The Consequences of Canceling Physics: Revisiting a Case Study in an At Risk Urban High School

Alison Stucky[1], Marcus Bellamy[2], Donna Llewellyn[3], Marion Usselman[4]

Abstract - Georgia Institute of Technology (GT) partners with local at-risk urban high schools in the Student and Teacher Enhancement Partnership (STEP), an NSF funded GK-12 program, to place graduate students in high school classes to enrich the schools. GT students often focus on the advanced courses. These courses can be an issue in less affluent areas that lack sufficient resources to continue them while still helping the lower performing students. Standard and lower level courses are important in achieving Adequate Yearly Progress so schools often shift focus to these courses to improve their pass rate. In 2004, science graduation test scores at Cedar Grove High School dropped dramatically, causing the administration in this urban, lower income, 97% African American school to enact several measures, including reducing the offerings of physics, a significant higher level class in the sciences. This paper is a longitudinal study to evaluate the consequences of these decisions.

Keywords: GK-12, NCLB, K-12 education, minority education

Introduction

In recent years, engineers and engineering firms in the United States have urgently broadcast the message that the pipeline of new engineers needs to be dramatically widened to meet future national needs. Numerous college campuses across the United States have responded to this need with initiatives that support females and minorities in science, technology, engineering and mathematics, (STEM), as these under-represented populations are the most promising source to meet the growing need for highly trained individuals in the workforce [4]. This need to promote full participation in STEM by all groups resulted in Congress establishing the Commission for the Advancement of Females and Minorities in Science, Engineering and Technology in 1998. The goal of this commission was to research and recommend ways to increase the number of women, minorities and people with disabilities in the fields of science, engineering and technology [2]. The National Science Foundation (NSF) currently funds numerous grants and projects in order to increase the number of minorities entering STEM fields. One of the programs aimed at increasing the achievement in STEM areas, the NSF GK-12 program, facilitates the placement of STEM graduates and undergraduates from institutes of higher education into K-12 classrooms. The authors are involved with this program, which allows the GK-12 Fellows the opportunity to work closely with teachers to enrich their classrooms in ways that are often an extension of what is already taking place. It is important to note that the primary authors (Stucky and Bellamy) are graduate students placed at a high school in Georgia and that all observations and data collected have been collected while in the NSF GK-12 Program.

In 2001, the federal government introduced the No Child Left Behind (NCLB) Act. The general purpose of this act was to increase accountability and ensure that educational standards were equitable across the nation. All states are required to have statewide testing in place and set academic standards that are in line with the federal requirements. The level of the standards is raised annually until all students will be required to pass the statewide tests by 2014. Every year, student participation and performance on statewide tests as well as achievement in other academic

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[1] School of Chemical and Biomolecular Engineering, Georgia Institute of Technology, 315 Ferst Dr, Altanta, GA 30318, alison.stucky@chbe.gatech.edu
[2] School of Industrial and Systems Engineering, Georgia Institute of Technology, 765 Ferst Dr, Altanta, GA, 30332-0205, marcus.bellamy@gatech.edu
[3] Center for the Enhancement of Teaching and Learning, Georgia Institute of Technology, Atlanta, GA 30332-0383, donna.llewellyn@cetl.gatech.edu
[4] Center for the Education Integrating Science, Mathematics and Computing, Georgia Institute of Technology, Atlanta, GA 30332-0282, marion.usselman@ceismc.gatech.edu

indicators is measured. If a school achieves the level of performance required by the state, it is considered to have made Adequate Yearly Progress (AYP). However, if a school falls short, the school will be in the "In Need of Improvement" category and will face certain consequences under the NCLB legislation. This plan is readily available on the state's Department of Education website. The consequences accumulate the longer that a school is in this category. To exit the "In Need of Improvement" category, the school must meet AYP two out of three years. In Georgia high schools, AYP is measured by performance on the Georgia High School Graduation Test (GHSGT), participation on the GHSGT, and a second indicator of either attendance or graduation rate. The GHGST covers mathematics, English/language arts, social studies and science. Currently, only the mathematics and English/language arts sections are included for AYP.

