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Measuring the Effectiveness of an Intensive Math Preparation Program to Enhance the Success of Underrepresented Students in Engineering

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Developing an Intensive Math Preparation Program to Enhance the Success of Underrepresented Students in Engineering

Abstract:

In order to meet the current and future demands for engineers needed to retain and increase the economic competitiveness and innovation capacity of the United States, there is a growing need to engage students from traditionally underrepresented groups in engineering. At Cañada College, a federally designated Hispanic-serving community college in the San Francisco Bay Area, a large number of students from traditionally underrepresented minority groups enter with high levels of interest in engineering. However, their success and completion rates have been low due primarily to low levels of preparation for college-level work, especially in math. To address this major barrier to student success, Cañada College developed Math Jam as a one-week intensive math placement test review program. Since its development in 2009, Math Jam has served over 2500 students, and the demand continues to grow such that the program is now offered in six separate sessions each year – both day and evening sessions during three one-week periods immediately preceding the fall, spring, and summer sessions. It has expanded from a program designed to help students review for the placement test to a program where returning students can also prepare for their next math class. For the last eight years of program implementation, underrepresented minority students (Hispanic, African American, and Pacific islanders, and Native Americans) have participated in Math Jam at a higher rate than other students. This paper explores the similarities and differences in the program outcomes for minority and non-minority students. Comparisons will be based on student retention and success rates in subsequent math courses, pre- and post-program math self-efficacy survey, and surveys that assess satisfaction with the program and student perception and knowledge of resources and skills needed for academic success.

1. Introduction

With the increasing demand for a skilled and technically savvy workforce in the United States, addressing retention problems in the first two years of college is a promising and cost-effective strategy to address this need. A recent Committee on STEM Education National Science and Technology Council report *Federal Science, Technology, Engineering, And Mathematics (STEM) Education 5-Year Strategic Plan* indicates that the United States needs make STEM education a priority. To achieve that goal, the Department of Education has committed $4.3 billion to encourage states to develop "comprehensive strategies to improve achievement and provide rigorous curricula in STEM subjects; partner with local STEM institutions, businesses, and museums; and broaden participation of women and girls and other groups underrepresented in STEM fields." The report also cites the need make a "concerted and inclusive effort to ensure that the STEM workforce is equipped with the skills and training needed to excel" so that the United States can maintain its historical preeminence in the STEM fields. [1]

The California Community College System, with its 112 community colleges and 71 off-campus centers enrolling approximately 2.6 million students – representing nearly 25% of the nation's community college student population – is in a prime position to help address the need to strengthen the future STEM workforce. [1] Community colleges serve as the gateway to higher education for large numbers of students in the United States, especially minority and low-income students. For instance, almost three-fourths of all Latino and two-thirds of all African American students who go on to higher education begin their postsecondary education in a community college. [2] However, for many of these students, the community college gateway does not lead to success. Recent findings on the achievement of California community college students indicate that only one in four students wanting to transfer or earn a degree/certificate did so within six years. African American and Hispanic students have even lower rates of completion; only 14% of African American students and 20% of Latino students completed a degree or certificate within six years, compared to 29% of white students, and 24% of Asian students. [3]

2. Incoming Student Interest and Level of Preparation for Engineering

Cañada College is federally-designated Hispanic Serving community college in the San Francisco Bay Area. The College opened in 1968, and it is located in Redwood City, California. During the 2012 – 2013 academic year, Cañada College enrolled 10,268 students. The student body is multi-cultural with Hispanic students as the largest single group at 42.8%; white students comprise 31%, Asians 9.2%, African-Americans 3.8%, Filipinos 3.5%, Pacific Islanders 1.7%, American Indian/Alaska Natives 0.2%, multi-racial 3.2%, unknown 4.6%. Like all of the California Community College System institutions, Cañada College is an open-enrollment institution, designed to welcome students of all ages and backgrounds to higher education.

