Project Accelerate: Bringing AP® Physics 1 to Underserved Students

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Economically disadvantaged and underrepresented high school students in many urban, rural, and small suburban communities don't have access to Advanced Placement® (AP®) courses either because of a lack of trained teachers, limited or no AP program, or a school history of low participation. Physics is often a "gate keeper" course to entry into physical science, technology, engineering and mathematics (STEM) careers and academic programs. Lacking opportunity to access rigorous physics courses in high school, these demographic groups are hard pressed to compete in STEM fields and academic programs with their peers from more affluent communities. Project Accelerate is a partnership program between Boston University (BU) and the nation's high schools combining the supportive infrastructures from the students' traditional school with a highly interactive private edX online instructional tool to bring a College Board accredited AP Physics 1 course to schools not offering this opportunity. During the 2015-16 academic year, Boston University piloted this model with four Boston Public School (BPS) high schools and three small suburban high schools. During the first year of the pilot, students enrolled in Project Accelerate outperformed their peer groups enrolled in traditional AP Physics 1 classrooms.

The problem

There is a critical need to develop STEM competencies among youth from demographic groups underrepresented in the STEM workforce. While underrepresented youth make up more than 50% of today's high school population, African-American/black and Hispanic/Latino youth each comprise only 7% of STEM graduates and 6-7% of the STEM workforce.[1] Underserved high school graduates are just as likely as non-underserved populations to be interested in STEM —49% in each case. However, underserved students are far less prepared for college STEM coursework than are students overall (e.g., only 25% of underserved STEM students met the ACT College Readiness Benchmark in science compared to 59% of students who are not underserved). These data indicate that a program to increase academic readiness can succeed in increasing participation in STEM baccalaureate and career pathways.[2]

Evidence exists that students who score 3 or higher on AP exams have greater success in college than students who did not take an AP course. However, students who receive scores lower than 3 do not perform noticeably better than a comparison group of high school students who did not take a STEM AP course.[3-5] This indicates how critically important quality curriculum, prepared teachers, and appropriate scaffolding are to student success.[6]

The most recent reports indicate schools with predominantly low-income students, both rural and urban, lag in AP offerings by a 2:1 margin, and underrepresented groups lag in taking these courses even when offered by a factor of 2 compared to whites and 4 compared to Asians.[7,9] There is also recent evidence that in schools that do offer AP programs, there is a large gap in participation between low- and high-income students, regardless of race. What is clear is that economically disadvantaged and underrepresented student groups share an equal interest in STEM as non-underserved students, but are too often lacking the opportunity to access these gateway courses to success in physical science college programs and STEM careers.[2] Robinson et al. have shown that "taking advanced courses in mathematics and the sciences in high school, e.g., AP courses, is good preparation for university work in engineering and other STEM careers."[8] More recently, the State of California and the College Board have collaborated on bringing more AP courses to underserved students. The latest data indicate that a large fraction of underrepresented students (30% or 8800 students in CA) could potentially succeed in AP STEM courses but are not enrolling due to lack of opportunity.[9]

Boston Public Schools (BPS) is a prime example of this national problem. Locally, the Boston Public School system, a typical urban school system, has 34 high schools serving a district student population of 51,000 students. Of these 34 schools, based on the Massachusetts Department of Education website, only four high schools during the 2015-16 academic year offered algebra-based AP Physics 1, the curriculum supported by Project Accelerate. A total of only 151 BPS students took the AP Physics 1 exam during the 2015-16 school year. Of the 151 students who took the AP Physics 1 exam, in a traditional classroom environment, only 8% earned a 3 or better. The BPS AP Physics 1 passing rate is less than one-quarter the Massachusetts state average of 43%. Boston Public Schools, with demographics of 75% black or Hispanic and nearly 100% on free or reduced lunch programs, shows an AP Physics 1 profile score similar to the national AP® Physics 1 scores for underrepresented minorities. The success rate (score of 3 or higher) nationally for black and/or Hispanic students taking the AP Physics 1 exam during the 2015-16 academic year was 16%. AP scores are reported on a 5-point scale, with scores of 3, 4, and 5 defined by the College Board as qualified, well qualified, and extremely well qualified.[15]

Project Accelerate

Project Accelerate is a *partnership* between Boston University (BU) and local, regional, and national high schools providing a structured, supportive, and rich educational opportunity for underserved students. Project Accelerate is a potential scalable and sustainable solution to closing this access gap to STEM careers and academic programs.

