

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