2006-1436: THE CONSEQUENCES OF CANCELING PHYSICS: AN INITIAL STUDY IN AN AT RISK URBAN HIGH SCHOOL

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Consequences of Course Cancellation: An Initial Study in an At Risk Urban High School

1. Introduction

The importance of an equitable education for all Americans is evident to most citizens and has been demonstrated and examined by many researchers[1]. As technology continues to advance and becomes more important in the widening global economy, the need for well educated individuals to participate in science, technology, engineering and mathematics (STEM) fields increases. According to the findings of a National Science Foundation (NSF) committee, there are not enough highly trained Americans to meet this growing demand[2]. However, the committee recognized that one way to meet the growing need for people trained in the STEM areas is to increase the number of minorities in the STEM fields. If underrepresented minorities participated in the STEM fields at numbers equal to their portion of the population (i.e. were no longer underrepresented), the number of Americans in the STEM fields would approach the growing need.

The NSF is addressing this need for increasing the number of minorities entering the STEM fields by funding numerous grants and projects. The authors are involved with one such program, the NSF GK-12. The NSF GK-12 program provides support for institutions of higher education to place STEM graduate and undergraduate students into K-12 classrooms for ten hours per week. The tasks in which GK-12 Fellows (the university students) are engaged within the K-12 schools often represent variations on activities and educational objectives in which teachers are already engaged. Fellows may introduce new pedagogical techniques, new curricula, new technologies, and/or extend the educational outreach to targeted groups of students. The primary author is a graduate student Fellow working at the Georgia high school under study, and it should be noted that the observations and data collected have been done while in the NSF GK-12 program.

The federal government has also implemented the No Child Left Behind (NCLB) legislation to address equity in education in all areas of K-12 study. This law requires all states to establish statewide testing systems and academic standards which meet the federal requirements. A key component of NCLB is Adequate Yearly Progress (AYP). AYP measures year-to-year changes in student participation and achievement on the statewide tests and other academic indicators. Ever year the AYP objective is increased, so that all students will be required to pass the statewide tests by the year 2014. If AYP is not met, the school will suffer penalties under the NCLB legislation. A school will enter the “In Need of Improvement” plan after two consecutive years of failing to meet the AYP. The “In Need of Improvement” plan is clearly documented on the Georgia Department of Education website, and lists consequences for ten years of consequences in the “In Need of Improvement” plan[3]. The table below highlights consequences for the first five failing years. A school exits the “In Need of Improvement” program when it meets AYP two out of three years.

Number of consecutive failing years	Category	Consequences
2	In Need of Improvement- Year 1	Students offered choice of transferring to other public schools
3	In Need of Improvement- Year 2	Above actions & students offered supplemental educational services, including private tutoring
4	In Need of Improvement- Year 3	Above actions & school must undergo outside corrective actions which may include replacing staff or implementing new curriculum
5	In Need of Improvement- Year 4	Above actions & school must undergo re-structuring which may include change in governance

Table 1: In Need of Improvement program for schools failing to meet AYP [3]

In the state of Georgia, there are three objectives which must be met to achieve AYP. There must be 95% participation in the statewide tests, the achievement on the tests must meet that year's objective, and a second indicator of attendance or graduation rate must be met.

The achievement tests used for Georgia high schools are the Georgia High School Graduation Tests (GHSGT), and the Georgia Alternate Assessment (GAA) for severely cognitively impaired students. The GHSGT cover mathematics, English/language arts, social studies and science. AYP currently uses only the mathematics and language arts sections, but the science portion will be included starting in the 2007-8 school year [3].

With the implementation of NCLB and the need to make AYP, schools are under a great deal of pressure to increase the number of students passing the GHSGT. In addition, the increase in students passing the GHSGT should result in an increase in the graduation rate, which may also be an AYP indicator. The benefit is that failing students are now given a great deal of attention to ensure that they are keeping pace with the standards. One potential downside may come to the high achieving students [4, 5]. There is no incentive to focus on those students already passing the statewide exams, and to continually challenge the exceptional students. In affluent districts where large numbers of students are enrolled in the upper track or Advanced Placement (AP) level courses, this shift in attention may not result in serious consequences to the curriculum offerings. However, in less affluent at-risk areas, where school resources are not over-abundant, educators are faced with the challenge of raising the low performing students on a tighter budget which may mean sacrificing opportunities for the high performing students. This is the situation under examination in our initial study. It should be understood that the goal of this paper is to outline some of the main issues, and to provide a foundation for what may be done after more careful, longer-term analysis, and further consideration.