At Cañada College, low degree completion and transfer rates for STEM majors can in part be attributed to inadequate preparation for college-level mathematics courses. This disadvantage has broad implications at Cañada College where the interest to study Engineering is high but is impacted by high rates of attrition. The first two years of typical engineering curricula require two years of courses in calculus and physics. A student who starts at college algebra has an additional one and a half years of mathematics (college algebra, trigonometry, and pre-calculus) on top of the two-year sequence of lower-division transferable courses. A student who starts at pre-algebra has an additional two and a half years of mathematics (pre-algebra, algebra, college algebra, trigonometry, and pre-calculus) before they are ready to begin the calculus sequence. Hence, a large percentage of Mexican Americans and African American students will need at least four years at Cañada College before transferring to a four year institution. For many of them with family obligations and no family support, this is simply too long of an education path.

One of the strategies developed to address the issue of under-preparation in math for aspiring engineering majors was the Summer Math Jam – a two-week intensive mathematics program initially designed to help developmental level students prepare for the math placement exam. However, over time, Math Jam has evolved to help returning and higher level students prepare for their next math class. This paper looks at the impact Math Jam has on minorities in college-level STEM math classes.

The program was initially developed through a grant from the Department of Education through the Minority Science and Engineering Program. Day time Math Jam has been institutionalized and is currently being funded by the College. Evening Math Jam is being funded by the Department of Education through the Hispanic-Serving Institution Science, Technology, Engineering, and Mathematics (HSI STEM) grant.

3. Overview of Math Jam

To address the low levels of preparation of incoming Cañada College students, particularly those that expressed interest in pursuing STEM majors, Math Jam began in 2009 as a two-week summer intensive math tutorial program to help incoming students improve their initial math placement results.

The original Summer Math Jam was developed with the following program goals:

1. Help students progress faster through Cañada's math sequence to enable them to transfer to a 4-year university earlier or to complete an associate's degree earlier;
2. Increase students' awareness of the tools, skills, and resources they need to be successful college students; and
3. Develop a community of learners among program participants

Having served over 2500 students in the past six years, Math Jam has continued to grow. Instead of one two-week summer session during the day, the program is now offered in six separate sessions each year – both day and evening sessions during three one-week periods immediately preceding the fall, spring, and summer semesters. The day sessions meet from 9:00 am to 3:00 pm, and the evening sessions meet from 6:00 pm to 9:00 pm. This credit-free program is completely free to students. They are recruited by instructors, STEM Center staff, STEM Center student ambassadors who make announcements in classes, counselors, and the assessment testing center.

Staying true to its roots, Math Jam still has the same three original goals. However, the program has evolved quite a bit. No longer just a program targeting incoming students looking to place higher on the placement test, Math Jam now has a large percentage of continuing students who want to prepare for their next math class. At Math Jam, students are grouped by the math class that they are entering. This is determined by their Compass placement test results for incoming students or for continuing students, their most recent math class completed. For the first several years, there were four groups – pre-algebra, elementary algebra, intermediate algebra, and one group for everyone in trigonometry and above which basically consisted of a few students entering trigonometry and pre-calculus. Each group is assigned a Math Jam instructor who is a math instructor or an instructional aide. Each Math Jam instructor is assisted by a group of student tutors such that four or five students are assigned per tutor for the developmental groups and up to ten students per tutor for the trigonometry and above groups.

Math Jam originally focused on students in developmental math classes since the highest level math class that the Cañada College placement test places students into is Calculus I. As Math Jam gained in popularity, the trigonometry and above group consisted of students entering

trigonometry, pre-calculus, Calculus I, Calculus II, Calculus III, linear algebra, and differential equations. Math Jam evolved from a program focused on placement, to a program that attracted "repeaters," students who return to Math Jam time and time again, to help them prepare for their next class. In particular, the trigonometry and above group began to get larger and larger, and in June 2013, a new group for students entering Calculus I or above was added. That allowed trigonometry and above students to interact more directly with other students they would be taking classes with, and more importantly, for the instructors and tutors to work on more specific skills for students transitioning to college level math in trigonometry and pre-calculus and other skills for students who are taking calculus, linear algebra, and differential equations.

