

The Student and Teacher Enhancement Partnership at Georgia Tech:  
Factors Influencing Successful Partnership

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The Student and Teacher Enhancement Partnership at Georgia Tech:  
Factors Influencing Successful Partnership

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## LIST OF ABBREVIATIONS

CETL	The Center for the Enhancement of Teaching and Learning at Georgia Tech
CEISMC	The Center for Education Integrating Science, Math and Computers at Georgia Tech
EOCT	End-of-Course Test
GHS GT	Georgia High School Graduation Test
GK-12	The National Science Foundation's Graduate Teaching Fellows in K-12 Education grant program
GRA (RA)	Graduate Research Assistantship (Research Assistantship)
GTA (TA)	Graduate Teaching Assistantship (Teaching Assistantship)
K-12	Kindergarten through 12 <sup>th</sup> grade public education
NSF	National Science Foundation
STEM	Science, Technology, Engineering and Mathematics

## SUMMARY

The Georgia Institute of Technology (Georgia Tech), one of the nation's leading engineering schools, has limited institutional history of collaboration with surrounding K-12 schools. K-12 outreach is not a part of Georgia Tech's mission, though recent years have seen greater outreach activities. Campus organizations have sponsored tutoring, academic schools have sponsored recruitment fairs and the College of Engineering has established a partnership with a high school. Two offices within Georgia Tech, the Center for the Enhancement of Teaching and Learning (CETL) and the Center for Education Integrating Science, Math and Computers (CEISMC), have been working to expand and deepen Georgia Tech's K-12 outreach through a National Science Foundation grant program combining graduate student development and K-12 outreach. Through this program, the Student and Teacher Enhancement Partnership (STEP), CETL and CEISMC seek to build meaningful and lasting relationships between Georgia Tech and local high schools.

Given the novelty of mutually rewarding relationships between Georgia Tech and local high schools, this study attempts to account for differences in outcomes of the (STEP) program over its first three years. STEP's Project Officers at Georgia Tech developed dyadic relationships with high school personnel with the same programmatic goals in mind. However, at the end of three years, some of these pairings were more mutually rewarding. A narrative analysis of these relationships is presented through case studies and tested against a literature-based logic model depicting factors likely to lead to successful, inter-organizational partnerships.

# CHAPTER 1

## INTRODUCTION

In 2001, the Center for the Enhancement of Teaching and Learning at Georgia Tech received a grant from the Division of Graduate Education at the National Science Foundation that funded a pilot program combining graduate student development and K-12 outreach. This program, the Student and Teacher Enhancement Partnership (STEP), sponsors graduate and advanced undergraduate students at Georgia Tech to serve as teaching Fellows in Atlanta-area high schools. In 2003, the National Science Foundation (NSF) enabled the STEP program to continue for an additional 5 years through Track 2 funding. Through the STEP program, Georgia Tech has a unique opportunity to realize sustainable and mutually beneficial partnerships with local high schools, especially those most separated from the university by culture and history.

Math and science educational partnerships like STEP are a timely research topic. The Department of Education has committed approximately 1 billion dollars to fund its new Math and Science Partnership programs, which operate in diverse contexts across the nation. The demands of the information economy and the sluggish achievement of American students, especially among under-represented groups, make investments in math and science education a democratic as well as an educational priority. However, partnerships as an educational treatment have not been adequately studied, creating the need for robust evaluation methods linking partnering to educational outcomes. This study attempts to contribute to the knowledge base that will help to build evaluative frameworks useful in various math and science educational partnerships.

Georgia Tech is a Research Extensive institution and one of the nation's leading engineering schools. It has neither an organizational history of K-12 collaboration nor an institutional mechanism for consistent K-12 outreach. Georgia Tech does not offer a teacher certification program or require volunteer service of its students; K-12 outreach is not a part of the core mission of the university.

Select campus organizations have sponsored K-12 tutoring, and various academic schools have sponsored high school recruitment fairs and academic competitions. The College of Engineering has established a partnership with a school that is participating in STEP, but this relationship is not a campus-wide effort. Two offices within Georgia Tech, the Center for the Enhancement of Teaching and Learning (CETL) and the Center for Education Integrating Science, Math and Computers (CEISMC), have been working to expand and deepen Georgia Tech's K-12 outreach through STEP and other programs. These centers seek to leverage existing trends to build meaningful and lasting relationships between Georgia Tech and local high schools. CETL and CEISMC are generating strategies on how to continue STEP or a similar program after NSF grant funding ends in 2009.

Given the novelty of mutually rewarding relationships between Georgia Tech and local high schools, this study attempts to account for differences in outcomes of the STEP program over the first three years. STEP's Project Officers at Georgia Tech developed dyadic relationships with the coordinators and key teachers at participating high schools with the same programmatic goals in mind. However, at the end of three years, some of these pairings were more mutually productive and rewarding than others. A narrative analysis of the dyadic relationships between Georgia Tech and each of the participating high schools is presented through case studies. Characteristics of the dyadic relationships that developed between

participants at each school and participants at Georgia Tech are then tested against a literature-based logic model depicting factors likely to lead to successful, inter-organizational partnerships.

**CHAPTER 2**  
**NSF’S GRADUATE TEACHING FELLOWS**  
**IN K-12 EDUCATION PROGRAM**

**2.1 NSF Involvement in K-12 STEM Education**

The National Science Foundation, an executive agency more traditionally associated with higher education and research, views K-12 education as a vital element of STEM workforce development. An ultimate goal of NSF’s efforts in this area is to change the way scientists and professors think about teaching and K-12 education. There is a current trend towards the establishment of offices of K-12 outreach on university campuses around the nation and many states are moving towards a K-14 or K-16 paradigm of public education (NCSL, 2002). The NSF has expressed support of this holistic view of public education as a main component of systemic reform in K-12 STEM education<sup>1</sup>.

In 1991, NSF initiated its Statewide Systemic Initiative program, which granted funds to “local school systems with well-thought out plans for how to reform K-12 science and mathematics education at the state, city, or regional level.”<sup>2</sup> The Systemic Initiative program encouraged cross-sectoral collaboration at the local, state and/or regional levels to achieve educational improvement. The cumulative total of participants and alumni for these programs is relatively small, but the experiences and influences of these individuals may work towards a “tipping point” in K-12 – university relations, and, resultantly, K-12 STEM education reform.

