

**Expanding access to engineering, science, and
technology with an online pre-matriculation program**

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Abstract

There have been numerous calls to increase the number of students interested in, matriculating to, and graduating from science, technology, engineering, and mathematics (STEM) bachelor's degree programs. In terms of expanding access at the K-12 level, stakeholders focus largely on promoting math and science achievement, while also nurturing interest in STEM through curricular activities (e.g., science experiments, competitions, computer classes). Postsecondary institutions generally expand access to STEM by identifying and recruiting students who meet admissions criteria and already have an interest in STEM. However, current K-12 STEM programs and focused undergraduate STEM student recruitment neglect students who may be interested in STEM bachelor's degree programs, but are underprepared for college level studies in these fields.

In this paper, we describe an online pre-matriculation mathematics intervention, the e-Math Forum, which was developed to expand access to STEM bachelor's degree programs at one university. The e-Math Forum was used to strengthen mastery of mathematics concepts considered critical for success in STEM degree programs. However, it also presents an opportunity for increase access to STEM among students that may not have otherwise been accepted to the institution, but who can succeed. This particular initiative involves collaboration among admissions, academic affairs, student support services, the mathematics department, and the Faculty Innovation in Teaching and Learning Center. In addition to describing the program, we also present preliminary data that suggests the intervention does expand access to STEM bachelor's degree programs, and in more ways than one.

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I. Introduction

There have been numerous calls to increase the number of students interested in, matriculating to, and graduating from science, technology, engineering, and mathematics (STEM) bachelor's degree programs [1,2]. In terms of expanding access at the K-12 level, stakeholders focus largely on promoting math and science achievement, while also nurturing interest in STEM through curricular activities (e.g., science experiments, competitions, computer classes). Postsecondary institutions generally expand access to STEM by identifying and recruiting students who meet admissions criteria and already have an interest in STEM. However, current K-12 STEM programs and focused undergraduate STEM student recruitment neglect students who may be interested in STEM bachelor's degree programs, but are underprepared for college level studies in these fields.

In terms of postsecondary entry, STEM academic programs maintain high admissions standards that effectively reduce the number of potentially eligible students in the pipeline. Although standardized achievement scores and high school grades may be good predictors of first-year college achievement, research shows that the relationship between these factors is mixed after considering ethnicity/race, gender, socioeconomic status, and institution type [3,4]. This suggests that promising students interested in STEM but who are considered underprepared may still be successful [5].

Further complicating the postsecondary STEM access is remediation, or lack thereof. In 2000, approximately one third of all first-year students needed remedial work in mathematics [6]. Despite this need, four-year institutions have significantly decreased (often by either State or Board mandate), and in many cases eliminated remedial coursework. Again, this limits access, as students that could potentially enter the STEM pipeline but lack the time and resources to strengthen basic skills (i.e., foundational mathematics and core science knowledge) are excluded.

Finally, work like Treisman's (1992) at the University of California, Berkeley has sought to address underprepared students who do matriculate to STEM bachelor's degree programs [7]. These structured support programs often focus on mathematics, providing students with resources to facilitate study groups, improve study skills, and other activities noted to promote persistence in STEM. These programs have proliferated throughout higher education, yet many students, both those considered prepared and those deemed underprepared, still leave STEM because of poor foundational knowledge of mathematics. In fact, "gateway" mathematics classes that are required for enrollment in more advanced coursework continue to pose a significant challenge to many students interested in and pursuing STEM bachelor's degree [8].

Despite efforts like Treisman's, the lack of remediation and traditional postsecondary recruitment strategies have effectively denied access to students potentially eligible for STEM bachelor's degrees or eliminated students interested in these fields due to resource deficits. In this paper, we describe an online pre-matriculation mathematics intervention, the e-Math Forum, which was developed to expand access to STEM bachelor's degree programs at one university.

The e-Math Forum was used to strengthen mastery of mathematics concepts considered critical for success in STEM degree programs. This particular initiative involves collaboration among admissions, academic affairs, student support services, the mathematics department, and the Faculty Innovation in Teaching and Learning Center. In addition to describing the program, we also present preliminary data that suggests the intervention does expand access to STEM bachelor's degree programs.