Although students are required to pass the GHSGT in order to graduate, the pass rate is not equivalent to the graduation rate as many students do not continue in high school through their junior or senior year. The students begin taking the test in the fall of their junior year in high school so that the students who need additional assistance have the opportunity to receive supplemental instruction, retest and qualify for graduation by the end of their senior year. The general goal of the GHSGT is to ensure that all graduating students have achieved a base level of understanding and skill in the different subjects [3]. If students are not able to pass all portions of the GHSGT after five tries, they will not receive a high school diploma but instead will only receive a certificate of attendance. Because success on the GHSGT is crucial both in enabling students to graduate, and schools to achieve AYP, schools that have not met AYP often funnel significant resources into initiatives to assist students in moving from the failing into the passing range. There is no corresponding incentive for schools to increase the number of students in the advanced or "exceeds" category. This may not be an issue for an affluent school, where academic expectations and parental involvement generally ensure that the needs of the top students are taken into account. However it may become a serious challenge for less affluent, at-risk high schools, where the schools may be forced to make difficult decisions regarding the allotment of resources. Because of the rules of NCLB, it is likely that these decisions will often be biased towards the lower achieving students while leaving the high achieving students with fewer and fewer opportunities.

This study is a continuation of a study previously presented wherein this particular high school had recently undergone significant changes, both to the scheduling and course offerings. These changes were in response to a dramatic drop in the scores on the science portion of the GHSGT. In an effort to improve the pass rate, more emphasis was placed on the lower level courses, such as Physical Science. The number of sections of these courses was increased and many teachers who had previously taught only higher level courses were reassigned to cover these extra sections. Additionally, the schedule was changed to ensure that all students would be enrolled in a science course during the spring semester of their junior year when they would also take the GHSGT for the first time [1]. The overall format of this paper mimics that of the original paper and, when possible, data will be provided from the original paper and compared to more recent data. The goal of the original paper was to outline what the authors perceived to be the main issues that arose from these changes and to build a foundation upon which later, longer-term analysis could be done.

Longitudinal Study

Snapshot of School

The student body at this school is 97% African American students. This is significantly different from the average student population of the state. Because the school is so predominantly African American, it provides ample opportunity for increasing the number of minorities in the STEM fields. In order to do this, the study of mathematics and science should be encouraged and higher level classes made available to students. It is also of note that the school has a high population of students eligible for free or reduced price lunches. This is similar across the state.

Table 1. Comparison of school to state average: ethnicity of student population [3, 2008]

Ethnicity	This School	State Average
Black, not of Hispanic origin	97%	38%
Multiracial	2%	3%
White, not of Hispanic origin	<1%	47%
Hispanic	1%	9%
Asian, Pacific Islander	<1%	3%

Table 2. Comparison of school to state average: distribution of student subgroups [3, 2008]

Student Subgroups	This School	State Average
Students eligible for free or reduced price lunch program	61%	50%
Students with disabilities	10%	12%
Limited English proficient student	1%	5%

Academic Performance

The data presented in the previous paper indicated that the results for the GHSGT for Mathematics and English/Language Arts were quite promising although a slight decline was seen in the pass plus or exceeds category in the Mathematics Test [1]. This occurred simultaneously with an increase in the number of students in the failing category. Since the time of the original paper, with data presented through the 2004-2005 school year, the school has seen four straight years where the Mathematics results did not meet the requirements.

The high school has seen much better results for the English/Language Arts test, achieving the required passing rates since the inception of NCLB. Students have consistently scored significantly better on the English/Language Arts GHSGT than on the Mathematics test. Unfortunately, during the 2007-2008 school year, performance on the English portion also fell into the "did not meet" category. As of yet, it is difficult to tell whether this trend will continue. The school continues to have a passing rate of over 80%, but has failed to improve performance to match the increased standards.