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<sup>1</sup> “A More Synergistic Whole” at [www.nsf.gov](http://www.nsf.gov). 5-20-05.

<sup>2</sup> “A More Synergistic Whole” at [www.nsf.gov](http://www.nsf.gov). 5-20-05.

## 2.2 The Graduate Teaching Fellows in K-12 Education Program

The Graduate Teaching Fellows in K-12 Education (GK-12) program is one of three major fellowship programs administered through NSF's Division of Graduate Education (DGE), which is housed in the Education and Human Resources Directorate (EHR). The GK-12 policy seeks to contribute to the development of STEM university students and to provide their grantee universities with "an opportunity to make a permanent change in their graduate programs by including partnerships with K-12 schools in a manner that is of mutual benefit to their faculties and students (NSF, 2005)." The agency's efforts through GK-12 are directed at influencing the "next generation of faculty to think differently,"<sup>3</sup> i.e., to reflect on ideas such as teaching and communicating effectively.

GK-12 funded programs should feature:

- Opportunities for K-12 students to increase their STEM content knowledge and skills, and to work with STEM professional role models with whom they can relate;
- Strong and enduring partnerships with schools and school systems;
- Opportunities for STEM graduate students and upper division undergraduates<sup>4</sup> to learn new teaching methods within their discipline and to improve their communication skills; and,
- Opportunities for K-12 teachers to serve as mentors to STEM graduates and upper division undergraduates and, in the process, become more knowledgeable about STEM content and concepts and more confident in their skills within STEM (NSF, 2005).

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<sup>3</sup> Personal meeting notes. GK-12 Regional PI Meeting. November 2004.

<sup>4</sup> NSF announced in 2005 that the GK-12 Program would no longer fund undergraduate Fellows.

### 2.3 GK-12's Operational History

The GK-12 program offers Track 1 and Track 2 funding. Track 1 funding lasts for 3 years and Track 2 funding is for 5 years. Grants from either Track are not renewable. Track 2 funding may be granted to an existing GK-12 project for a variety of reasons, including expansion or improvement. GK-12 initiated its first cohort of grants in 1999 for the 1999 – 2000 and 2000 – 2001 school years<sup>5</sup>. The first cohort of grants involved nearly 400 Fellows working in 31 projects across the country. By the 2001 – 2002 school year, there were 56 total GK-12 projects in operation. GK-12 grants range from \$200,000 to \$500,000 and fund Fellow stipends<sup>6</sup>, supplies for use in the classroom, stipends for high school coordinators, and part of the project officers' salaries.

### 2.4 Expected GK-12 Project Outcomes

Expected GK-12 project outcomes include:

- Improved communication and teaching-related skills for Fellows;
- Incorporation of GK-12 like activities as an integral part of the institution's graduate programs in STEM;
- Content gain and professional development opportunities for GK-12 Teachers;
- Enriched learning by K-12 students;
- *Strengthened partnerships between higher education institutions and local school districts; and,*

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<sup>5</sup> History of GK-12 cohorts taken from Mitchell (2003).

<sup>6</sup> Undergraduate Fellows receive lower compensation - GK-12 Fellowships are notably higher than most other forms of funding available to university students.

- *Documentation of project outcomes to provide a research base to inform development of GK-12 like activities and partnerships.*<sup>7</sup>

GK-12 Fellowships are intended to benefit the Fellow through improvement of skills useful in any academic or employment setting – planning, communication, teaching and team building. Participating teachers may experience growth in content knowledge and exposure to high quality professional development opportunities, such as authentic research experiences. K-12 students involved in a GK-12 program are supposed to benefit from enriched learning through the enhancement of their teachers and the promotion of inquiry-based pedagogy. The institution of higher education (IHE) may benefit from the well-rounded development of the Fellows, who can use their skills to advance the nation’s scientific enterprise in the university environment or in industry<sup>8</sup>.

## **2.5 Building Bridges Between K-12s and IHEs**

Dorothy Stout, an NSF officer who assisted in the development of the GK-12 program, indicated that the GK-12 Fellows are intended to act as “bridges between the research and education communities by serving as resources for their local school districts.”<sup>9</sup> Though some Fellows may be personally inspired to pursue a career in K-12 teaching as a result of their Fellowship, the budding scientists and engineers who serve as Fellows are more likely to impact K-12 STEM education through less direct means, such as exposure to authentic research experiences for students and teachers. After their Fellowship, the GK-12 alumni can continue to

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<sup>7</sup> Emphasis of partnership elements added.

<sup>8</sup> Though not a goal of the GK-12 program, an individual Fellow may pursue a K-12 teaching career either because of pre-existing interest or because of the Fellowship experience.

<sup>9</sup> www.nsf.gov “A Revolution in University Culture”

act as bridges between the higher education and the K-12 community by continued interest and outreach from their professional positions in industry or academia. Alumni can then spread the idea to colleagues and dedicate their professional resources without the aid of the GK-12 program.

## **2.6 A Unique Resource for the IHE**

K-12 schools offer the IHE a unique resource. The young ages and the varying backgrounds of the students in the K-12 environment provide a context for the development of teaching, communicating and leadership skills that the university environment cannot offer. In the K-12 environment, Fellows can encounter students and sometimes teachers who may not readily understand STEM content information, even after presentation of the material. This scenario encourages creative and self-critical<sup>10</sup> efforts to convey facts, concepts and ideas. In addition, the often-challenging life conditions of the K-12 students present situations in which the Fellow cannot solve a problem just by knowing information. As in the modern workplace, their success at the school requires not just intelligence, but also planning, team building, motivation and creative problem solving.

## **2.7 Mutual Renewal for K-12 Schools and IHEs**

As opposed to more traditional school-university collaborations, the GK-12 program offers renewal for the IHE as well as the K-12 environment<sup>11</sup>. Simultaneous renewal for both environments seemed to be a mutually beneficial feedback loop that can benefit the scientific and technical human capital of the nation. Professors of freshman and sophomore core STEM courses can encourage or discourage future scientists and engineers at a critical point in the

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<sup>10</sup> Self-critical as in monitoring one's effectiveness with the audience.