At Math Jam, students study math either in small group workshops or individually using an online math software system. Originally all students used Pearson Education's MyMathTest which was developed to help diagnose student skills and math readiness with adaptive tests and provide tutorial exercises.[4] While most groups continue to use MyMathTest, beginning in the January 2014 Math Jam, the software that was used for the trigonometry and pre-calculus group was changed to better align with the mathematical approach used in Cañada College's curriculum. While MyMathTest provided standard problem sets for trigonometry and pre-calculus, it was misaligned with the approaches and order of content students were being taught in the classroom. To address those differences, the online software system was changed to MyOpenMath that had problem sets consistent with both the trigonometry and pre-calculus courses. In fact, the pre-calculus Math Jam group worked on problem sets that were from the actual text used in the course offered at the college. In addition, since higher level math classes rely on a student's foundational math knowledge, particularly around algebra, the trigonometry and pre-calculus Math Jam curriculum was redesigned to be more focused on algebraic skills along with some basic right angle trigonometry and graphs of trigonometric functions.

Each day, students have the option of attending one to four mini-lessons and activities that either introduce them to new topics or involve tying previously learned algebraic ideas together so that they can get a bigger picture idea of how they will be using these math skills in their next classes. For example, for trigonometry and pre-calculus students, there are workshops on logarithms, the Pythagorean Theorem, and the difference quotient and how to use it to find rates of change for quadratic and rational functions. On the first day of the program, student tutors and instructors work together to assess student skills and needs, and they come up with a list of workshops for the week. Throughout the week, both instructors and different student tutors take turns teaching lessons on various topics that students usually find challenging. Students also have the option to participate in some fun, interactive activities such as Function Flash Cards where they create flash cards with different function families, their equations, domains, ranges, and graphs, and Function Yoga where a tutor leads students in various poses of graphs of the different functions such as linear, reciprocal, exponential, square root, and absolute value, to name a few. Similarly, in the calculus and above group, students get to pour liquids into geometrically shaped containers to observe related rates in action, use play dough to create volumes of revolution, and cut spherical coordinate shapes out of cantaloupe, oranges, and watermelons. A sample schedule of daily activities for the trigonometry and pre-calculus group can be found in Appendix A, and a

link to the Math Jam Toolkit with best practices and more details about the program can be found in Appendix B.

4. Results

In order for students to take major courses in engineering and other STEM fields, they must successfully complete college level math classes from trigonometry through calculus and beyond. From previous studies, Math Jam has shown to be successful for students in developmental level math classes. Here, a closer look is taken at the performance of students in college level STEM math classes, which include trigonometry, pre-calculus, Calculus I-III, linear algebra, and differential equations, who completed Math Jam immediately prior to the semester in which they enrolled in the course compared to those who did not attend Math Jam in 2013 and 2014.

Table 2 shows the success rates, the percentage of students who earned a "C" or higher, in STEM math classes for underrepresented minority students (Hispanic, African American, and Pacific islanders, and Native Americans) and non-minority students and whether or not they attended Math Jam. Overall, minorities who attended Math Jam had a large increase in their success rate in their STEM math classes at 71% compared to 59% of minorities in the same classes who did not attend Math Jam. While non-minorities experienced some gains in success for students who attended Math Jam, their pass rate was 74% compared to 70% of non-minorities that did not participate in the program.

Table 2. Success rates in STEM math classes from 2013 to 2014

	Minorities			Non-Minorities		
	Total	Success Rate	Difference	Total	Success Rate	Difference
Attended Math Jam	38	71%	12%	78	74%	4%
Did Not Attend Math Jam	348	59%		831	70%	

Among students who do not attend Math Jam, non-minorities successfully complete college-level STEM math classes at a significantly higher rate than minorities, over a 10% difference. However, for students that successfully complete Math Jam, minority pass rates increase by 12%. Though non-minorities who attend Math Jam successfully complete STEM math courses at a rate higher than minorities who attended Math Jam, the difference between their pass rates is not statistically significant. Overall, it appears that Math Jam is helping minorities close the achievement gap in STEM math classes.