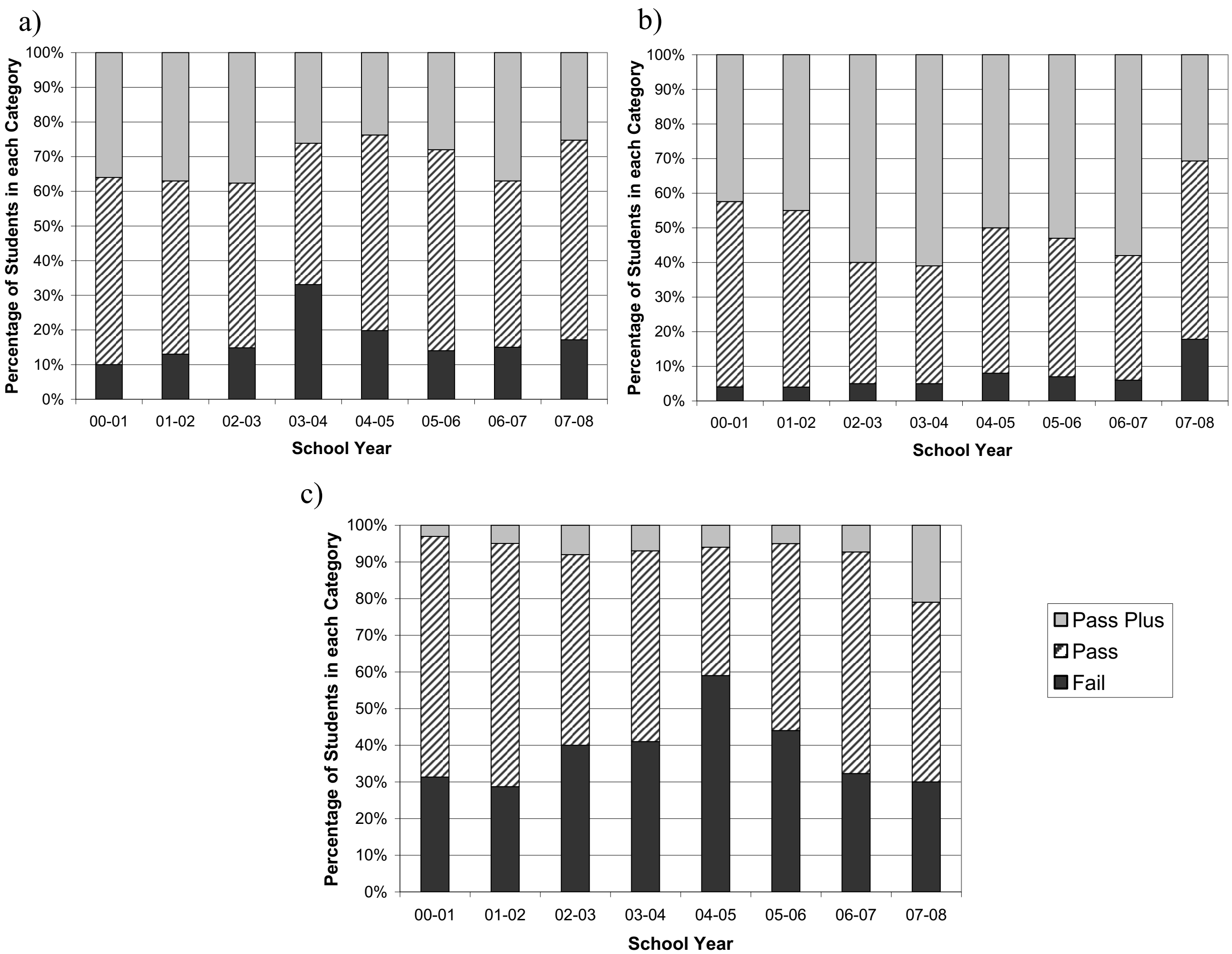

Figure 1. GHSGT Results in a) Mathematics and b) English/Language Arts and c) Science; source: GA Department of Education Report Cards [3]

The primary cause for concern at this school in 2004 was the science portion of the GHSGT. Originally, the science portion was slated to be included for AYP beginning with the 2007-2008 school year [1]. However, this has been postponed and there is currently no firm date for this to occur [6]. This portion of the GHSGT is the one students have most difficulty passing and is often the only hurdle between them and high school diplomas. To address these issues, the school has enacted a variety of changes discussed below.

Course Scheduling

The school is on 4x4 block scheduling. Each semester, a student takes four classes for 90 minutes each day. Each course is a course that would normally take an entire year but has been compressed into one semester, or a half-year course. Over the year, a student will end up taking eight courses. Because a semester-long course presents problems for the Advanced Placement courses, most AP courses are double blocked so that the students are taking the course for the entire year. The school switched to block scheduling in the 2003-2004 school year [1].