2. Initial Study

2.1 School Snapshot

The student body at this high school is very homogenous, with 98% of the students being black. This is quite a contrast from the average student population in the state. This mainly black student body presents a great opportunity for increasing flow into the minority pipeline for the STEM fields, and it becomes clear that the study of math and science must be fostered in such environments if the goal is to increase minority representation in the STEM fields. Also, this school has a large population of students eligible for free or reduced price lunches, although it is comparable to the state average.

Ethnicity	This School	State Average
Black, not of Hispanic origin	98%	38%
Multiracial	< 1%	2%
White, not of Hispanic origin	< 1%	49%
Hispanic	< 1%	8%
Asian, Pacific Islander	< 1%	3%

Source: GA Department of Education 2004-2005

Table 2: Distribution of student ethnicity; comparison between the state average and this school [3]

Student Subgroups	This School	State Average
Students eligible for free or reduced price lunch program	46%	46%
Students with disabilities	2%	12%
Limited English proficient students	1%	4%

Source: GA Department of Education 2003-2004

Table 3: Distribution of student subgroups: comparison between the state average and this school [3]

2.2 Academic performance

The benchmark test score for college preparation has long been the SAT. In comparing the average combined SAT scores for the last several years, it becomes clear that this school exhibits a gap in achievement between the nation, its state, and even its local district. This gap in SAT scores suggests an overall lack of achievement at this school in the core subjects of English/language arts and mathematics. Without a strong foundation in these core subjects, it becomes difficult to build strong programs in other areas, such as the sciences.

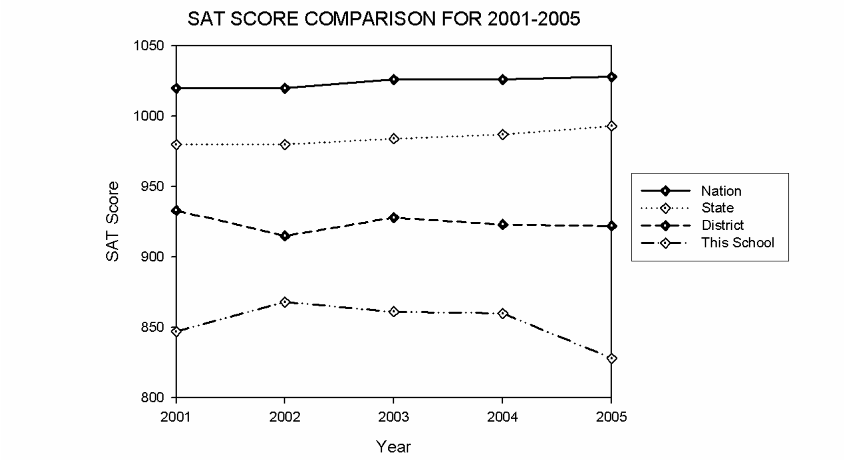
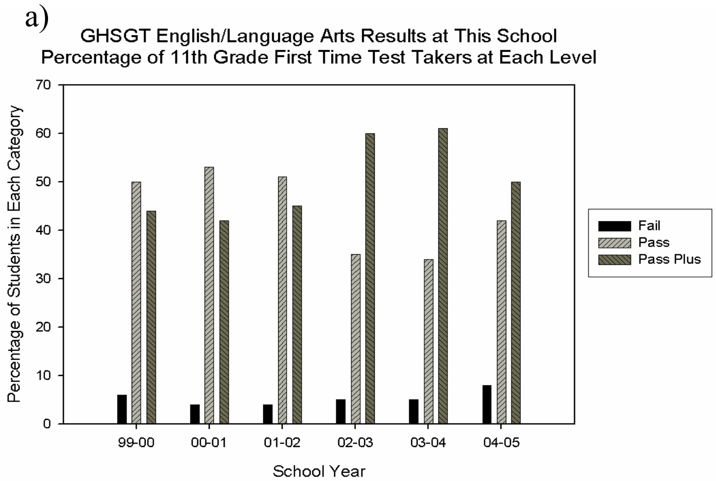


Figure 1: SAT score comparion; source: GA Department of Education Report Cards [3]

While the low SAT scores should be of concern, it is only the GHSGT scores that matter in the NCLB accounting. The GHSGT is administered for the first time to high school juniors in the spring. The students then have five opportunities to take and pass the exam to qualify for their diplomas. For the purpose of AYP, the first-time passing rate is used.