II. Background

Polytechnic Institute of New York University (NYU-Poly) is a relatively small STEM-focused institution with fewer than 2,000 undergraduates. Among all undergraduates, approximately 80% are enrolled in engineering programs; the remainder matriculates into other STEM-related fields (e.g., Computer Science, Construction Management, Integrated Digital Media, Business and Technology Management). Despite NYU-Poly having a low proportion of female undergraduates on campus (approximately 20%), it is one of the most diverse institutions ethnically/racially. According to IPEDS, in 2010 the student body was comprised of 30% Asian/Pacific Islander, 26% White, 13% International, 12% Latina/o, and 10% African-American students [9]. In addition, NYU-Poly enrolls a large proportion of Pell-eligible students (41% in 2008-2009), which is significantly higher than the national average of low-income students enrolled in a private institution, making it an economically diverse institution as well. In terms of geography, well over half of all NYU-Poly students come from New York State and a large percentage from New York City.

Like most institutions, NYU-Poly has struggled with expanding access and promoting persistence in its undergraduate degree programs (all of which are in the STEM fields). In response, NYU-Poly began a "General Studies" (GS) program in 2004 to provide access to promising students that do not meet the desired academic standards for admission. The admissions office reads applicant files holistically using various applicant data points (including, but not limited to, standardized achievement scores, high school academic records, and essays) in determining whether students should be admitted to NYU-Poly through the GS program.

Students accepted into the 1-year GS program receive an array of services, beginning with a mandatory non-credit summer program prior to the start of their freshman year at no cost to the student. The program continues throughout the academic year with mandatory weekly tutoring and advisement sessions. Upon successful completion of the 1-year GS program (i.e., at least a 2.0 grade point average and a minimum of 24 earned credits), students are guaranteed full admittance into the University during their second year.

The GS summer program was designed to help bridge the gap between students' high school math, science, and writing skills, and those needed to navigate the rigorous undergraduate STEM curriculum at NYU-Poly. However, in past years some GS students continued to struggle academically after participating in the summer program, and especially in math courses. To address this, NYU-Poly developed a mandatory online summer math component in 2010 to introduce GS students to math at the college-level. The e-Math Forum was designed to increase student mastery of mathematics by providing an opportunity to review and deepen the mathematics they learned in high school.

A secondary goal of the GS online summer program was to provide an incentive for students from outside of the New York City area that could not attend the on-campus summer program. By participating in the e-Math Forum, these students have a chance to maintain their interest in matriculating to NYU-Poly by gaining a tangible understanding of the administrative and curricular expectations, but also developing relationships with their peers, and NYU-Poly faculty and staff.

III. Problem Statement

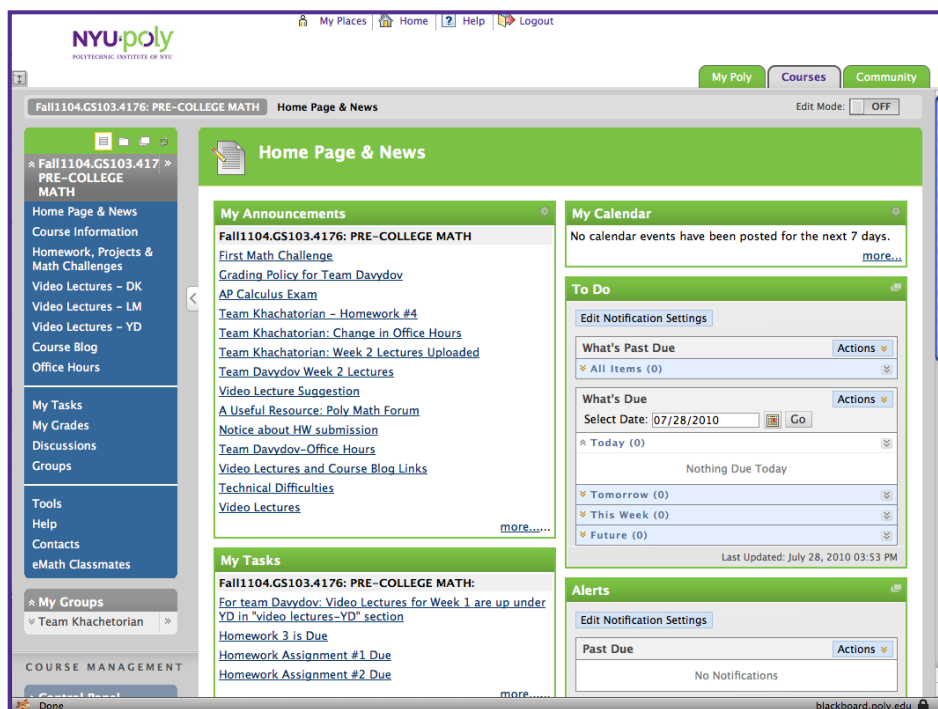
Students entering NYU-Poly in the first-year programs are typically placed in pre-Calculus, Calculus I, or Calculus II based on a placement exam and high school achievement information from their admissions application. While the institution strives to place students in the appropriate mathematics course, predicting their success is an imprecise endeavor. In addition, students often matriculate feeling confident in their own assessment of their ability, regardless of faculty and staff advice. This has contributed to many students, both those with and without exposure to advanced mathematics in high school, facing challenges related to inadequate understanding of foundational math. (It is important to note that there are other factors that may contribute to poor academic performance in mathematics including, but not limited to, poor study skills, hours spent at work, commuting, and an imbalanced course load.)

