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Accelerating Student Success in Mathematics through Personalized Adaptive Learning

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Abstract

Math Launch is a program designed to help incoming first-year students prepare for calculus 1 and set them up for success in their chosen STEM major. With a focus on expanding students' knowledge and capabilities in algebra, trigonometry and precalculus, Math Launch helps students become calculus ready in a single semester through an accelerated boot camp style, math course. Students selected to participate in the Math Launch pathway begin their first term (fall or spring) as part-time students (9-11 credit hours) and are provided with a dedicated support team to assist them throughout their first semester math course. Math Launch gives students in calculus critical majors the opportunity to prepare for calculus 1 through a structured, accelerated program while providing additional services to support them in their designated math course. Students register for a 3-credit hour math course (MAC1906 – Independent Study) and have the opportunity to master three subject areas (courses), potentially becoming calculus 1 ready by the beginning of their second semester. Students meet for in-person assistance during the scheduled class time in the Math Assistance and Learning Lab (MALL) which is staffed by graduate teaching and undergraduate learning assistants. Using the online adaptive ALEKS platform, students begin their journey in the math subject (course) determined by the math placement test or college level credit earned while in high school. During the first few days of class, students complete a concept test to determine their knowledge and if they can move up their starting point in the class. Guided by instructors, undergraduate learning assistants and peer coaches, students then begin working through the different concept modules. Students receive additional in-person assistance during their required Open Lab hours in the MALL. After only two years, positive results are shown through completion rates of math prerequisite courses and subsequent performance in calculus 1. Progress will be discussed as it relates to future metrics including increased completion of STEM degrees, decreased time to degree and increased four-year graduation rates. This paper will provide insight to the use of ALEKS as an adaptive learning tool for accelerating math progression along with the technical structure of the course, a roadmap for practitioners on how to establish and assess this type of math assistance program, and details on the program components and how the program has partnered across the STEM colleges for the success of students.

1.0 Introduction

1.1 The Challenge of Increased Course Failures

Many students enter college calculus courses without a solid foundation in prerequisites resulting in precalculus and calculus courses often having high failure and withdrawal rates. The national average of unsuccessful calculus 1 students is reported to be around 25% [1]. At some institutions, the calculus 1 failure rate has been noted at 40% [1]. Such totals can negatively affect students' academic progress and career ambitions. Interestingly, research shows different results on the relationship between taking prerequisite courses and success in calculus, for instance, students who took precalculus as a prerequisite had a higher mean grade point average (GPA) of 2.303 in calculus 1 compared to 2.134 GPA for those who took college algebra and

trigonometry [2]. Also, some studies suggest that taking high school calculus does not necessarily contribute to success in college calculus. Instead, mastering the prerequisites (algebra, geometry, and trigonometry) is more important. Hence, we find it crucial not to make assumptions on what the student does or does not know and start with diagnostics to assess students' prior knowledge and provide paths that allow the student to progress effectively.

1.2 The Consequence of Prolonged Time to Degree Completion

Calculus 1 serves as a critical gateway course for many advanced science, technology, engineering, and mathematics (STEM) classes. However, a sizable number of incoming students struggle with calculus readiness. They often come with gaps in prerequisite knowledge necessary for an inherent difficulty in college level calculus which demands fundamental mathematical skills in algebra, geometry, and trigonometry. Postponed or lack of completion of calculus 1 can drastically disrupt a student's academic progress. This interruption leads to delayed enrollment in advanced courses that require calculus as a prerequisite [3], and increases likelihood of changing majors, and extends the time to degree completion. According to data from the National Center for Education Statistics, roughly 50% of students who initially enter a STEM field end up leaving it before graduating, as they switch to other majors such as business, social sciences, and education; consequently, nearly half of all students who intend to major in STEM change their field of study before completing their degree [4]. The shift adds additional semesters of study which means more cost as the student must continue to pay for tuition, housing, food, and other living costs. In fact, studies show that delayed time-to-degree is associated with lower post-college earnings with an average of 8–15% depending on the length of delay [5].