For the past several years, this school has managed to meet the state mandated passing rates for the math and language arts portions. This data is quite encouraging.

a)



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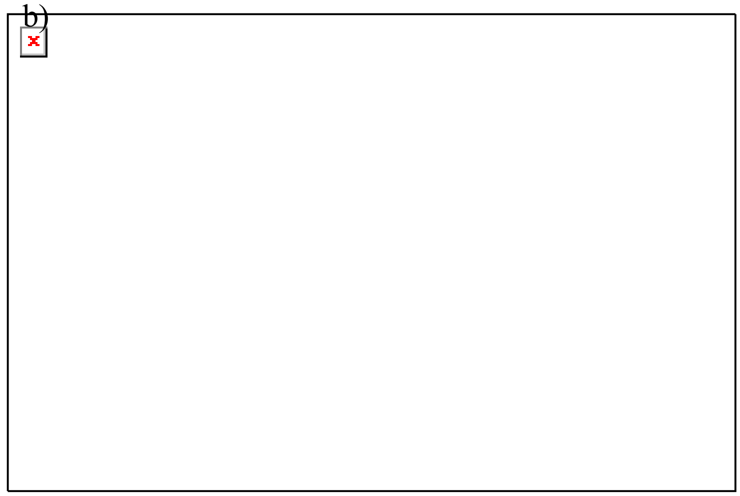

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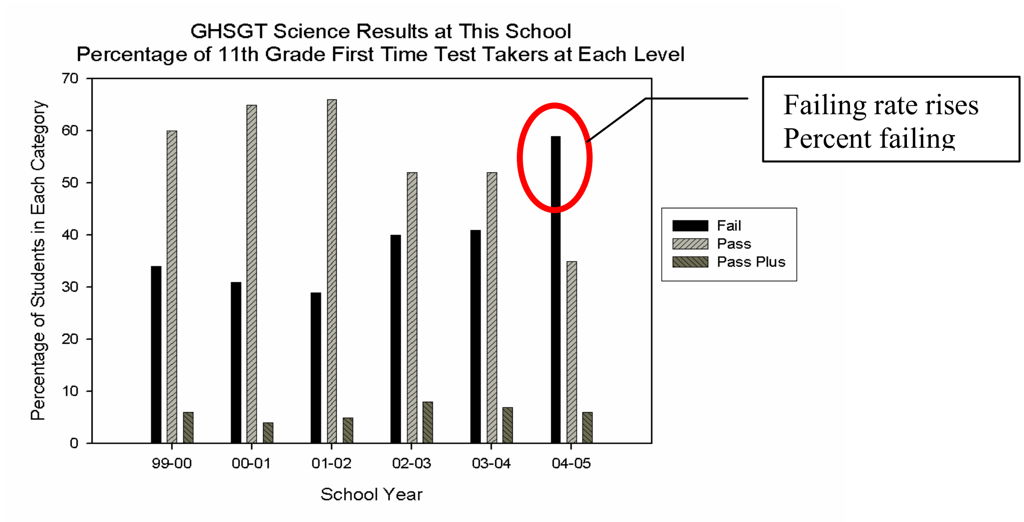

Figure 2: GHSGT Results in (a) English/Language Arts, (b) Mathematics, (c) Science; source: GA Department of Education Report Cards [3]

Upon closer examination of the GHSGT math scores, it is apparent that this school has exhibited a gradual decrease in the number of students in the pass plus category, and a concurrent increase in the failure rate. However, as long as the total number of students passing meets the state mandates, there are no NCLB consequences.

The major cause for alarm comes from the dramatic decrease in the number of students passing the science portion of the GHSGT. Most notably, during the 2004-5 school year, the passing rate for the science portion of the graduation exam dropped well below 50%. If this trend continues, the school will be in an unfavorable position when the science portion of the GHSGT becomes an AYP indicator in the 2007-8 school year [3].

2.3 Course Scheduling

The scheduling at this school is the 4 x 4 block system. In the 4 x 4 block, a course that is normally scheduled for one entire school year is compressed into a half-year course. Students may take four courses their first semester and another four courses during their second semester. Each student takes four 90 minutes courses per day, and a total of 8 classes per year. The block schedule was implemented in the 2003-4 school year [6].

2.4 Science course progression

Students at this school are currently required to take three classes in science. Starting with the graduating class of 2008, students will be required to take four classes in science. This move towards four years of science classes coincides with the GHSGT science portion coming online as an AYP indicator.