IV. Intervention Strategy

The e-Math Forum presents an innovative approach to teaching and learning utilizing an online platform (see Figure 1). The e-Math Forum is a supplementary four-week program that provides GS students with access to full course content online using the Learning Management System, Blackboard and the virtual classroom tool, Wimba. All course communication, homework, sample exams, and quizzes are posted on Blackboard to facilitate access to and engagement with math coursework. For example, video lectures are provided online for students to view through Blackboard and their portable electronic devices (e.g., smart phones, iPads, and netbooks) (see Figure 2). In addition, students have access to a daily 6-hour online office hour to engage in and solve assigned problems with instructors using the chat and audio functionality in Wimba.

Student grades for the e-Math Forum component of the summer program are contingent upon homework completion, math challenges, and team assignment grades (as noted in Figure 1). Students are placed into six teams for group-work based on their SAT scores and grades in high school math courses. Specifically, there are 4 weekly homework assignments with about 10 questions each, and 1 math challenge team assignment.

Figure 1: Example e-Math Forum homepage screen shot



V. Results

In the 2010 pilot cohort, 91 students participated in the online GS e-Math Forum, and 98% successfully completed the program. In terms of math course placement after the e-Math Forum, students were placed in Pre-Calculus (61%), Calculus I (38%), and Calculus II (1%) during their first year. As of September 2011, approximately 70% of the pilot cohort that successfully completed the online GS e-Math Forum, matriculated through the 1-year GS program, *and* are currently enrolled at NYU-Poly for the fall 2011 semester.

In the 2011 cohort, 60 students successfully completed the e-Math Forum, and 90% of these students matriculated to NYU-Poly in the 1-year GS program starting in the fall 2011 semester. Among those students who matriculated, 75% entered Pre-Calculus and 25% entered either Calculus I or II.