Course Progressions in Math

Each student at the school is required to complete four years of mathematics classes. There are several avenues that a student may take to meet these requirements. In 2008, there was an installment of new mathematic courses, labeled as Math 1, 2, 3 and 4. The state of Georgia went through a three-to-four year process of rewriting the curriculum so that educators could teach the topics more in-depth. Mathematics 1 – 4 and Accelerated Mathematics 1 – 3 will be the new math courses for Georgia's public schools. The new curriculum is an integration of Algebra, Geometry and Statistics. According to the *Georgia Department of Education*, one of the primary goals is to make a shift towards applying mathematical concepts and skills in the context of authentic problems and for the students to understand concepts rather than merely follow a sequence of procedures. Under the new system, the goal is to more effectively focus on problem solving, reasoning, representation, connections, and communication. This new system does not affect the number of math classes each student must complete. In this county, all students are still required to complete 4 years of math [3,5].

Some students are now fitting their math course progression to the new course structure, while others choose to continue with the traditional track. The most common general and advanced tracks are listed below [7].

Traditional System

Common General Tracks

Algebra I → Geometry → Algebra II → Algebra III → Pre-Calculus

Common Advanced Tracks

Advanced Geometry → Advanced Algebra II/Trigonometry → Analysis → Calculus, AP Calculus or AP Statistics

New System

Common General Tracks

Mathematics 1 → Mathematics 2 → Mathematics 3 → Mathematics 4

Common Advanced Tracks

Accel.Math 1 → Accel. Math 2 → Accel. Math 3 → Calculus, AP Calculus or AP Statistics

Table 3. Breakdown of new Mathematic Course Progression [3]

Course	**Corresponding Traditional Courses**
Mathematics 1	Algebra/Geometry/Statistics
Mathematics 2	Geometry/Algebra II/Statistics
Mathematics 3	Advanced Algebra/Statistics
Mathematics 4	Pre-Calculus Trigonometry/Statistics
Accelerated Mathematics 1	Geometry/Algebra II/Statistics
Accelerated Mathematics 2	Advanced Algebra/Geometry/Statistics
Accelerated Mathematics 3	Pre-Calculus Trigonometry/Statistics

Course Progressions in Science

Previously, students at the school were required to take only three science courses during their tenure at the school [1]. Due to changes in the curriculum requirements set forth by the Georgia Department of Education, this was increased to four. The first class that fell under the new standards was the graduating class of 2008. Although all students are now required to take four courses, the offerings at the school have not changed. The school offers Biology, Physical Science, Chemistry, Physics and Environmental Science. Many of these courses are also offered at an accelerated or advanced level. Previously, the weaker students would typically take Biology, Physical Science and Environmental Science. Due to the new requirement, these students will also take General Chemistry as their fourth science course. This has increased the need for General Chemistry classes, which is not always met with additional sections of class. Some of these classes have even outgrown the classrooms they meet in.

An advanced student in this school is likely to begin their high school career with Accelerated Biology, followed by Accelerated Chemistry, Accelerated Physics and finally, AP Chemistry, AP Biology or AP Environmental Science. However, students in the General Chemistry or Biology classes can easily be pulled into the advanced track if the teacher feels it is appropriate. The original study that was done investigated the removal of a physics course from the course schedule. One of the most obvious responses to this change is that many advanced students opt to wait until their senior year to take this course. Because of this, the advanced students may not have seen the physics concepts in physical science above a middle school level when they take the GHSGT, since they have yet to take a physics class.

The most important courses to consider when attempting to increase interest in the STEM fields are the AP courses. These courses are designed to be equivalent to the first college semester of the particular subject. The College Board's AP program allows students in these classes to take an exam. With a sufficient score on the AP exam, a student can potentially receive college credit at the college that they eventually attend. In lower performing schools, the AP classes will likely not be equivalent to those at a higher performing school. At this school, performance on the exams is quite low. The students entering the AP courses are often under-prepared and therefore do not have sufficient time to cover the material required to score well on the exam. During the 2006-2007 school year, 247 AP exams were taken in a variety of subjects by 176 students. Out of these exams and students, only eight achieved a score of a 3 or higher. This corresponds to a passing rate of 3.2% on all AP exams. During the 2007-2008 school year, 19 AP Chemistry students took the AP exam with no students passing the test [3]. It is clear from this data that the AP classes at this school are not equivalent to those at higher performing schools. It is likely that these classes primarily serve to prepare the highest achieving students for entry level courses in college or for other post-high school training.