However, it's important to point out that there is still a lot of work to be done. Two key courses in the STEM math sequence are trigonometry and Calculus I, both considered to be gatekeeper courses. Trigonometry, the first class students take after completing the developmental algebra sequence, has historically had a low success rate at Cañada College with only 33% of students passing the class in Spring 2010 and averaging a 53% success rate from 2013 to 2014 as shown in Table 3. For many students, trigonometry has been a barrier to calculus and ultimately STEM major courses resulting in the attrition of many aspiring STEM majors.

Table 3. Success rates for select semesters and the two year period from 2013 to 2014 in trigonometry and Calculus I courses at Cañada College

	Spring 2010	Fall 2013	Spring 2014	Spring 2013 – Fall 2014
Success rate in Trigonometry	33%	43%	51%	53%
Success rate in Calculus I	59%	89%	66%	65%

Math Jam has gained in popularity for the trigonometry and above students at Cañada College since its inception in 2009, so some of the increases in success in these gatekeeper courses can be attributed to it. As shown in Table 4, students in trigonometry who attended Math Jam increased their success rate by 23% from 51% to 74%. However, while Math Jam participation for students in trigonometry and above has increased over the past six years, only about 10% of students in STEM math classes are participating. More recruitment needs to be done for this group of students, particularly students entering trigonometry.

Table 4. Success Rates in trigonometry and Calculus I for 2013 to 2014 by Math Jam Participation

	Trigonometry			Calculus I		
	Total	Success Rate	Difference	Total	Success Rate	Difference
Attended Math Jam	27	74%	23%	45	69%	5%
Did Not Attend Math Jam	245	51%		356	64%	

Despite the higher success rates in trigonometry overall in 2013 to 2014 as shown in Table 3, minorities are still succeeding at almost a 20% lower rate than non-minorities as shown in Table 5. While the achievement gap between minorities and non-minorities narrowed to 11% in Calculus I, the difference between their success rates is still statistically significant. Programs like Math Jam can really make a difference in keeping minority students in the STEM pipeline. But it's important to note that there still needs to be a strong connection between what happens at Math Jam and what happens in the classroom during the regular semester.

Table 5. Success Rates in trigonometry and Calculus I for 2013 to 2014 by minority status

	Trigonometry			Calculus I		
	Total	Success Rate	Difference	Total	Success Rate	Difference
Minorities	109	42%	19%	119	57%	11%
Non-Minorities	163	61%		282	68%	
	p = .003 Statistically significant at the .05 significance level			p = .043 Statistically significant at the .05 significance level		

From Spring 2010 to Fall 2014, the success rate in trigonometry increased from 33% to 51% as shown in Table 3. While a 50% success rate in a critical course like trigonometry can still be

improved upon, a 20% increase in success over several years is still significant. While Math Jam is partially responsible for the increased success rate, there were other factors that could have affected the increase in student performance as well. Math faculty changed textbooks from a unit circle approach to a right triangle approach to trigonometry and student tutor-led study groups were paired with several trigonometry courses.

At the same time, Math Jam supported these important curricular changes. As stated previously, the online software used for the program was changed to MyOpenMath so that the questions were better aligned with the way the actual classes were being taught. Also, many student tutors who led the study groups during the school year were recruited from previous Math Jam students. During Math Jam, some of these student tutors worked with the trigonometry and pre-calculus group so that students could get to know the tutors prior to taking the class and have some continuity in their math education. These students were more likely to participate in study groups than students who did not attend Math Jam.

Meanwhile, in Fall 2013, there was a big jump in the Calculus I success rate as shown in Table 3. Up 30% from Spring 2010, 89% of students passed Calculus I. That semester, two out of three faculty members teaching the class implemented several Reading Apprenticeship strategies that focused on helping students increase their metacognitive abilities when reading text and solving problems.[5] Because of that increase in success in the calculus classes, and recognizing that having strong metacognitive skills is key to being successful in STEM courses, Math Jam tutors are now trained in Think Alouds, one of the Reading Apprenticeship metacognitive techniques. Changes to Math Jam and classroom instruction also need to work together to support student success.