1.3 Mounting STEM Education Disparities

The longstanding inequities in access, representation, and support for underrepresented groups are familiar disparities in STEM education, and they are noticeable among Black and Hispanic students. The underrepresentation is most pronounced in math, physical sciences, and engineering. In 2018, Black students earned just 7% of STEM bachelor's degrees despite comprising 10% of all bachelor's degree recipients and 12% of the adult population; and Hispanic graduates accounted for 12% of STEM degree holders, a proportion lower than their 15% share among all college graduates that year [6]. The solution to these gaps requires complete reforms that improve STEM education access in underserved communities, provide mentorship programs, and foster an inclusive STEM academic' environment.

We focus this paper on a preparation program, Math Launch, that proved to help students master prerequisite skills before attempting calculus while offering accelerated pathways to prerequisites. The program improved collective success among all groups.

2.0 Related Work and Overview

Colleges and universities have been implementing programs to provide remediation or prerequisite acceleration for calculus as they aimed to improve student success rates and reduce attrition in STEM fields. University of Cincinnati offers a supplementary session for mainstream calculus students, corequisite model of calculus with precalculus option, combining a 4-credit

calculus section with a 2-credit supplementary precalculus session [7]. The authors of [8], discuss similar challenges and applied online programs that use a just-in-time teaching model, targeted remediation, and structured weekly lessons to address prerequisite deficiencies. They emphasize communication between instructors and students and integrating remedial skills with course material. Cornell University offers supplementary courses for calculus that meet weekly to augment lecture material, answer questions, and provide tips for effectively learning the material. Students who enroll in a support course receive tutoring services and one credit with a Satisfactory/Unsatisfactory grade determined by attendance [9].

It is important to mention that prior to implementing Math Launch another university program was ongoing since 2016 in which large classes of college algebra used ALEKS (Assessment and Learning in Knowledge Spaces) [10]. Before adopting ALEKS a review was conducted by faculty, staff, and a team from Students Accessibility Office to evaluate ALEKS's accessibility and the findings were positive. ALEKS follows the Web Content Accessibility Guidelines (WCAG) 2.0 AA and it supports screen reader technology. Moreover, the platform is fully navigable using a keyboard and does not rely solely on color to convey information (making it accessible to colorblind users), offers options to adjust color contrast and settings for color blindness, and its content does not rely on audio (accessible to students with hearing impairments) [10]. In 2018, after successful implementation of ALEKS at the university and modeled after similar programs at Wright State [11], EXCEL, a STEM learning community, developed a one-week math bootcamp using ALEKS. Focused on early interventions, the purpose of the bootcamp was to increase math preparation and placement of students in math critical STEM majors who were not calculus ready. Using ALEKS modules in algebra, precalculus algebra and trigonometry students could work through in an intensive one-week bootcamp style course. Students began their studies using initial math placement results and could work, self-paced with assistance from the instructor and teaching assistants, through the calculus prerequisite material. At the conclusion of the week, students would re-test for math placement often testing up one or two subjects with many becoming calculus ready. The program saw great success from 2018-2022 with over 80% of those students participating placing up one or more subjects. Offered to only a small population of students, the expansion of the bootcamp was critical to providing better preparation for the general university STEM population.
Math Launch was tailored to meet the needs of the growing STEM population. The University of Central Florida has over 59,000 undergraduate students [12] with the College of Engineering and Computer Science (CECS) having over 14,000 students enrolled (one of the largest engineering programs in the country) [13]. While university enrollment growth had been held steady, the number of engineering and technology undergraduate majors continued to grow by an average of 5% [14]. Furthermore, the university is also ambitious about expanding its engineering program and will depend on programs such as Math Launch for achievement. It is an innovative program aimed at equipping incoming first-year students with the mathematical foundation needed to succeed in calculus 1 to pursue their chosen STEM majors. The program does not only provide math teaching it also addresses familiar challenges in transitioning to higher-level math [15]. It offers an accelerated, individualized boot camp-style structure that allows students to expand their knowledge in algebra, precalculus, and trigonometry within a single semester. The students could master these essential subject areas by enrolling in a one 3-credit hour course and position themselves to be calculus-ready by the start of their second semester. For a holistic experience, Math Launch provides strong support through a dedicated

team of instructors, graduate teaching assistants, undergraduate learning assistants, advisors, and peer coaches. A network that aims to increase students' sense of belonging to a community [16].