Figure 2: Example screen shot of e-Math Forum video lecture notes

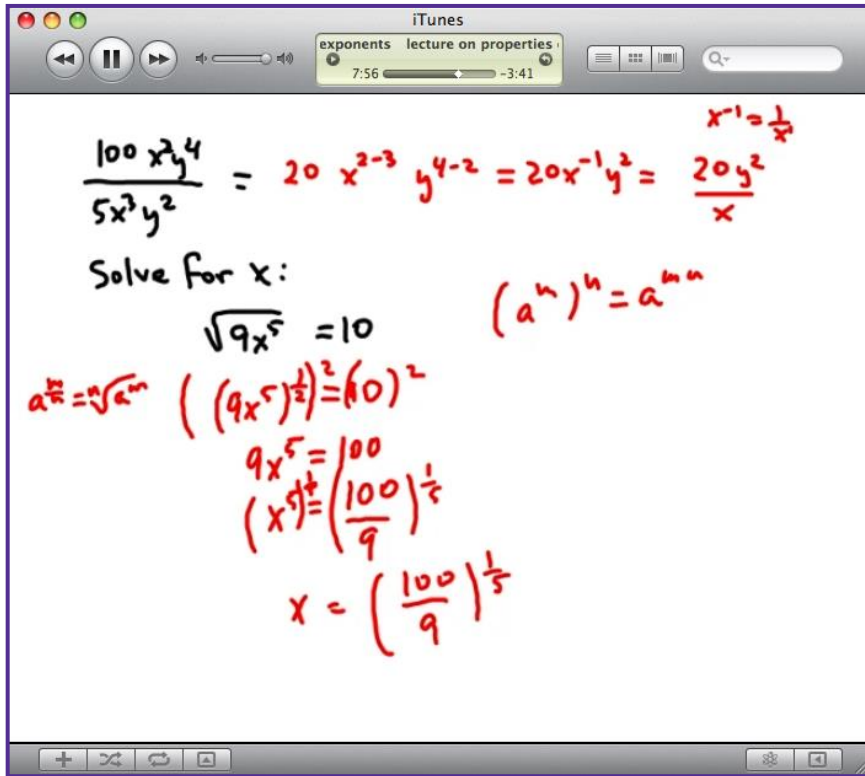
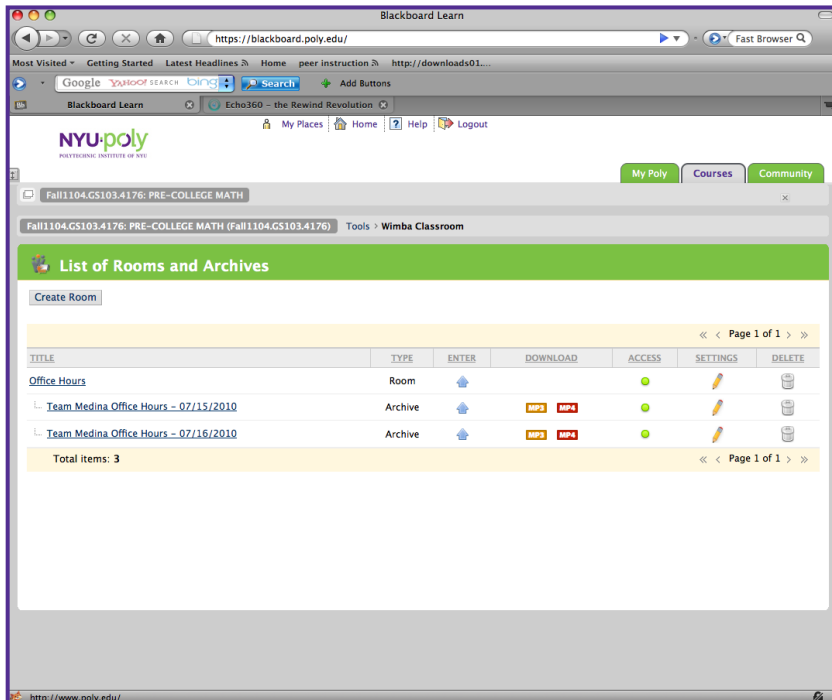


Figure 3: Example screen shot of e-Math Forum Rooms and Archives



VI. Conclusions

The e-Math Forum highlights the possibilities and complexity of expanding access to STEM given the necessary collaboration across organizational units at NYU-Poly.

The success of the e-Math Forum can be measured by the number of students successfully completing the program, matriculating into the 1-year GS program, *and* subsequently enrolling as a regular full-time NYU-Poly student beginning in their second year. In effect, the 59 students from the 2010 online GS program who are enrolled as second-year students in STEM bachelor's degree programs at NYU-Poly represent students that would not have been admitted or enrolled without the e-Math Forum. These preliminary results suggest that the e-Math Forum can propel underprepared and underserved students into college-level mathematics courses and subsequently STEM bachelor's degree programs.

In the future the e-Math Forum will also be evaluated with reference to: a) improvement in student preparation for gateway mathematics courses, and b) persistence through NYU-Poly STEM degree programs.

We may also consider the benefits of expanding the e-Math Forum to all admitted NYU-Poly students, adding a physics curriculum, evaluating it as recruitment tool for students living outside of New York City, and conducting cost-benefit analyses.

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