<sup>11</sup> "A Revolution in University Culture" at [www.nsf.gov](http://www.nsf.gov). 5-19-05.

pipeline. Lower attrition rates from these courses may be achieved through more inclusive teaching methods and educational practices. Both K-12 schools and universities can be enriched through their sustained interactions. K-12 STEM education can be enhanced through exposure to university faculty and resources. The Fellows and universities can be enhanced through the crucial communication opportunities that can be experienced daily in the K-12 schools and the increased attention to effective teaching as part of campus practice that can follow.

## **2.8 Support for the Idea of K-12/IHE Partnership**

The idea of K-12/IHE partnership was championed by Dr. Judith Ramaley, Assistant Director of NSF's Education and Human Resources Directorate (EHR). Under her leadership, the EHR Directorate administers programs intended to enhance STEM achievement throughout K-12 schools and institutions of higher education through research-based interventions and innovation.<sup>12</sup> Dr. Ramaley had advocated pre-K – 20 collaboration in her former position as president of the University of Vermont. As a Director of the Vermont Business Roundtable, among other affiliations, she had professional exposure to multiple sectors that could contribute to K-12 education.<sup>13</sup> Dr. Ramaley considered K-12/IHE collaborations “an investment in the talent pool” of future STEM professionals.<sup>14</sup> In her testimony before the U.S. House of Representatives Committee on Science, Dr. Ramaley expressed that institutions external to K-12 school systems have a real interest in quality STEM education throughout the educational continuum. She stated:

*Alliances that engage broad and diverse sectors of society in promoting student interest and improving achievement in science, technology, engineering and mathematics can contribute*

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<sup>12</sup> *ibid.*

<sup>13</sup> Brief bio of Dr. Judith Ramaley from [www.solent.ac.uk/rtconference](http://www.solent.ac.uk/rtconference)

<sup>14</sup> [www.nsf.gov/od/lpa/news/03/pr03112.htm](http://www.nsf.gov/od/lpa/news/03/pr03112.htm)

*significantly to preparing citizens to fully participate in our democracy, and are very important to our Nation's progress and growth*<sup>15</sup>.

NSF Director Rita Colwell also expressed an interest in connecting higher education with K-12 STEM education. She commented, “[w]e cannot expect the task of science and math education to be the responsibility solely of K-12 teachers while scientists, engineers, and graduate students remain busy in their universities and laboratories.”<sup>16</sup>

Through encouraging collaboration, the NSF appears to be binding K-12 schools and IHEs through proposing common goals and suggesting mutually beneficial exchanges. These are characteristics of successful partnerships, yet these parties do not have a consistent history of successful partnering. IHEs could bring the authentic practice of advanced science and mathematics to K-12 classrooms. K-12 classrooms can provide meaningful contexts for personal and professional growth that the university sometimes does not offer. NSF policies have acknowledged that the movement of talented individuals through the pipeline starts with entrance into formal education – elementary or pre-elementary school. The success of university students is built upon the foundation of quality educational experiences in high school, and success in high school is built upon strong elementary preparation.

The program solicitation for GK-12 indicates NSF’s long-range goal of incorporation of GK-12 like activities as an integral part of STEM graduate programs at IHEs. The NSF also hopes that GK-12 programs will serve as a tool for strengthening partnerships with local schools. The NSF expects to benefit by using the pool of data collected from GK-12 projects to inform future programs.

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<sup>15</sup> Testimony Before the U.S. House of representatives Committee on Science Subcommittee on Basic Research. March 30, 2004 at [www.nsf.gov/about/congress/108/jar\\_congmedal33004.jsp](http://www.nsf.gov/about/congress/108/jar_congmedal33004.jsp). 5-20-05.

<sup>16</sup> [www.nsf.gov](http://www.nsf.gov) “A Revolution in University Culture”

The GK-12 objective for perpetuation of a STEM educational partnership is somewhat visionary considering typical baseline relationships between institutions of higher education and K-12 schools. Colleges and universities do not typically feature consistent K-12 interaction as an integral part of their STEM graduate programs, although different IHE groups, such as schools of education or student organizations, may participate in K-12 tutoring or special high school recruitment events.

The next chapter introduces Georgia Tech's GK-12 grant program, the Student and Teacher Enhancement partnership (STEP). Through the STEP program, graduate and advanced undergraduate students have served as teaching Fellows at ten Atlanta-area high schools over the past four years. The following chapters of this paper are devoted to an analysis of this program.

Georgia Tech's STEP program, which is funded by the NSF through the GK-12 program, is unrelated to NSF's STEP program.

## CHAPTER 3

### THE STUDENT AND TEACHER ENHANCEMENT PARTNERSHIP

#### 3.1 STEP Program Goals

Georgia Tech's GK-12 program, the Student and Teacher Enhancement Partnership (STEP) has focused on two overarching goals: "to improve the teaching-related communication and leadership skills of participating Georgia Tech students" and "to use the exceptional scholarly expertise available at the Georgia Institute of Technology to assist the local, metro-Atlanta area school systems in increasing the mathematics, science, and engineering performance of Atlanta-area high school students (CETL, 2005)<sup>17</sup>."

To accomplish these goals, the Project Officers intended to build "constructive mentoring relationships" (CETL, 2004) between participating high schools and Georgia Tech. The STEP program does not promote a particular implementation model, special program or curriculum. The STEP Fellows themselves are intended to be dynamic and responsive "resources" for the high schools, and their impact on the high school is enhanced by the knowledge base and experiences available on the Georgia Tech campus.

STEP was implemented at each school site in an open-ended, bottom-up manner. This is a positive characteristic of STEP designed to serve the unique needs of each school. In the big picture, STEP Fellows were only present in a relatively small number of classrooms for relatively limited periods. Students often benefit indirectly through a program's impact on the

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<sup>17</sup> STEP Page on CETL website at <http://www.cetl.gatech.edu/services/step/overview.htm>. 7-17-05.

teachers and school. Nonetheless, the goal of improvement in teaching skills was left to the Fellows and Cooperating Teachers to manage and assess in their own ways.

The STEP program was built upon the idea of mutual benefit to Georgia Tech and the participating high schools. The STEP program allows Georgia Tech students who serve as Fellows to develop teaching, coping and team-building skills while enhancing the STEM knowledge and skills of students and teachers at participating schools. Furthermore, many students who attend high school close to Georgia Tech's campus may never think that it is a possibility to attend Georgia Tech or any college at all. Georgia Tech has an additional special interest in reaching out to these students.