In any given term, the program offers three to six sections of the Math Launch MAC 1906 Independent Study course. Fall term has the highest enrollment and thus the larger number of sections (maximum six to date) with Spring and Summer terms fluctuating between two to three sections each. The number of students in each section varies between 150-250 depending upon the room assignment and term of completion. To ensure students can access help when needed, there are six undergraduate learning assistants, one graduate teaching assistant and the instructor assigned to each section of the course, and a combination of six to seven graduate teaching or learning assistants assigned each hour of open lab. The coaching staff consists of one professional Senior Academic Success Coach (ASC) and at least three peer coaches per term. With the program set to receive recurring budget from the institution, the coaching team will be expanded to two professional ASCs and at least five peer coaches per term. Additionally, two full-time instructor/lecturers dedicated to this program will be joining the lead instructor in Fall 2025.

3.0 Math Launch Pedagogy

Addressing diverse learning needs in math classes is challenging as students arrive with varied skills and learning styles [17]. In a traditional classroom, the instructor assumes a central role with students becoming passive recipients of knowledge [17]. The research highlights considerable limitations in the ability of lecturing to address the diverse learning needs of a broader student population. Akbulut and Cardak (2012) stated that such methods disproportionately benefit students who already possess strong foundational skills or students that are practiced at traditional learning styles [18]. On the other hand, students with varying backgrounds or gaps in prerequisite knowledge can struggle to keep pace and consequently perform less. We agree based on our experiences that working with large number of students requires the use of adaptive and targeted teaching approaches in instruction through the integration of effective teaching methods such as incorporating active learning, peer collaboration, and technology-enhanced instruction. Keller introduced the Personalized System of Instruction (PSI) in the 1960s enabling students to learn independently without the constant presence of an instructor [19]. The formal version of PSI developed later in 1968 suggested five essential elements consisting of formulation of written materials, modularized content, self-paced schedule, mastery as a prerequisite to access future modules, and supervisors or proctors [20]. An orderly review of PSI highlights its effectiveness in improving student engagement and performance across various disciplines including mathematics. Students in PSI courses report higher satisfaction due to its personalized approach. But challenges like procrastination demand strategies such as setting up milestones and actively coaching the students [21]. More faced challenges are institutional constraints such as limited budgets and new ideas requiring extensive planning. Lastly, most PSI research focuses on psychology and behavior analysis of students, raising concerns about the generalizability of findings to other disciplines and diverse student populations [21]. Accordingly, careful planning was done in Math Launch to benefit from PSI and address identified challenges. The customized PSI tenets in Math Launch pedagogy are:

1. *Preparation of written materials*: ALEKS was set up so it provided an explanation page before a student attempted an exercise which enhanced student understanding and helped with improving self-efficacy in attempting challenging topics. The explanation page provided detailed step-by-step solutions and the student was encouraged to write, record key points, formulas, and problem-solving strategies in a notebook. This procedure improves study skills.
2. *Modularized content*: ALEKS objectives or modules were structured to offer clear expectations, incremental learning, and consistent feedback. Each sub course had its own curriculum or ALEKS pie which divided into 9 to 11 modules. The student was only enrolled in one sub course at a time so the student could stay focused and ensure smooth transitions between sub-courses. When a student was in a sub course and working on a module the student would need to reach a certain mastery before the subsequent module becomes available.
3. *Self-paced schedule*: Since this a sticky point of PSI, the instructors depend on three main factors to improve pacing and minimize procrastination problem. The first factor was effective communication of pacing options and schedules based on students' placement. The communication was included in first day orientation, in the syllabus, and the weekly announcements. Secondly, the instructors relied on the LAs, advisors, and peer tutors to help students with managing time and setting priorities, offer flexible pacing options and support resources. Thirdly, the instructor persistently used learning data analytics for intervention and feedback. For emphasis, a separate SPI's tenet (number 6) was added.
4. *Required mastery for progression to subsequent modules*: Setting a high mastery threshold such as 90% ensured higher expectation and promoted deep understanding. This approach allowed students to learn at their own pace, receive immediate feedback, and address gaps in their knowledge. The modules threshold along with midterm test performance expectation improved proficiency and promoted a growth mindset.
5. *Human Link*: The human aspect was enhanced by providing various roles like undergraduate learning assistants (LAs), graduate teaching assistants (TAs), instructors, advisors, and peer coaches. TAs acted as LAs or as instructors of record based on their assignments. LAs acted as tutors and supported both class meetings and open lab hours. Peer coaches helped students with study skills and success strategies to meet Math launch goals. Advisors helped with administrative quests and tasks. Instructors guided the curriculum, managed the tenets such as the written notes, mentored the students and provided guidance on pacing. Face-to-face tutoring in open lab hours supported mastery of challenging concepts. The coordinated efforts of these roles created a collaborative network that maximizes PSI benefits.
6. *Learning Analytics*: Analyzing data from ALEKS and taking actions enhanced feedback and interventions in adopted PSI pedagogy. Analytics provided real-time data on student performance, identifying strengths, weaknesses, and areas requiring support. Analytics also enabled targeted interventions by identifying at-risk students early, allowing for prompt support, such as tutoring or meeting with team members. Instructors benefit from the data by refining their just in time reviews or customize the review sessions [22].