Like most high schools across the country, this school offers advanced and general tracks in science. With a variety of classes offered at both the general and advanced level, there are many different course sequences a student may take. Several typical course progressions are shown below.

Typical General Tracks

Biology → Physical Science → General Chemistry (average student)

Biology → Physical Science → Environmental Science (weaker student)

Typical Advanced Tracks

Accelerated Biology → Accelerated Chemistry → Accelerated Physics → AP Chemistry

Accelerated Biology → Accelerated Chemistry → Accelerated Physics → AP Biology

While many other course progressions are possible, the one commonality is that most of the students in any Advanced Placement (AP) science class pass through accelerated physics, making accelerated physics the entry point for AP chemistry and AP biology.

This is significant for those interested in the STEM pipeline from schools such as this one. In higher performing schools, students who graduate without taking a particular AP class may still progress to college level STEM classes and majors. However, in a school such as the one under examination, the AP classes are very necessary for attending college level science classes.

Although they are titled "Advanced Placement", the pass rate on the College Board's AP exams is quite low due to the fact that most students come into the AP class under-prepared. For instance, in the 2004-2005 school year, only one senior out of a class of 293 students had the PSAT score that the College Board recommends for success in an AP class. Given this information, the low AP exam pass rates should not be surprising. In the 2004-2005 school year, 184 AP exams were taken by 142 students. Only 16 exams had a score of a 3 or higher giving an 8.7% passing rate on all the AP exams. In AP chemistry, there was only one score of 3 or higher that year, out of a total of 14 students (7.1% pass rate). With this evidence, it becomes clear that the AP class functions more as a college-preparatory class, than as a college-equivalent class. In this way, enrollment in the AP classes become even more essential to ensuring success in STEM majors and classes post-high school.

3. Discussion

3.1 School Response

Given compelling reasons to increase the pass rates on the GHSGT science portion, the school responded by reallocating its resources to best address the failing and borderline students. These actions include changing the class schedules, re-assigning teachers, and focusing resources (money and time) on the lower and middle portion of students.

For a school under the 4 x 4 block schedule, such as the school under examination, it may be possible for a junior taking the GHSGT in the spring to not be currently enrolled in a science class when the test is administered. This lag between actively learning science and taking the test certainly makes the standardized test more difficult. In order to eliminate this factor, the school administration has re-scheduled the classes so that all juniors are taking science in the spring.