Discussion

Initial School Response and Additional Changes

The initial school response in 2004 was to change the schedule to ensure that juniors were in a science class at the same time that they first took the GHSGT [1]. This was done to ensure that the science knowledge was fresh in the students' minds. Many teachers were reassigned to teach the lower level science courses in order to have enough sections of the junior science courses. In the last few years, this change has been reversed and now many students take their science course in the fall of their junior year. These students have the additional resource of pull-out sessions which are offered in the spring to prepare them for the test.

Additional concerns were raised in the original paper about the effect on higher level courses due to the elimination of the accelerated physics class and possible movement of resources. Because this school cannot appropriately fund both the lower and higher achieving students, it would be easy for these resources to be aimed entirely at the lower achieving population in order to raise the passing rate. This could potentially lead to higher level classes being cut entirely from the schedule. Fortunately this has not happened and these courses are still consistently on the schedule. Although the classes are small, this does not seem to reflect changes in the accelerated physics class either. Several students in the AP Chemistry class, comprising half of the entire class, opted to take the AP course their junior year and accelerated physics their senior year.

Results of Changes

The initial changes made in the science department at this school were not warmly received by teachers and may have proven, at least preliminarily, to be ineffective. Fortunately, the administration then made additional changes that have been significantly more effective. As can be seen in Figure 1, the science scores on the GHSGT have been steadily improving since the initial decrease in the 2003-2004 school year. Not only have more students been able to pass the science test, there has also been an increase in students in the pass-plus category within the last few years. The results that will eventually be used for NCLB are only for first-time test takers. However, the administration and teachers are still making their best efforts to ensure that students who do not pass the first time have additional instruction. Additional pull-out sessions are often coordinated for these students so that they can successfully pass all portions of the GHSGT and receive their high school diploma.

This school has understandably chosen to funnel significant resources into those students in the failing category of the GHSGT. The fear is that this shifting of resources may have negative consequences for the more advanced students. Fortunately, this has not entirely been the case. The school has limited resources but these have been shared among all the science courses [6]. One might argue that an accelerated or AP course would require more resources than the base level courses. Unfortunately, the schools finances are such that this is not currently a possibility. The support that the GK-12 program provides is integral to the higher level courses offered at this school.

The change in mathematics curriculum at this school is significant and should be revisited in later years. As this is the first year of this change, it is difficult to make predictions about the outcomes. It is likely, however, that the implementation of this new curriculum at this school will be significantly different than it would be at a more affluent school.

AP Program vs. Advanced Topic

At many lower achieving schools, there are concerns that the AP program will be neglected. This could easily occur in a school where resources are limited and base level standards must be met. The AP program at this school is no exception and STEP fellows are in a unique position to observe these classrooms as this is where most STEP fellows are placed. The intent is to raise the standard in the classroom and enrich the laboratory and lecture experience by incorporating activities and experiments at the college level. This year is no exception as both of the primary authors work with the teachers of different AP level courses. The discussion of the AP program at this school is therefore based on the experience gained in these classrooms and discussions with several AP teachers.

The issue of equitable education comes into play when considering the Advanced Placement courses in place at high schools. However, the level of the AP courses offered is unlikely to be equivalent for high achieving schools and lower performing schools. This can be easily seen in the low performance on the AP exams (Table 4). What then is the purpose of the AP courses? A student at a high performing school can successfully move from the high school setting to the college setting without performing well on an AP exam or even having taken an AP level course. Unfortunately, many students at lower performing schools will not make the transition successfully without the higher level skills learned in the AP course. Due to the requirements for the GHSGT and End-of-Course Tests, many teachers in the lower-level courses will focus on the lower performing students in order to increase the passing rates for the tests. This shift in focus occurs in many classrooms whether advanced or not and often means that the teachers will spend much more time on the basic skills necessary for the class and never cover all the topics necessary for a student to continue in a higher level math or science course. As students begin their time in the AP classes, the teachers often find that students are not familiar with many topics assumed to be "review" topics. Teachers must then backtrack or spend more time teaching skills and concepts that students should already be comfortable with.