4.0 Math Launch Structure
4.1 Purpose and Implementation

As mentioned, the purpose of the Math Launch program was to assist incoming first-year students prepare for calculus. To implement the program university wide, support from the highest levels of leadership was critical in bringing together the needed human and financial resources. Collaborators from the engineering college, the Mathematics Department, university marketing, advising, the registrar, data analytics, admissions and student financial assistance met to establish parameters for empowering student success in the new model. Though improvement of performance metrics was the original driver of the program expansion, the success of students was at the forefront of every conversation. Preparing students to be calculus ready was critical to student motivation and progression in their STEM major, but would also benefit them financially. Students who successfully complete Math Launch in the first semester could (1) decrease time to degree completion by one to four terms saving them tuition for additional math and other courses necessary to maintain full-time enrollment prior to being eligible for major courses, (2) increase motivation by being calculus ready and making faster progress in the major, (3) increase learning and preparation for future courses by mastering foundation material and (4) improve four-year graduation rates making students career ready earlier and increasing lifetime earnings.

Math Launch has shown vast and continued improvement since the initial implementation in Fall 2022. During the pilot, engineering students were pre-registered for Math Launch but able to opt out of the program. The Math Launch course (MAC 1906) was initiated as zero credit hour independent study and without an assigned lecture pattern to accommodate students who were already enrolled in courses. Lecture times were assigned, announced in the Learning Management System (LMS) and lectures recorded for those who could not attend. In addition to the lecture time, the Math Launch Center was staffed with undergraduate learning assistants. Weekly knowledge checks and testing took place in the CECS Evaluation and Proficiency Center (EPC).

Starting in Spring 2023, the course was assigned three credit hours with a designated meeting pattern available on a student's schedule. Study hours were required in the Center however, as the majority of students were returning from fall, they did not subscribe to the change and many failed to utilize the assistance. By Summer term B 2023, the current structure was established. In addition to prior changes, attendance at lecture and in open lab – both now housed in a computer lab called Mathematics Assistance Learning Lab (MALL) – were required, knowledge checks were completed during those hours in the MALL and midterm/comprehensive testing remained in the EPC. Students participated in required class activities, which in combination with the other components listed, were considered in the final grade. In Fall 2023, as an effort to allow students additional time to move through the multiple prerequisite course subjects needed to be calculus ready, any engineering student, or other majors who opted-in, not calculus ready were limited to 11 credit hours. College of Sciences (COS) math critical (requiring higher than calculus 1) majors (Chemistry, Data Science, Forensic Science, Mathematics, Physics, Statistics) were placed in the program, but could opt-out. Computer Science majors could opt-in. Beginning in Summer 2024, all students in the College of Engineering and Computer Science (CECS) who were not math ready for their chosen major were required to participate in the Math Launch

program during their first major term (fall or spring). College of Sciences (COS) majors could still opt-out.