 DOI: 10.1119/1.5080583

Four components to Project Accelerate

Project Accelerate combines four components to support student success: 1) An interactive edX small private online tool; 2) The supportive infrastructures of the partner high school; 3) The coordination and academic support of the university partner; and 4) A hands-on laboratory option.

• *Online instruction tool:* The online instructional tool is supported through the edX platform. EdX was founded by Harvard University and MIT in 2012 as an online learning destination. Today there are more than 90 global partners, including Boston University, in the edX online provider community.

The Project Accelerate online instructional tool is short on "video professor segments." Instead, students are engaged throughout the online instructional tool with interactive explorations using Direct Measurement Videos by Peter Bohacek, PhETs from University of Colorado, and interactive HTML5 simulations by Andrew Duffy, co-PI on Project Accelerate. Videos when included are no longer than seven minutes and are provided as an alternative learning modality reviewing instruction provided through engaging simulations, Direct Measurement Videos, and interactive instruction. The online component is authored specifically to work seamlessly with a typical high school schedule. There are 28 graded virtual laboratories, 28 graded homework assignments, 24 graded quizzes, and eight graded, proctored, and timed simulated AP-style tests. The end-of-term tests are proctored by the partner-building liaisons and all assignments are graded through the edX online instructional tool. Participating students pose queries and engage in discourse with Project Accelerate staff and the larger student learning community through an online discussion forum.

• *High school partner:* The high school appoints a professional staff member to serve as "HS liaison" (e.g., science teacher, outreach coordinator, or guidance counselor). The HS liaison facilitates communication between the school, students, and the project team. The high school is provided a set of guidelines for enrolling students (i.e., maximum of 10, Algebra 2 proficient, potential for independent learning, demonstrated history of submitting assignments in a timely fashion, and interest in academic challenge), but is provided a good deal of latitude in vetting students into the program. The high school assigns participating students in-school time like any other major course and includes the course on the student's transcript and report card. The HS liaison is the chief encourager and nagger keeping students on task and on schedule. The HS liaison does not provide formal content instruction.

• *University partner:* The Project team appoints a "university liaison" who coordinates all aspects of the program. The university liaison monitors student performance, and communicates regularly with the HS liaison concerning issues that might impact student performance. The university liaison provides formal midterm reports, end-of-term grades, and end-of-course grades. The university liaison monitors discussions on the online forum and where applicable supervises undergraduate teaching assistants who facilitate the on-campus hands-on laboratory component of the course.

• *Hands-on laboratory option:* Students within commuting distance to the university are required to attend weekly small group 2½-hour laboratory sessions on the university campus. Sessions give students an opportunity to explore concepts through hands-on inquiry-based laboratories, receive additional support based on individual learning needs, and gain exposure to a university campus. Sessions are facilitated by trained and supervised undergraduate teaching assistants—physics undergraduates trained in STEM pedagogy and physics preconceptions through a two-credit one-semester course. School partners not within commuting distance are encouraged and wherever possible supported in providing students with a hands-on laboratory component to complement the online instruction tools. Partner schools, including our commuting partner schools, offering a significant and quality hands-on laboratory component report the course as an accredited College Board AP Physics 1 course. Other partner schools record the course as AP Physics 1 Preparation. However, all students are required to register and complete the AP Physics 1 exam.

Research agenda

Our research agenda explores three aspects of the program: 1) the efficacy of the program, 2) the scalability of the model, and 3) the long-term sustainability of the program.

• *Efficacy:* We explore program efficacy by measuring student outcomes through AP exam performance, pre/post scores on the Force Motion Concept Evaluation (FMCE), course completion rate, and impact on student STEM choices and longitudinal college and career choices and performance.

• *Scalability:* We additionally explore the structure of the blended model and university to school partnership both in the local pilot program, and in terms of whether it can be replicated at other sites around the country.

• *Sustainability:* We look at long-term sustainability through a cost analysis of delivering the program at a price point that would likely be attractive to school administrations.

Pilot project

• *Student demographics:* During the 2015-16 academic year, BU partnered with seven high schools in four districts to bring a blended AP Physics 1 course to underserved secondary school students who would otherwise not have access to AP Physics. Our partner schools included four Boston Public School (BPS) high schools and three small suburban high schools. None of the participating schools offered their students the opportunity to enroll in AP Physics. A total of

24 students enrolled in this pilot project. Seventeen attended four high schools in the BPS system, and seven attended three schools in central and western Massachusetts. The demographics for our first cohort were 67% black and Hispanic and 75% on free and/or reduced lunch programs.