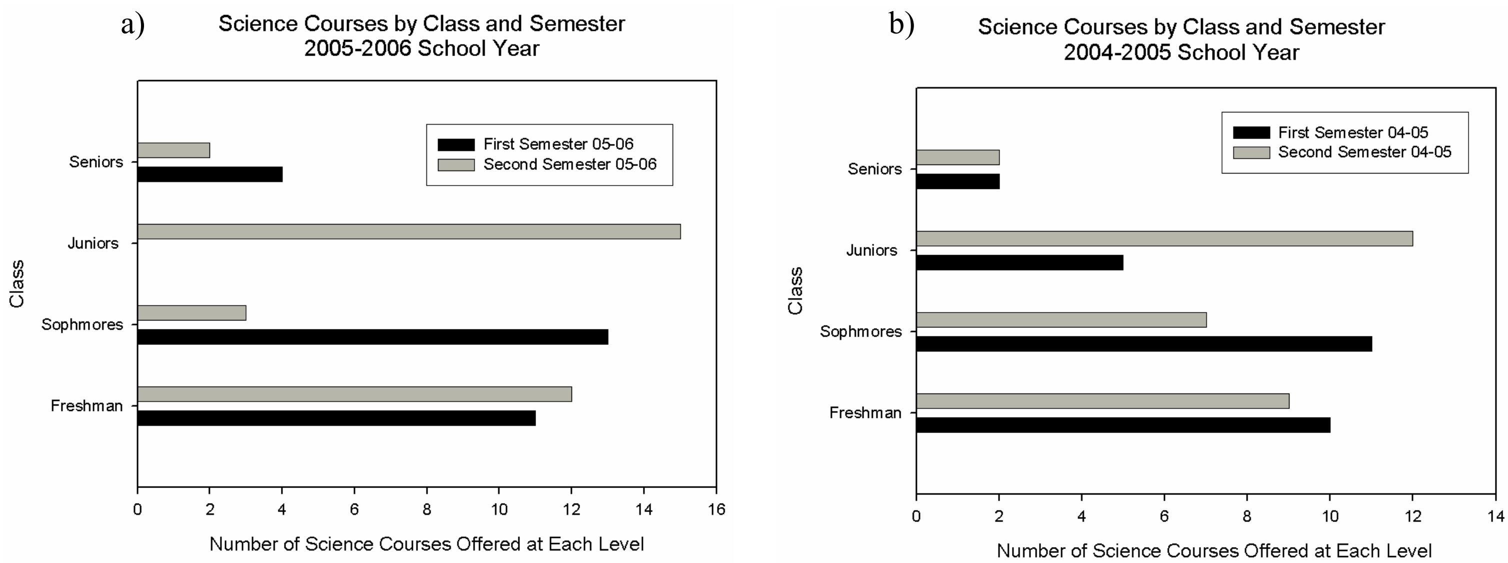

Figure 3: Science course offerings by class level and semester for the (a) 2005-2006 school year, (b) 2004-2005 school year

3.2 Effects of Schedule Changes

In order to stack the science classes in such a way that all 11th graders are in science during the spring, teachers who normally teach high level science classes, such as chemistry and physics, throughout the year must be re-assigned to teach lower level physical science classes during the fall. While this re-assignment may seem innocuous, and even a positive change for the physical science students, the negative effect on teacher morale may be severe. When experienced teachers with high levels of content knowledge are unexpectedly placed into regular, or lower-level, classrooms, they may not be prepared for the disruptive conduct issues and the low student motivation that arise in a less mature, lower-level class. Adding to those stresses are planning for a new course (often with only a few days notice) and working on a strict curriculum that may need to be coordinated among many teachers and classrooms. Much of the independence of teaching higher level classes is removed, and the enjoyment of teaching science is greatly diminished. In a marketplace where there is a severe shortage of knowledgeable high school science teachers, these types of schedule changes are likely to drive the experienced teachers out of the at-risk schools to the easier science classrooms of the suburbs.

Another outcome of the teacher and class re-allocation is that all of the classes must be completely filled. As the administration reviews the available funds and teacher time, it becomes clear that neither time nor money should be wasted on classrooms that are only partially filled. In a low-achieving school, it is the high level, upper-track classes that may suffer under this scrutiny. With only a small number of talented and highly motivated students, classes such as accelerated physics and AP chemistry are usually very under-filled. As an example, during

2005-2006, the AP chemistry class has only ten students enrolled. For this reason, it becomes an easy decision to reduce the number of higher level classes being offered. As a result of the schedule changes of 2005, the accelerated physics class for spring, 2006, was cut to only one section, and in the past five years there have always been two offerings of this course. As mentioned earlier, the main stream for students in the advanced sciences is through the accelerated physics class. So, it is hypothesized that by lowering the class offerings for accelerated physics this year, there will be fewer students qualified for AP science classes in future years. The overall effect is that fewer and fewer students will graduate from this school and be prepared and encouraged to enter STEM majors in college.

3.3 Shortcoming of the 4 x 4 Block

While the problem of meeting AYP and addressing high achieving students may seem contrary, the authors feel that there are ways to tackle both issues. The school administration can not be faulted for the actions taken to increase scores on the AYP indicators. In particular, having students enrolled in a science class during the term the science GHSGT is administered seems like a good, basic decision. However, it appears that the true issue that is not addressed is actually a limitation of the block schedule, especially when the large drop in GHSGT science scores occurred the year following the change to the block schedule for this school.

This problem of yearly testing is even more evident in AP courses, where the course should culminate with the AP exams administered in the spring. Neither of the two alternatives (running an AP class only in the fall semester or only in the spring semester) is an ideal option. For an AP class that runs only in the fall, the students must attend extra review sessions in order to retain the material for the spring exam. For the spring AP class, the exam would come too early in the term and there would not be enough time to fully cover the course material. One alternative is to use a block schedule, where students alternate between 2 classes for the entire year on "A" or "B" days. This type of block has been named the block 8 or A/B block schedule, and is in use in a number of schools.

Educators in the state of Georgia have examined schools on the block schedule and compared performance on standardized and AP tests[6]. As stated by Ms. Kathy Cox, the State Superintendent of Schools in Georgia, "with few exceptions, since 1998-99, non-block schedule schools have demonstrated slightly higher Georgia High School Graduation Tests (GHSGT) passing rates, higher average SAT scores, and higher Advanced Placement (AP) test-taking and passing rates (scoring 3 or higher) than did block schedule schools"[6]. While this study does not separate the inherent differences that may exist between schools that choose a block or a traditional schedule, the findings seem to indicate that there is a trend in slightly lower test performance for block scheduled schools. Also, these findings agree with other studies on achievement in blocked schedules [7, 8].