4.2 Course Content

The Math Launch course covered three main subject areas or sub courses (College Algebra with integrated Intermediate Algebra, Precalculus Algebra, and Trigonometry) in one main course called MAC 1906. The main goal of MAC 1906 was to prepare students to be calculus 1 ready in one term regardless of their starting sub course**.** Students take additional courses during their first term, however, they were required to maintain a reduced course load capped at 11 credit hours. The purpose for the limit was to ensure that students can fully dedicate themselves to the concentrated demands of the program. Moreover, it positioned students to be on the calculus 1 track with confidence. As far as course details, ALEKS, an online learning platform using artificial intelligence to create adaptive tests and personalized learning paths [10], was used for the assignments. The MAC 1906 course was divided into three separate sub courses relating to the three mentioned subjects. The student must complete successfully one sub course before being placed into the next sub course if needed. Each sub course had its own ALEKS pie or domain of content linked to the student's LMS course. After enrollment in MAC 1906 the student was placed in a sub course based on qualifications or placement test scores. The student had to earn an overall grade of 70 or higher to earn the credit. If the student needed another calculus 1 prerequisite, then the student was switched to another sub course given specific criteria were met. The latter is called *test up* or *placing up* criteria and guarantee that the student did beyond a minimum to pass. Since different students had different placements a pacing schedule was shared with the students to guide them to achieve the goal of becoming calculus ready in one term. The three sub courses shared a similar structure so when the student moves from one sub course to another the student knows exactly what to expect.

The first assignment is each sub course was an initial knowledge check (IKC) that serves as a pre-test to gauge student familiarity with the course content. This adaptive test determined students' prior knowledge pertaining to the sub course and set up the topics the student needed to learn. After the IKC the student was provided access to the modules or the ALEKS objectives. As the student keeps learning, ALEKS presented periodic knowledge checks that were adaptive assessments with up to 30 open-response questions to evaluate student's mastery of topics. Similarly to IKC, knowledge checks were not for a grade and helped to identify strengths and weaknesses to adjust the learning experience. Those periodic checks reinforced retention by guiding the student to review forgotten topics. Each module was set up to 90% mastery, meaning the student must complete 90% of a module to gain access to the next module. Modules earned 15% of the final grade. When the student finishes about half of the modules the student would reserve to take a proctored midterm test in a designated computer lab called Evaluation and Proficiency Center (EPC) or at Students Accessibility Office (SAS) with an existing accommodation. The midterm test was worth 15% of the final grade. It was one attempt and served as a good intervention point if the student performed below expectation. The student continued to learn objectives and when reaching about 80% of the modules the student would take an assigned knowledge check (AKC) in class or during open lab time. AKC was similar to IKC, yet it is for a grade, and worth 5% of the final grade. The goal from the AKC was to help the student recognize mastery levels prior to taking a final test called a comprehensive test that

was worth 55% of the final grade. The comprehensive test becomes available for the student to take after completing the last module with 90% or better. Students reserved to take it proctored at EPC or SAS. A scientific nonprogrammable calculator was allowed to use on tests. The comprehensive test offered two versions and if a student needed to take the second version, a careful remediation criteria must be achieved before it can be accessed. Remediation criteria was another opportunity to increase time on task, teach the student best practices in studying, and how effectively to communicate progress against the goal. If the student took both versions the version with the best score was used for the final grade calculation. Attendance of class was required along with an additional three weekly hours in the MALL to increase their time on task and provide them with individualized tutoring. Both class and lab hours were worth 10% of the final grade. Since there were three sub courses (subjects) in one main course and a student must complete successfully one sub course before the next sub course, the student generated a final grade for each completed sub course. To motivate the students to complete more than one sub course, when necessary, the best grade achieved in any completed sub course was recorded to the main course (MAC 1906). If a student needed only one sub course, then the main course final grade would be the same as that sub course.

4.3 Cocurricular support

Creating curricular learning communities where like-students are placed as cohorts in key courses for their major has long been a strategy for increasing retention and sense of community in a higher education setting [23]. Math Launch created this course environment and then supported the students with additional interventions to magnify success in mathematics. These interventions began at admission to the university and continued through student orientation and into the classroom.

Key to the customized PSI tenets in Math Launch pedagogy, *communication* with the student and their support system was a priority from the point of admission. The Math Launch Admissions Pathway was promoted on the university website with an additional announcement included in the Admissions packet. It was important that both students and families understand the purpose, requirements and even restrictions associated with the program early in the college decision making process. Approximately two months before new student orientation a program communication was sent to all students in a major associated with Math Launch and then, two weeks before the scheduled orientation students received a communication that they were selected for the program. At orientation, students learned more about how the program worked and were automatically registered for the MAC 1906 course. Communications continued a week before the start of classes notifying students of their subject assignment and expectations for the first week of class. Timely and informative communications from the program administration continued throughout the semester in addition to instructor in-class announcements. At the conclusion of the semester, student enrollment was swapped from MAC 1906 to reflect the highest math subject earned. The new course posted to the transcript allowing students to easily meet degree requirements even if the student transferred internally to a new major or externally to another institution.