While successful completion of a math class is key in keeping students in the pipeline, it is critical to maintain high retention rates as well. For minorities, students who attended Math Jam had a slightly increased retention rate of 81.6% in their STEM math class compared to 80.2% for minorities that did not attend. The same slight increase in retention rates for non-minorities was observed as well – 88.5% for Math Jam attendees compared to 87.5% for non-Math Jam attendees. Table 6 summarizes the retention rates of students by minority status and Math Jam participation.

Table 6. Retention Rates of Students in STEM math classes in 2013 to 2014

	Attended Math Jam		Did Not Attend Math Jam	
	Total	Retention Rate	Total	Retention Rate
Minority	40	81.6%	348	80.2%
Non-Minority	78	88.5%	831	87.5%
	p = .313 Not statistically significant at the .05 level		p = .001 Statistically significant at the .05 level	

However, when we look at the retention rates of minorities versus non-minorities who did not attend Math Jam, the difference in their retention rates was statistically significant. That is for non-Math Jam attendees, retention was associated with whether or not a student was a minority, with minorities being retained at a 7.3% lower rate. On the other hand, for students that attended

Math Jam, the difference in retention rates for minorities and non-minorities was not statistically significant. So there was no association between minority status and retention. One caveat is the relatively small sample size of Math Jam attendees, 118. If the sample size was larger, the association between minority status and retention might be statistically significant. Even then, among the Math Jam attendees, minorities still had a 6.9% lower retention rate, which is still cause for concern since students from underrepresented groups such as ethnic minorities and women leave STEM majors at higher rates than others. [1]

While minority status may be a factor in retention in STEM math classes at Cañada College, it appears that there is no difference in genders in relation to retention rates regardless of whether or not students attended Math Jam. Table 7 shows that there are very similar retention rates across genders, with females being retained at a slightly higher rate. There is no association between Math Jam attendance and gender with respect to STEM math class retention. This is important because women earn a smaller proportion of science and engineering degrees than men. [6] During 2013 to 2014, only 36% of students in STEM math classes were female, compared to 64% male. Because of the small sample sizes of Math Jam participants, disaggregation of this data by minority status and course is not shown.

Table 7. Retention rates of students in STEM math classes by gender and Math Jam Attendance for 2013 to 2014

	Attended Math Jam		Did Not Attend Math Jam	
	Total	Retention Rate	Total	Retention Rate
Female	45	86.7%	411	86.6%
Male	70	85.7%	750	84.8%

These successes for Math Jam students are not just due to the math content they acquire or review during the program. The Math Jam experience also includes learning to spend a lot of time on task, doing math for long periods of time both individually and in small groups. Students spend up to six hours a day for five days working on improving their math skills. Very seldom do students get the opportunity to concentrate all of their efforts on math during the regular semester. To that end, in an effort to describe the effect of Math Jam on participant self-efficacy (the participant's belief in their capability to complete specific tasks or goals) a self-efficacy instrument was administered as part of the pre- and post-program surveys. Students were asked 18 of the 34 question Mathematics Self Efficacy Scale developed by Nancy Betz and Gail Hackett to measure student self-efficacy related to math both at the very beginning of Math Jam and again on the last day of the program. The questions related to math tasks that students might encounter in day-to-day life. The analysis of the responses is shown in Table 8. Overall, students in STEM math classes increased their math self-efficacy. It is important that students believe in their capacity to complete math tasks because "there is evidence linking STEM attrition to such attitudinal factors as motivation, confidence, and beliefs about one's capacity to learn STEM subjects." [7]

Table 8. Change in participant self-efficacy in math tasks for students in STEM math courses in 2013 and 2014

	Math Tasks Efficacy Pre-Math Jam	Math Tasks Efficacy Post-Math Jam	Change in Efficacy	p
All Pairs	7.23	7.75	0.52	0.038