### **3.2 STEP Program Objectives**

According to the CETL<sup>18</sup> website (2005), there are seven specific objectives of the STEP program:

- To provide Fellows with the training required to enable them to effectively communicate standards-based science and mathematics to both high school students and teachers from varying backgrounds
- To pair Fellows with master teachers in participating schools such that they can experience effective teaching methods and real-life teaching challenges
- To provide Fellows with rewarding practicum experiences during which they can practice science and mathematics pedagogy and classroom management strategies by engaging in direct inquiry-based science content instruction during regular classes and in extracurricular activities

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<sup>18</sup> [www.cetl.gatech.edu](http://www.cetl.gatech.edu)

- To facilitate knowledge transfer from Georgia Tech to the participating school systems by enabling Fellows to work directly with high school STEM teachers to enhance teachers' content knowledge through professional development activities
- To facilitate the development of constructive mentoring relationships between Fellows and K-12 students and between teachers and university students and faculty, encouraged through actual and virtual field trips, class visits, tutoring and mentoring and electronic communication
- To support the unique partnership between Georgia Tech's College of Engineering and the Rockdale County School System in the development of a model School for Science and Technology. Curriculum units and laboratory exercises developed for the engineering and information technology-based curriculum will be disseminated to all other participating school systems.

### **3.3 STEP Program Anticipated Benefits**

Benefits are anticipated for a broad range of potential STEP program participants, including teachers, students and the school itself on the K-12 side, and faculty and students on the IHE side. Teachers who host a Fellow in their classroom can benefit not only through growth in knowledge and skills, but also through growth in motivation and professional esteem. Through the STEP program, teachers also have the opportunity to participate in rewarding professional development on Georgia Tech's campus, such as the Georgia Industrial Fellowships for Teachers (GIFT), and to form collegial relationships with practicing scientists on faculty. The math and science departments at the schools receive resources through the supply budgets granted to the STEP Program Coordinator and the Fellows.

Fellows can more deeply master content knowledge by teaching it to others and can glean classroom management skills from master teachers. They may even expand their own content knowledge through being placed in a classroom that is outside their area of expertise. Being exposed to the wide range of students and life scenarios at the high schools helps the Fellows to be more sensitive to different kinds of learners and the challenges and shortcomings incoming college freshman bring with them.

### **3.4 Operational Overview**

#### Decision to Focus on Grades 9 Through 12

The Project Officers chose high schools as the target population of the STEP program because many other current programs in Atlanta focused on younger students, leaving a need at this level. In addition, high schools have a natural link to colleges in the form of applicants and enrollees. Though more advantaged high schools tend to send more of their graduates to Georgia Tech, opportunities abound for more applicants from more diverse backgrounds. Finally, high school students, who are close in age and ability level to undergraduates, provide realistic teaching experiences for Fellows on track to become professors.

#### The Fellows: Selection and Characteristics

According to the Project Officers, the STEP program is not only growing, but also becoming more of a normal part of campus life at Georgia Tech. Within STEP's first three years, the number of applications more than doubled and more students and faculty became familiar with the program. Over this time, applicants have been diverse in race and gender. The Project Officers form teams of at least two Fellows to serve at each school. In teams, the Fellows can

support each other and pool resources as needed. The Project Officers have tried to balance Fellow teams by characteristics such as gender and maturity, and they have been sensitive to instances in which minority Fellows wanted to serve the minority community. They also take into account practical considerations such as commuting times.

The Project Officers interview applicants and choose finalists based on three criteria: passion for helping others, capacity to grow from the STEP Fellowship, and teamwork ability. Depending on an applicant's prior sources of funding, such as Teaching or Research Assistantships or Fellowships, the STEP stipend may have represented higher pay than other forms of student employment or financial support. The Project Officers were careful to select Fellows whose interest in the program did not start or stop with the stipend. The majority of applicants had engaged in some form of prior K-12 outreach such as volunteer tutoring through the Black Graduate Student Association or through church-based programs. Some had been Teaching Assistants during their academic careers at Georgia Tech, and almost all of the graduate students had research experience.

They must submit application materials to the Project Officers that includes personal motivations and their advisor's recommendation. Though no specific GPA is required, the applicant must be in good standing at Georgia Tech, a rigorous school, and must have the approval of the advisor, who has a good idea of what the student can manage without damaging his or her academic career.

In the spring, Fellows begin to think about the upcoming year at their assigned high school. STEP Fellows serve for one year only<sup>19</sup>. The Project Officers sponsor a kick-off celebration to display STEP accomplishments and bring together old and new Fellows and a

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<sup>19</sup> GK-12 programs may set the length of the Fellowship. Some GK-12 Fellows are selected for the duration of the grant.

wide range of high school and university participants. During the summer, the CETL and CEISMC Project Officers provide comprehensive training over ten weeks consisting of sessions on teaching methods and a reorientation to the high school environment. During this time, Fellows write action plans for their involvement at the school through collaborative brainstorming and planning with cooperating high school teachers and other Fellows<sup>20</sup>.

Some Cooperating Teachers and School Coordinators were present at Georgia Tech over the summer for professional development and provide lesson demonstrations and orientation sessions during summer training. Fellows are to make contact with teachers during the summer to formalize their roles at the high school. The Project Officers monitored this process and provided support to Fellows, Teachers and Coordinators as needed.

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<sup>20</sup> The Action Plan document was of greater importance in Years 1 and 2 than in Year 3. Over time, the Action Plan has become less important as a document as parties have become more familiar with each other's needs and expectations. However, the process of writing the Action Plan still helps Fellows to focus their thinking and planning for the upcoming school year.

## CHAPTER 4

### HISTORY, THEORY AND PRIOR STUDIES

#### 4.1 History of K-12/IHE Partnering

Clark (1998) reports that the first recorded instance of K-12/IHE partnering dates back to the 1892 Harvard Committee of Ten. This arrangement was based on the idea that the expertise of the IHE in each subject should improve the rigor of instruction in secondary schools. Better preparation of college education majors to serve in the classroom was also an intended benefit of K-12/IHE interaction. This historical arrangement led to the development of the College Board exams. In the 1920's, the College Board's SATs became a standard part of the college admissions process, encouraging the sentiment that colleges are superior to K-12 schools. This tension remains an issue for K-12/IHE collaboration today (Waddle & Conway, 2005). Despite this history, Clark (1998) also notes instances of successful K-12/IHE collaboration dating from the 1950's, especially in response to the Sputnik crisis.