The cocurricular human link provided by Math Launch was just as important as the support in the classroom. In addition to the graduate teaching and undergraduate learning assistants

previously mentioned, Math Launch students received assistance from a team of coaches focused on first semester success and progression in the math subjects. An advisor or Senior Academic Success Coach (ASC) provided weekly progress checks to keep the students on track in the subject coursework. Students could schedule an appointment to set goals for the course, talk about time management and transition to the university or even receive advising assistance. The Math Launch ASC worked in tandem with the students assigned ASC for their major who tracks their academic progress through to degree completion. The Math Launch ASC had a team of trained peer coaches who provided daily assistance to students and provided progress monitoring. Assigned a group of students in the course, the peer coaches began communicating with the students in the first week of class and hosted multiple appointments with the students to help them set goals and stay on track. This peer-to-peer assistance was often preferred by the students, hearing from someone who has traveled the same pathway.

5.0 Results and Discussion

As previously stated, the goal of the Math Launch program was to increase four-year graduation rates by providing the opportunity for students to become calculus ready in one semester thus decreasing time to a degree. As four-year graduation was a long-term goal, intermediate goals were established to measure short-term successes of the program. These short-term goals, class success and subject completion, first-year retention and calculus performance are discussed further.

Tables I through IV show fall-to-fall and summer-to-summer performance since the inception of the program. Table I displays the total number of students in each fall cohort, how many became calculus ready and the number of subjects or sub courses (0 – 4) students completed compared to how many were needed. For example, one can see that while only 29% of the Year 1 cohort (Fall 2022) became calculus ready in one semester, 64% of the Year 2 cohort (Fall 2023) met this same goal. Additionally, in Fall 2023 of the 247 students who needed three or more subjects, 49% (n=122) met this goal. After significant increases in completion from Year 1 to Year 2 of the program, there were slight course completion drops in Year 3. Increases were directly tied to improvements in the structure of the course and interventions. Clear communication of expectations, required attendance, two day a week lectures and credit hours tied to the course held students more accountable for completion of subject material. The administrators expected slight decreases in Year 3 as the program nearly doubled in size and expanded to include all majors in CECS, for some of which (Computer Science and Information Technology) math was less critical to timely progression as it had less of an impact on required major courses. In fact, 45% (n=46 of 102) of those who completed no subjects during Fall 2024 were in majors across CECS and COS where calculus was less critical to progression in the major.

When looking at individual subject completion, one sees the same significant increase from Year 1 to Year 2 with a slight decrease in Year 3. Subject completion was defined as completing the subject in which the student placed into and started in the class. This data assists in comparing the impact of the Math Launch intervention. The idea was not to outperform the traditional math courses, though that has been the case in most subjects, but instead, to assess that students participating in the intervention had the same success rate in the math course while having the opportunity to accelerate progression to calculus. Table II shows the number of students who

started and completed a particular subject or sub course. This does not mean that is the only subject they completed, but simply represents the percentage of students who completed the initial subject course.

Table I
Fall to Fall Comparison of Subject Completion

Result	Fall 2022		Fall 2023		Fall 2024	
	N	%	N	%	N	%
Participant Total	365	-	586	-	1019	-
Calculus ready end of term	106	29%	374	64%	632	62%
1+ subjects completed	207	57%	553	94%	917	90%
2 + subjects completed	79 (n=302)	26%	343 (n=479)	72%	524 (n=769)	68%
3 + subjects completed	20 (n=169)	12%	122 (n=247)	49%	164 (n=386)	42%

Table II
Fall to Fall subject pass rates

Subject	Fall 2022		Fall 2023		Fall 2024	
	N	%	N	%	N	%
Intermediate Algebra	19 (n=26)	73%	51 (n=53)	96%	92 (n=111)	83%
College Algebra	74 (n=143)	52%	182 (n=194)	94%	249 (n=275)	91%
Precalculus Algebra	60 (n=90)	66%	263 (n=276)	95%	424 (n=460)	92%
Trigonometry	42 (n=106)	49%	57 (n=63)	91%	151 (n=173)	87%