Table 4. AP Exam Scores for the 2006-2007 and 2007-2008 school years in Math and Science [5]

	AP Score	Biology	Chemistry	Environmental Science	Calculus (AB)	Statistics
07-08	1	9	9	22	8	9
	2	0	1	1	0	0
	3	1	0	0	0	0
06-07	1	9	16	6	0	20
	2	1	0	0	0	0
	3	1	0	0	0	0

These teachers must then determine what the goal of the course is. The goal of an AP course is generally to prepare students for the AP exam at the end of the school year. However, in a school where so few students score well on the AP exam, this may not be possible. Should this then continue to be the goal? Many teachers would agree that the more pressing goal is to prepare students for a college setting and to ensure full understanding of the topics covered in the class. It may be very difficult for teachers to accept this new goal when they are often under tremendous pressure from the administration to improve scores on the AP exams. The need to see results in the AP scores is understandable and causes this to continue to be a sticky subject for teachers and administrators alike. In the end, it is difficult for teachers to make this decision for every class and every student.

Summary and Conclusions

In 2004, an at-risk, low-income, urban high school saw a dramatic decrease in scores for the science portion of the GHSGT. The school responded by reallocating resources to focus on the students who scored in the failing category on this test. Courses were rearranged to ensure that all first-time test takers were in a science course during the semester of the test. Additionally, more teachers were moved to teach the base level courses in science. Whether these changes would have been effective in the long term is impossible to determine as the administration of this school made further changes during the next few years. The somewhat drastic initial changes were scaled back and replaced by more individualized pull-out sessions for students. Since the 2004-2005 school year, the school has seen increasing test scores on the science portion of the graduation test. This is a good indication that the efforts currently being made at this school are working.

Another concern was raised in the original paper as to the consequences of canceling a high level physics course [1]. The feared consequences never came to fruition as this change was reversed. Additionally, although students may not have sufficient access to the accelerated physics course, this doesn't seem to affect their enrollment in AP courses. It likely affects how prepared they are for the AP course, but many students are not entirely prepared for the AP course regardless of their previous enrollment in the physics course. While it cannot be stated conclusively, the changes being implemented at this school seem to be having the desired effect of improving science test scores. It remains to be seen how the newly implemented mathematics course progression will affect mathematics test scores in the future.

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Alison Stucky

Alison N. Stucky is a Ph.D. candidate in the school of Chemical & Biomolecular Engineering at the Georgia Institute of Technology. She received her B.S. in Chemical Engineering at Kansas State University, Manhattan. Alison is a STEP Fellow in the Georgia Tech NSF GK-12 program.

Marcus Bellamy

Marcus A. Bellamy is a Ph. D. candidate in the school of Industrial & Systems Engineering at the Georgia Institute of Technology. He received his B.S. in Mechanical Engineering at the University of New Mexico, Albuquerque. Marcus is a STEP Fellow in the Georgia Tech NSF GK-12 program.

Donna Llewellyn

Dr. Donna C. Llewelyn is the Director of the Center for the Enhancement of Teaching and Learning at the Georgia Institute of Technology. She received her doctorate from Cornell University in Operations Research and spent ten years on the faculty in the school of Industrial & Systems Engineering at Georgia Tech. Her primary research interests are now in the educational domain, specifically improving access and equity in STEM disciplines for underrepresented groups. Donna is the PI of the NSF GK-12 grant, STEP.

Marion Usselman

Dr. Marion C. Usselman is a Senior Research Scientist at the Center for Education Integrating Science, Mathematics and Computing (CEISMC) at the Georgia Institute of Technology. Marion received her B.A. in biophysics from the University of California, San Diego, and her Ph.D. in biophysics from Johns Hopkins University. She focuses on K-12 educational reform, university-K-12 partnerships, and equity issues in education. Marion is the co-PI of the NSF GK-12 grant, STEP.