In 1983, the publication of "A Nation at Risk" created a sense of "urgency" among policymakers, politicians, and the public that "set the stage for sweeping reform and the call for additional resources (Druckman et al, 2002:11)."<sup>21</sup> This need for new methods and supplies caused K-12 school systems to look for help from qualified external groups to accomplish reform and improvement. Partnerships with community colleges, colleges and universities, businesses and non-profit organizations followed suit. These external groups offered the kind of human resources, tangible supplies and experiences that schools considered necessary for improvement.

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<sup>21</sup> This report helped to usher in a period in which policymakers, politicians and the public paid increased attention to education. Thus, more people from multiple sectors were paying attention to the issue of education.

Over time, decision-makers at some IHEs began to view K-12 outreach as a service obligation to the surrounding community. Beyond that, some saw that interaction with a K-12 school or system offered actual and potential returns to the university in various forms.<sup>22</sup> The growth of regional consortia has also promoted K-12/IHE partnership.<sup>23</sup>

#### **4.2 Inter-Organizational Theory**

An interesting aspect of this study is that there is not a standard theory on math and science partnerships. Partnerships in general can be hard to define and evaluate. Therefore, this study relies upon essential writings in the field of inter-organizational theory for a meaningful conceptual framework and useful terminology.

K-12 schools currently and in the past have had many different types of relationships with external groups, including IHEs. A common and current example is a “Partners in Education” or similarly named program, wherein a local businesses is paired with a K-12 school to provide volunteer service hours, in-kind donations or cash support. This kind of partnership is not the intention of Georgia Tech’s STEP program or its sponsoring GK-12 program. Therefore, at this point in the paper, the term “partnership” will receive special attention. The program under study, the Student and Teacher Enhancement Partnership, employs the term “partnership” in its name. However, without a widely accepted, exact definition of partnership, it is necessary to both define and distinguish between different forms of inter-organizational relationships that could be called partnerships in common discourse. The Ohio Center for Action on Coalitions provides a useful litany of terms for this task:<sup>24</sup>

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<sup>22</sup> Ibid.

<sup>23</sup> Ibid.

<sup>24</sup> Copied from the Ohio Center for Action on Coalitions Fact Sheet at <http://ohioline.osu.edu/bc-fact/0001.html>. 7-17-05. Emphases added to distinguish among terms.

- *An alliance* refers to individuals or organizations working together through common effort, with a common purpose, to use resources more effectively and/or efficiently. This term is interchangeable with the term coalition.
- *Collaboration* refers to the process of individuals or organizations sharing resources and responsibilities jointly to plan, implement and evaluate programs to achieve common goals.
- *Cooperation* refers to individuals or organizations *associating* to accomplish a common goal.
- *Coordination* refers to individuals or organizations *working together* to accomplish a common goal.
- *A Network* refers to individuals or organizations who share information, ideas, resources or goals to accomplish individual or group goals.
- *A Partnership* refers to individuals or organizations *working together in a side-by-side effort* to accomplish a *common goal* with a *shared sense of purpose* and *shared responsibility* for the outcomes.

Goodlad defined a school-university partnership as “a planned effort to establish a formal, mutually beneficial inter-institutional relationship characterized by sufficient commitment to the effective fulfillment of overlapping functions to warrant the inevitable loss of some present control and authority (1998:16)” Partnering with an external party poses a certain amount of uncertainty and risk for the other party. As noted in a study by the Eisenhower Regional Consortia, “[m]ost institutions are slow to relinquish any degree of autonomy, to commit significant resources to an entity beyond their direct control, or to change entrenched policies and procedures (2004:19).” The risk and uncertainty can cause some organizations to keep the collaborative interaction at its periphery, as an add-on and/or temporary program.

The Eisenhower study proposed that suggesting the idea of partnering through creating relationships between members of the K-12 community and members of the IHE community was the most effective way to invite parties to partner. The GK-12 policy and STEP program take this approach. STEP is a program that implements relationships between members of the K-12 and IHE communities. Relationships among Georgia Tech students, faculty and staff and the administration, teachers and students at participating high schools are the basis of the intended

partnership. How members from the two different camps interact with each other shapes the institutional-level partnership. Interestingly, how members *within each camp* interact with each other also shapes the institutional-level partnership (Firestone, 2002).

Essex (2001), recognizing that “there are multiple forms of school-college partnerships emerging across the country with varying degrees of success,” presented a list of minimum requirements for effective school-university partnership:

- The partnership has a clearly defined purpose and direction
- Top-level leaders in schools and colleges support the partnership
- The partners trust each other
- The partners have open communication
- The partners mutually respect each other
- There are mechanisms to assess progress and measure outcomes

Since educational partnerships have not been exhaustively studied from the vantage point of relationships between institutions<sup>25</sup>, literature on inter-organizational relationships from other sectors contributes to the conceptual basis of this study. Gulati and Gargiulo (1999) studied the development of inter-organizational alliances and their growth into networks among international businesses. Alliances are important because they can lead to membership in a stable network of relationships that ultimately affect an organization’s ability to obtain information and resources. Organizations can take “cues” (1440) from the experiences of others engaged in an alliance and form ideas about prospective partners. Important social learning surrounds inter-organizational alliances; how an organization such as a school or university functions now and in the future can be influenced by learning from others that have participated in alliances.

Gulati & Gargiulo (1999) identified factors that increase the probability of the formation of a new alliance. These include interdependence, prior mutual alliances and common third

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<sup>25</sup> Though the individual perspectives of Firestone and the Eisenhower study are valuable, K-12 schools and IHEs also behave as institutions. For example, K-12 schools have often formed external relationships for reasons traditionally attributed to firms, e.g., to obtain resources to stay “competitive” in a challenging environment.

parties. Organizations typically enter alliances because they are already interdependent<sup>26</sup>. Instead of expending energy trying to determine with whom to ally, “organizations tend to create stable, preferential relationships characterized by trust and rich exchange of information with specific partners.” “Over time, these ‘embedded’ relationships accumulate into a network that becomes a growing repository of information on the availability, competencies, and reliability of prospective partners.”<sup>27</sup>

Kingsley and O'Neil (2002:2) adapted Gulati & Gargiulo's thinking about alliances to create a working definition of STEM educational partnerships: “voluntary arrangements between organizations from different sectors, anchored by agreements, to promote the exchange, sharing, or co-development of products or programs *designed to stimulate STEM education.*” This study adapts that definition to read “voluntary arrangements between Georgia Tech and local schools, anchored by the STEP program, to promote the exchange, sharing, or co-development of products or programs designed to stimulate STEM education at these schools and the university.”