Tables III and IV show the same data but for summer terms. It is important to note that the summer offering was only six weeks in length. Implemented in Summer term B, the course was meant to provide an opportunity for first-time-in-college, non-calculus ready students to become calculus ready and be on track in the major by fall term. This was important as university data show that fall calculus ready engineering students graduated in four years at 42.4% compared to 21.1% of those who were calculus ready by spring term [24]. Again, one can see increases in overall performance (calculus ready and completing multiple subjects) with slight decreases in subject completion as the program has grown.

First year retention was another important measure for Math Launch. Though the goal was to retain and expedite progress in a student's chosen STEM major, it was also critical to assist students into a new major when deciding STEM was not the right choice. Ultimately, the goal of the institution is the success of all students, regardless of the discipline of study. Students participating in Math Launch during the 2022-2023 academic year were retained through the first year at a rate of 91% to the University with 75% retained in a STEM major the following fall.

Students participating in Math Launch during the 2023-2024 academic year were retained through the first year at a rate of 92% to the University with 80% retained in a STEM major the following fall. As the intervention becomes more established the desire would be to continue an increase in the percentage of students retaining in STEM while tracking multi-year retention and progression in the major.

Table III
Summer* to Summer comparison of subject completion

Result	Summer 2023		Summer 2024	
	N	%	N	%
Participant Total	188	-	284	-
Calculus ready end of term	51	27%	129	45%
1 + subjects completed	176	94%	269	95%
2 + subjects completed	9 (n=102)	9%	124 (n=228)	54%
3 + subjects completed	43 (n=147)	29%	37 (n=156)	24%

*Offered Summer B term only (6 weeks)

Table IV
Summer to Summer subject pass rates

Subject	Summer 2023		Summer 2024	
	N	%	N	%
Intermediate Algebra	21 (n=21)	100%	36 (n=38)	95%
College Algebra	77 (n=81)	95%	112 (n=118)	95%
Precalculus Algebra	63 (n=65)	97%	93 (n=98)	95%
Trigonometry	15 (n=16)	94%	27 (n=30)	90%

The most compelling measure that the Math Launch intervention works was calculus progression. Once more, the idea was to assess that students participating in the intervention had the same preparation for and success in subsequent courses as students in a traditional math course. Looking at who took Math Launch in Fall 2022 and Fall 2023, it was determined that 83% and 86% of students, respectively, received a C or better in calculus 1 the following spring term. This compared to 65% and 78%, respectively, for students who took at least one math prerequisite at the university in the same fall terms and completed calculus 1 the following spring. The data shows that Math Launch students were equally if not better prepared in the math prerequisite knowledge as shown by performance in the next course in the sequence.

As the university invests in becoming the best engineering and technology institution in the state, one can only expect that Math Launch will continue to expand. The success of the program will be measured by maintaining, if not improving, on measures discussed here while the number of students increase. Future evaluation will include comparing data on completion of STEM degrees and reporting decreases in time to degree and changes in four-year graduation rates for Math Launch participants.

6.0 Conclusion

Math Launch has proven so far to be an effective program for preparing first-year STEM students for calculus 1 through an accelerated and structured approach using adaptive learning tools and in-person support. It showed significant increases in individual subject completion from Year 1 to Year 2, with a slight decrease in Year 3 due to program expansion. Students consistently outperform peers at the university in calculus progression as detailed above. The blend of a customized PSI and ALEKS along with improved human connection and targeted interventions ensured those outcomes. Furthermore, the dimension of learning communities helped greatly to ease the transition to university life by providing robust support from admission through the first semester, ensuring effective communication with students and families, and offering peer and academic coaching. Since the program is still in its preliminary stages, our future work will focus on collecting data, reporting iterations, and analyzing four-year graduation rates and impacts on STEM degree completion rates across different demographics. As far as the program challenges, they are associated with the expansion including the need for more classroom or computer lab space and the recruitment and training of instructors, tutors and peer coaches to maintain the achieved quality of support that is provided to participants.

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