- ***AP Physics 1 exam results:*** All participating students were required to take the College Board AP Physics 1 exam. Although the sample size was too small to provide statistical significance, preliminary results are very promising. Project Accelerate students did as well or outperformed their peer groups enrolled in traditional AP Physics 1 classrooms. Fourteen percent (2 out of 14—3 of the original 17 did not complete the course) of the BPS students completing the Project Accelerate program scored a 3 or better compared to 8% for BPS students enrolled in traditional AP Physics 1 classrooms. Seventy-one percent (5 out of 7) of the non-BPS students completing the Project Accelerate program scored a 3 or better compared to 43% for non-BPS Massachusetts students enrolled in traditional AP Physics 1 classrooms.
- ***FMCE:*** We administered the Force Motion Concept Evaluation (FMCE) as a pre/post-test. This instrument is used by many universities and colleges to gauge the learning gains of students within their own introductory college level physics courses. Students in Project Accelerate had a paired fractional gain of .53, which is considered very good by the physics education research community.
- ***Overall retention:*** Twenty-one of the initial 24 students enrolled in this program completed the course—resulting in an 88% retention rate. At week 7, a student withdrew and commented, "The course is more work than I want to do. I am a senior." A second student withdrew in week 15 with the comment, "Just not comfortable having to direct my own learning. I prefer having the teacher tell me what to do while I'm in class." A third student, dealing with personal issues, withdrew in week 17.
- ***Student attendance:*** BPS students attended a weekly 2½-hour laboratory block held from 4:00 p.m. to 6:30 p.m. on the BU campus. The attendance rate for BPS students at these laboratory sessions for the full year was 90%.
- ***Student STEM interest:*** Eight of our 14 Boston Public School completers applied to participate in summer STEM programs. Of these eight, six indicated in our post-course survey that participation in Project Accelerate was either "very important" or "somewhat important" in their decision to apply to a summer STEM program. The remaining two of those applying to participate in a summer STEM program indicated they were planning on applying to such a program prior to entering our course.

Fifty-two percent of all students indicated on the post-course survey that they were either "much more likely" or "somewhat more likely" to pursue a STEM program in college as a result of their participation in Project Accelerate. The remaining 48% of students indicated "no impact on their decision," and no student chose the two negative choices of "somewhat less likely" or "much less likely" to pursue a STEM program in college.

Scaling up and replication

- ***More partner schools and a replication site:*** Project Accelerate is a National Science Foundation (NSF DUE 1720914) funded project. With NSF support over the next three years, we will be offering Project Accelerate to an expanded number of partner schools and supporting several replication sites throughout the country. All schools partnering with Project Accelerate during our pilot year have requested to be part of the program again—a vote of confidence in the program. During the coming academic year, Project Accelerate will more than double in size, partnering with a total of 15 high schools, enrolling 67 students, and opening our first replication site. The project will include six BPS public and public charter schools, four other Massachusetts schools, and five West Virginia high schools. The five West Virginia schools will be supported through our first replication site partner, West Virginia University.

Conclusion

Project Accelerate offers a potential solution to a significant national problem of too few underserved young people having access to high quality physics education, resulting in these students being ill prepared to enter STEM careers and STEM programs in college.

Project Accelerate is based upon the compelling need to provide access to AP Physics for economically disadvantaged and other underserved groups. Research shows that providing high quality education is critical to students' success in the future, and on a growing body of evidence that blended course structures, combining online learning with in-person sessions, can be very effective in improving student learning outcomes (see a review by Means et al.[10]). In addition, several studies have demonstrated that technology improves access to information, and hybrid or blended models engage students more effectively.[11–14]

Thousands of our nation's high schools do not provide opportunities for underserved students to access AP Physics.[9] Project Accelerate blends together the supportive formal structures of the student's home school, immediate acceptance into school curricula through the AP designation, a private online instructional tool designed specifically with the needs of underserved populations in mind, and small group laboratory experiences to make AP Physics accessible to underserved students.

Finally, Project Accelerate is a scalable model of STEM success, replicable at sites across the country, and therefore setting up for success thousands of motivated but underserved students every year.

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