### **4.3 Type of Partnership Encouraged by GK-12**

GK-12 grants fund intergovernmental partnerships that draw together three independent sectors: the National Science Foundation, an executive agency; K-12 school systems; and public and private institutions of higher education. This trio does not have a long history of productive collaboration. Specific GK-12 projects may be public-private partnerships when the participating IHE is private, such as Emory University in Atlanta. However, even when all parties are

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<sup>26</sup> Interdependent means each party needs the other to make the final product, so to speak. School personnel may or may not feel that they need input from the IHE to provide quality STEM education. County level decision-making concerning participation in a GK-12 program does not necessarily indicate recognition of interdependence if county school systems were not reaching out to IHEs before the introduction of the GK-12 grant.

<sup>27</sup> p. 1440

technically “public,” they are from different sectors and dissimilar in organizational identities, rules and cultures (Goodlad, 1998). Partnering parties from different sectors stand to face higher transaction costs due to their different working styles, language and accountability structures.

One of GK-12’s expected outcomes is “strengthened<sup>28</sup> partnerships between higher education institutions and local school districts (NSF, 2005).” NSF wants these partnerships to involve “permanent change in [the IHE’s] graduate programs” to include K-12 outreach in a manner that is of “mutual benefit” to K-12s and IHEs (NSF, 2005).” Ongoing inter-organizational relationships that focus on a shared mission and bring mutual benefit to both parties are a partnership according to the taxonomy used in this study<sup>29</sup>. In order to achieve this type of relationship, parties who are only marginally committed to such collaboration will have to undergo “fundamental transformation” in their “core missions (Kingsley & O’Neil, 2002:6)<sup>30</sup>.”

#### **4.4 Evaluations of Other GK-12 Programs**

Mitchell et al (2003) performed case study analysis of 12 purposively selected GK-12 projects. The GK-12 programs in her study varied in their implementation models; some featured “classroom immersion” of the Fellows and some featured “exposition” of lessons or demonstrations by the Fellows across many classroom settings. Mitchell found that the programs in her study shared the achievement of some outcomes in line with GK-12 program goals:

- High content knowledge gain for teachers

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<sup>28</sup> Though NSF uses the term “strengthened,” some partners in GK-12 grant programs are working together for the first time. NSF does not require that parties to a GK-12 grant be previously embedded.

<sup>29</sup> The only dimension in which the description of a GK-12 grant does not meet the definition of partnership is in mutual accountability. Accountability structures are understandably different between K-12s and IHEs. This feature is addressed in the conclusion.

<sup>30</sup> It is important to note that the fundamental change is in the organizational mission, not the identity, of each partner. Ideally, GK-12 programs would lead to consistent, meaningful collaboration between high school and college, not a blurring of the lines between the two institutions.

- Fellows serving as positive role models for students
- Improved school – university relationships
- Improved communication and instructional skills of Fellows

Mitchell also found that it was common for teachers and Fellows to experience some confusion over their programmatic roles and for Fellows to report dissatisfaction with summer training. Confusion over the role of the Fellow led to over or under use of the Fellow by the teacher. In some instances, a Fellow may have spent far too much time in the classroom only passively observing. In an example of the opposite extreme, a Fellow was left alone to teach the class. Both of these scenarios are inconsistent with the role of the Fellow outlined by GK-12, and time and energy were lost on defining or clarifying roles in these scenarios. GK-12 programs prepare Fellows to function effectively in a K-12 environment by giving them summer training in pedagogies, learning styles, and important legal and social issues in the modern school environment. Many Fellows, upon serving in the school, felt that the summer training was not sufficient preparation.

Mitchell's study also touched upon the partnering element of GK-12 projects, but did not formally assess process or performance outcomes as this study does. However, data from Mitchell's study can be interpreted in terms of these outcomes. The majority of GK-12 participants in her study were building upon pre-existing educational collaborations between university and school, i.e., there were baseline relationships featuring positive or neutral embeddedness.

Mitchell concluded:

*cross-organizational collaborations are usually intended to strengthen ties between organizations. However, organizations do not collaborate. Individuals within these organizations work together towards common goals and objectives. The process of working together (particularly when goals are attained) is often adequate to bring about*

*mutual understanding and create trust. This, in turn, will create new relationships, strengthen existing relationships and thereby serve as the basis of future partnerships.*

Thompson (2003) analyzed data from a GK-12 grant program to assess for increases in the classroom teacher's understanding of the "nature of science" and inquiry. Comfort and competency with scientific inquiry is a major goal of science education reform because it brings the population closer to science. GK-12 is uniquely able to introduce elements of scientific inquiry to the K-12 school system that are not naturally occurring. Thus, the IHE has a needed element for K-12 STEM education reform; the school has to reach beyond itself to get what it needs. According to Thompson, GK-12's contribution to STEM education reform is in "recognizing the classroom teacher as the main vehicle through which images of the nature of science and scientific inquiry are portrayed for students." The Fellows, being acculturated to the actual practice of science and mathematics in the university (and, in some cases, industry) environment, expose the K-12 teachers and students to habits of mind that typical math and science curricula do not encourage or, in some cases, allow. These include reaching divergent answers or conclusions, having an experiment fail, having to repeat an experiment and improvising with comprehension of the implications of your alterations. Beyond following a teacher's guide or lab instructions, a teacher's beliefs and comforts affect these behaviors. The Fellows' presence in the classroom "reduce[s] the gap between science teachers, science educators, and educational researchers who are struggling to articulate, capture, and demonstrate inquiry-based teaching practices." The greatest benefit of GK-12 to K-12 schools, according to Thompson, is in "sustained collaborations" with the IHE that emphasize hands-on, inquiry based learning. Stamp and O'Brien (2005) also consider GK-12 collaborations to be a model to reform science education.