To evaluate the success of Math Jam in achieving its secondary goals of increasing student awareness of tools, skills, and resources needed to succeed in college, post-program student surveys were administered. Table 9 summarizes the student responses to the post program surveys students in STEM math class levels from 2013 to 2014. For the surveys, the prompt was, "Tell us how much you agree with the following statements," with a response scale of: 5 – Strongly Agree, 4 – Agree, 3 – Neutral, 2 – Disagree, 1 – Strongly Disagree. The average of the student responses for each survey question was computed and is shown in Table 8. Students seem to be confident that they will do well in math if they exert enough effort. Moreover, they perceive supportive relationships with other students, faculty, and student support staff. Because Math Jam is held in the Learning Center where tutoring and support service programs are offered, students become familiar with the environment and services offered.

Academic and social integration as articulated by Tinto's model of college student persistence/withdrawal strongly influences the retention of students. It is often assumed that at community colleges, both academic and social integration are more difficult to achieve because of students lack the time to participated in activities that facilitate this type of integration. [8] As shown in the post-program survey results, overall, students feel better connected with each other and ultimately the campus community. Students feel connected to their fellow students, the tutors, teachers, and staff in Math Jam – they are a part of a community of learners.

Table 9. Post Program Student Survey Results from All Math Jam Students in 2014.
Prompt: Tell us how much you agree with the following statements.
Response Scale: 5 – Strongly Agree, 4 – Agree, 3 – Neutral, 2 – Disagree, 1 – Strongly Disagree.

Attitudes	**Mean Score**
I am confident that Cañada College is the right college for me.	4.3
I think I will get a good grade in my next math course.	4.4
I am confident that I have selected an appropriate major	4.2
I believe that if I exert enough effort, I will be successful in math.	4.6
I have supportive relationships with other students at Cañada College.	4.0
I have supportive relationships with tutors at Cañada College.	4.0
I have supportive relationships with faculty at Cañada College.	4.0
As a result of participating in Math Jam, I am now more likely to consider pursuing a major in STEM (Science, Technology, Engineering, or Math).	4.2
I felt connected to the students, tutors, teachers and staff in Math Jam.	4.1
It was helpful for me to participate in Math Jam.	3.9

5. Conclusion

Through six years of implementation, Math Jam has been successful in enabling students to progress through the math sequence faster. Progressing through the sequence faster is not limited to just skipping classes by placing ahead, but it also includes students taking a class only one time and passing it on the first attempt. Math Jam has been shown to help students, particularly minorities, successfully complete STEM math classes at a higher rate which is critical to keeping them in the pipeline. More importantly, it helps students reduce the cost and time necessary to complete the degrees and/or the lower-division courses they need to transfer to a four-year institution.

By giving students a supportive, self-paced, and non-judgmental environment to learn and review math, Math Jam has helped students not only prepare to retake the math placement test, but it also helps students prepare for their upcoming math courses. Using fun hands-on activities, small group workshops, one-on-one instruction from tutors and instructors, and technology such as MyMathTest, and MyOpenMath, Math Jam has provided students with a variety of ways to learn math. Not only has the program helped students increase their content knowledge, it has also been successful in increasing students' self-efficacy and confidence, enabling them to seek help when needed, take advantage of campus services and resources, and connect with other students, and faculty members. It has made students feel more connected to each other, more comfortable at Cañada College, and ultimately, more connected to the campus community. Academic performance of Math Jam participants in their STEM math classes in the semesters following their participation was better for all students, but significantly better for minorities. There are still disparities in academic achievement for minorities, but Math Jam is helping to close the achievement gap.

As more students choose to attend community colleges to ultimately pursue careers in engineering and other related STEM fields, more programs like Math Jam need to be developed to help produce the well-educated work force that is needed to retain and increase the economic competitiveness and innovation capacity of the United States.