However, the connection between block scheduling and test achievement is not very clear. Other reviews indicate that student performance increases upon changing to a block schedule [9, 10]. Proponents of the 4 x 4 block schedule argue that longer class periods help students focus more in-depth in their classes, provide a mimic for a typical college class schedule, reduce the amount of time students spend in the hallways (reducing the chance for fights and disruptions), and allow teachers the ability to know each student better (3 or 4 classes per semester instead of 6 or 7) and provide more time to use different teaching techniques such as labs or problem-based methods. It should be noted that the last argument is true since each class period is longer, but it should be remembered that the total number of hours of instruction per subject remains fairly constant between blocked and traditional schedules, or even decreases on the block schedule, so there is no net gain in instructional time with a blocked schedule.

While the debate over block scheduling is on-going, it seems clear that for the purposes of yearly testing, the 4 x 4 block scheduling of core classes will be problematic. Perhaps a mixed format may be used where core classes always run for the entire year, and electives may be scheduled for only one semester. Scheduling classes based upon the needs of that particular subject is not a novel concept, and reports have shown that certain topics may even benefit from shorter instructional periods [11].

3.4 AP Program vs. Advanced Topics

The final issue raised in this initial study is the status of the Advanced Placement (AP) class. It is clear that the students do not arrive prepared for an AP level class, and the low AP passing rates serve to highlight this fact. The question that arises is whether or not the school should offer AP classes at all. If we revisit the opening motivation for this paper, the need for equitable education across this country, it is difficult to recommend that any school discontinue its AP program. However, there may be benefits to taking such harsh actions. Teachers would immediately have more freedom to tailor their advanced topics courses (previously AP) to focus on several key concepts, instead of having to cover the wide breadth of topics necessitated by the College Board. The modification in course content would hopefully encourage more in-depth study of these important topics, and allow for greater student involvement and enthusiasm. Additionally, without the pressure of the rigorous AP examination, counselors would be less apt to dissuade students from taking the course (which currently does happened frequently), and more students may elect to take a higher level course and stay in it. Of course, the negative consequences fall on to the few students who may actually be qualified for a true AP program. It is hard to say whether a few high achieving goals should be sacrificed for providing a better college preparation to the majority of the college-bound students. If we regard only the aspect of feeding the minority STEM pipeline, however, the option of changing AP courses to advanced topics in schools such as the one under investigation becomes a promising option as it should help and encourage a greater number of students from this minority school.

4. Summary and Conclusions

In conclusion, the effect of canceling even one section of a key class such as accelerated physics may impact the number of students entering the STEM pipeline after high school. When at-risk schools are faced with the need to make AYP or face the penalties associated with NCLB, administrators must make changes to increase the AYP indicators. The changes must be directed and focused on those students who are borderline or failing, as this is the population that will count against the school under the AYP accounting. There are no benefits under NCLB for having students achieve anything higher than the minimum passing rate. These regulations leave little room for attention to higher level classes and students; and in less affluent areas, these classes may be canceled.

For increasing the number of minorities in the STEM pipeline, this line of reasoning may have damaging consequences. Urban, at-risk high schools, such as the one under study, often have large minority populations. Canceling key courses and choking the flow of students into the upper level science classes inevitably reduces the number of students prepared to enter a STEM major in college. Overwhelmingly, the students being cut out of the STEM pipeline are then minorities from these more disadvantaged areas.

There are no clear-cut solutions for the issues raised in this preliminary study. While the block scheduling seems to hinder achievement on yearly, standardized tests, the effects of scheduling on the true goal of increasing student learning are uncertain. It would be interesting to continue this initial study, to see if scheduling science classes for juniors in the second semester improves performance on the GHSGT. Likewise, student enrollment in the science AP classes should be tracked to investigate the effect of cutting the number of accelerated physics course offerings. The hope is that awareness of the issues raised in this paper will assist educators in making decisions which ultimately increase the number of minorities entering the STEM fields while providing the most equitable education possible for schools across the country. This initial investigation raises the awareness of these issues, providing the motivation and foundation for a more complete and thorough examination in the next several years.

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