#### **4.5 Evaluation of a non-GK-12 Funded K-12/IHE Collaboration**

Burns (2002), reporting on a long-standing non-GK-12 partnership between a medical school and a local school district, listed how an IHE could benefit a K-12 school:

- Field trips and open houses
- Adopting a school
- Teacher training mini-courses over the summer
- Giving teachers course credit towards a degree or certification for professional development at the university
- Providing customized, special talks on science/health topics as requested by the school, in person or by videotape

Burns concluded that targeting the teacher is the best method by which an IHE can improve K-12 education. “One retrained, better equipped, motivated teacher will directly impact thousands of students during a teaching career.”<sup>31</sup> However, partnership features and benefits of collaboration to the IHE were not discussed in his study.

#### **4.6 Discussion**

This chapter reviewed two GK-12- funded and one non-GK-12-funded K-12/IHE collaborative programs. The diversity of projects demonstrates different ways in which K-12s and IHEs can benefit each other through collaboration. The conclusion is that one specific type of activity is not what determines successful K-12/IHE collaboration. This conclusion strengthens the reliance on factors such as embeddedness and interdependence taken from the inter-organizational literature. In the following chapter, variables from the inter-organizational literature are presented in a stage model predicting successful partnership.

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<sup>31</sup> Burns (2002:11)

## CHAPTER 5

### RESEARCH DESIGN AND METHODOLOGY

#### 5.1 Research Questions

Through the first three years of the STEP program<sup>32</sup>, dyadic relationships were built between Georgia Tech and the participating high schools. Different narratives describe these relationships; some dyads grew closer, some floundered or stagnated and some completely ended. Each dyad developed within the same regulatory and operational environment of the STEP program. The participating high schools are drawn from four county school systems, but the different outcomes do not appear to be grouped by county. Could factors affecting the formation and operation of inter-organizational relationships explain these different outcomes?<sup>33</sup>

#### 5.2 Hypothesis

Georgia Tech – high school dyads featuring higher degrees of embeddedness and alignment of strategic needs will experience more productive partnership formation and operations, leading to better achievement of process and performance outcomes.

#### 5.3 Rival Hypotheses

*Rival Hypothesis 1:* The degree of partnership in a Georgia Tech – high school dyad is a function of the program being championed by a particular individual, such as a highly influential Fellow or high school Coordinator. An influential Fellow can engender teacher buy-in that may

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<sup>32</sup> The STEP program will continue until 2009 (through Track 2 funding) under the name “STEP Up!”.

<sup>33</sup> One outcome of partnership is institutionalization, or perpetuation of the program independent of grant funding. Since STEP grant funding will not end until 2009, this outcome cannot yet be assessed.

not be replicated once that Fellow has left the school. An influential Coordinator may also direct teacher buy-in if serving in a leadership capacity, such as department head. If the champion should no longer serve in a leadership capacity, then level of buy-in may not be sustained.

*Rival Hypothesis 2:* The degree of partnership in a Georgia Tech – high school dyad is a function of the Fellow’s previous exposure to K-12 environments. Fellows with prior K-12 training and experience are more likely to have realistic expectations and do not face as steep of a learning curve as Fellows without prior exposure. Previous K-12 experience reduces the transaction costs associated with collaboration; their experience enables them to direct more energy towards meaningful lessons and experiences versus learning the basics of a high school classroom.

## **5.4 Methodology**

This research project employs a case study approach. Given the small number of cases, analytic, not statistical, generalization is offered. Case studies are a preferred methodology when the context of observed events is of utmost importance. The significance of this study’s conclusions is in the form of contributions to the theoretical understanding of the operations, successes, and shortcomings of STEM educational partnerships in American public high schools.

Case studies are ideal for researching “why” questions concerning contemporary events over which the researcher has no control; this study explores “why” programmatic relationships evolved in particular ways. Within the typology of case studies, this project is an “explanatory” case study, in that it seeks to “explain the presumed causal links in real life interventions that are too complex for survey or experimental strategies (Yin, 2003:15).”

Quantitative statistical analysis would not have been appropriate for this study. The number of participants in each STEP programmatic role varied sharply. The maximum number of STEP Fellows in any given year was 22, with Fellow assignments at each high school varying from two to four; the maximum number of high school coordinators was seven; the maximum number of teachers at each high school varied from 1 to 11; the maximum number of STEP Project Officers was two.

There is also a “dosage effect” at work, meaning that direct measures of program impact should not extend beyond the operations of the program itself. The STEP program has engaged a small fraction of K-12 schools in Atlanta, a small sample of students, faculty, and staff from Georgia Tech, and a small to moderate number of eligible teachers from each participating school. Over the initial three years of the STEP program, approximately 60 STEP Fellows and 30 high school teachers have participated in the STEP program.

### *Multiple Case Design*

STEP operated at ten high schools in the Atlanta area and developed steady relationships with six schools over three years. For this study, each Georgia Tech - high school dyad is treated as a single case with embedded elements. The high school and the university are social institutions comprised of people playing different roles and working in different subgroups or departments. Figure 1 depicts the embedded elements of the K-12 school teachers (who often function in concert as an academic department), students (not included in this study because of their minor status) and administration (who make strategic decisions for the school).

Figure 2 depicts the elements on the IHE side of the partnership – the strategic decision-makers at the university, such as the Office of the President, the offices which administer the

STEP program (CETL and CEISMC) and other collegial groups important to the operation of the STEP program (e.g., the Black Graduate Student Association). According to Firestone (2002), “the relationship between the school and the university is too simplistic to capture Future studies may therefore want to take into account the relationships between these subgroups at each institution. For a study focusing on STEP’s first three years only, a comparison of the ten school cases is appropriate.