Bibliography

1. Committee on STEM Education National Science and Technology Council. (2013). Federal Science, Technology, Engineering, And Mathematics (Stem) Education 5-Year Strategic Plan. Retrieved December 2014 from: http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-engage-to-excel-final_2-25-12.pdf

2. California Community College Student Success Scorecard. (2013). Cañada College College Profile. Retrieved December 2013 from: http://scorecard.cccco.edu/scorecardrates.aspx?CollegeID=371#home

3. Bailey, T., Jeong, D.W. &, Cho, S.W. (2010) Referral, enrollment, and completion in developmental education sequences in community colleges. (Economics of Education Review) 29, 255-70.

4. Pearson Education (2015). *MyMathTest Features: Testing for Any Scenario.* Pearson Education. Retrieved February 2015 from http://www.pearsonmylabandmastering.com/northamerica/mymathtest/educators/features/index.html

5. National Science Foundation, National Center for Science and Engineering Statistics. (2013). *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2013.* http://www.nsf.gov/statistics/wmpd/2013/pdf/nsf13304_digest.pdf

6. Schoenbach, R., Greenleaf, C., & Murphy, L. (2012). *Reading for Understanding. How Reading Apprenticeship Improves Disciplinary Learning in Secondary and College Classrooms.* (Jossey-Bass) 22 – 29.

7. Chen, X., Solder N. (2013). *STEM Attrition: College Students' Paths Into and Out of STEM Fields Statistical Analysis Report.* http://nces.ed.gov/pubs2014/2014001rev.pdf

8. Karp, M., Hughes, K., & O'Gara, L. (2008). *An Exploration of Tinto's Integration Framework for Community College Students.* Community College Research Center, Columbia College, Retrieved February 2015 from http://files.eric.ed.gov/fulltext/ED501335.pdf

Appendix A

Sample Trigonometry & Pre-Calculus Math Jam Schedule

	Monday	Tuesday
9:00 am – 10:30 am	• Registration • Welcome & Announcements • Math Jam Survey & Self-Efficacy Assessment Math Jam Diagnostic Test	• Welcome & Announcements • Self-paced work in MyOpenMath
10:30 am – 12:00 pm	• Self-paced work in MyOpenMath	• Self-paced work in MyOpenMath • Workshop: Function Flash Cards & Function Yoga!
12 - 1 pm	• Lunch	• Lunch
1:00 pm – 3:00 pm	• Self-paced work in MyOpenMath • Workshop: Intro to Function Families	• Self-paced work in MyOpenMath • Trig Workshop: Pythagorean Theorem

	Wednesday	Thursday
9:00 am – 10:30 am	• Welcome & Announcements • Self-paced work in MyOpenMath	• Welcome & Announcements • Self- paced work in MyOpenMath
10:30 am – 12:00 pm	• Self- paced work in MyOpenMath • Trig Workshop: Trig Ratios & Right Angle Trigonometry • Pre-Calculus Workshop: Slope Like You've Never Seen Before	• Self- paced work in MyOpenMath Trig Trig Workshop: Algebra for Trig • Pre-Calculus Workshop: Logarithms
12 – 1 pm	• Lunch	• Lunch
1:00 pm – 3:00 pm	• Self- paced work in MyOpenMath • Workshop: Horizontal & Vertical Compressions	• Self- paced work in MyOpenMath • Trig Workshop: Special Right Triangles around the Unit Circle • Pre-Calculus Workshop: Logarithms Continued

	Friday	Saturday
9:00 am – 11:30 am	• Welcome & Announcements • Math Jam Post-Test • Math Jam Post-Survey and Self-Efficacy Assessment • Pre-Calculus Workshop: Trig Highlights	Optional: Retake Math Placement Test
11:30 - 12	• Group photos	
12 – 1 pm	• Pizza!	
1– 3 pm	• Self- paced work in MyOpenMath	

Appendix B

The Math Jam Toolkit with resources and detailed documentation about the program, best practices, recruitment, organization, and curriculum can be found online at the following website:

http://canadacollege.edu/stemcenter/mathjamtoolkit.php