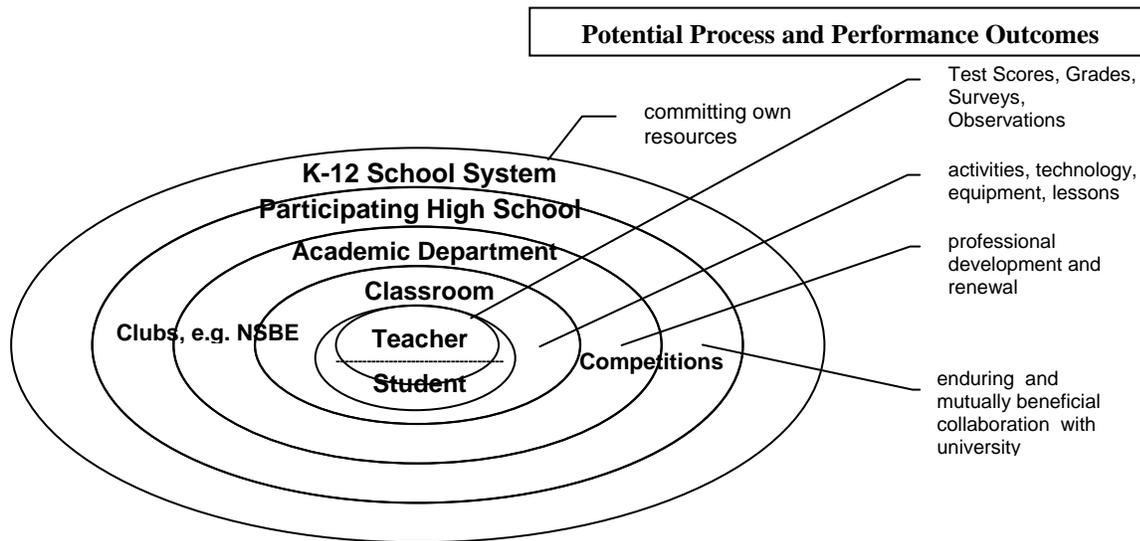


Figure 1: K-12 Embedded Elements of Analysis and Relevant Outcomes

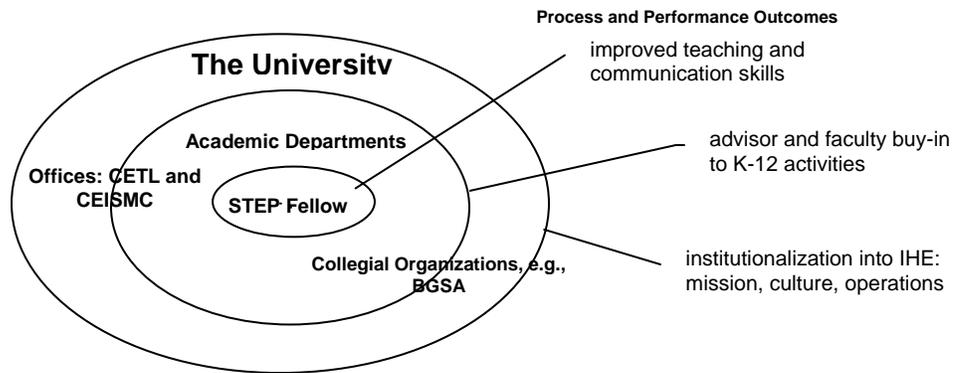


Figure 2: IHE Embedded Elements of Analysis and Relevant Outcomes

#### 5.4.1 Evaluation of Research Design

Four elements determine the quality of a case study: construct validity, internal validity, external validity and reliability (Yin, 2003). Table 1 presents the research design tests applied to this study. Construct validity is achieved by defining appropriate variables for the concepts being studied. Construct validity was tested for by mapping the nodes to the concepts of partnership used in this study. Internal validity is achieved by accurately identifying cause and effect in a scenario under study. Internal validity is dealt with in this study by addressing two rival hypotheses.

External validity refers to the ability to generalize results to other cases. “If two or more cases are shown to support the same theory, replication may be claimed (Yin, p. 33, 2003).” Ideally, the analysis of data from two or more of the high schools will confirm the theory of partnership at the core of this study. This study aims for “theoretical replication” (Yin, p.47, 2003), which “predicts contrasting results for predictable reasons.” The goal of this study is to contribute to a theoretical framework that will help to predict programmatic outcomes given a

particular background and context. This study seeks to confirm the theory of partnership across cases and simultaneously reject the rival theory, enabling a “Level Two Inference (p.33).”

The participating high schools were governed by the educational standards of the state of Georgia. The results are presumed to have limited generalizability, at best, to other Metro-Atlanta public high schools, but they may be useful for informing strategies for future K-12 outreach efforts by Georgia Tech. Reliability is achieved when a different researcher repeats the research methodology for the same case and realizes the same results. Due to practical limitations, an additional researcher could not replicate the entire research design and inter-rater reliability could not be determined for the NVIVO coding.<sup>34</sup>

Table 1: Research Design Tests Applied to Study<sup>35</sup>

<b>Design Test</b>	<b>Features of Study Design that Address Design Test</b>	<b>Stage in Research Process</b>
Construct Validity	<ul style="list-style-type: none"> <li>• Used multiple sources of data – interviewed program participants in different roles and used 2 types of data-journals and interviews</li> <li>• Maintained chain of evidence</li> <li>• Invited feedback of key participants (Project Officers) on draft of paper</li> </ul>	Data Collection  Paper Composition
Internal Validity	<ul style="list-style-type: none"> <li>• Explanation building</li> <li>• 2 rival hypotheses explored</li> <li>• Logic model included</li> <li>• Future studies should use pattern matching among school cases</li> </ul>	Data Analysis
External Validity	<ul style="list-style-type: none"> <li>• Used replication logic for multiple cases</li> </ul>	Research Design
Reliability	<ul style="list-style-type: none"> <li>• Followed case study protocol</li> <li>• Developed study database</li> </ul>	Data Collection

<sup>34</sup> Ideally, the degree of “inter-rater” reliability would suffice for reliability.

<sup>35</sup> Adapted from Yin (2003:34) “Case Study Tactics for Four Design Tests.”

## 5.4.2 Data Sources

The primary data source for this study is semi-structured interviews with STEP Program participants conducted annually or bi-annually over the initial 3 years of the program. Other sources are open-ended journals kept by STEP Fellows during the school year, electronic communication from program participants and alumni and the internal evaluation reports of the first and second years of the program. Semi-structured interviews were conducted with representatives from each type of STEP participant: Fellows and School Coordinators were interviewed in the Fall and Spring. County Administrators, Project Officers and Teachers were interviewed in the Spring. The interviews were digitally recorded and transcribed. Additionally, the Fellows maintained writing journals to record their experiences from their initial selection in May to the completion of the school year the following May.<sup>36</sup> This method allows events to be examined from multiple perspectives and through multiple media.

Georgia High School Graduation Test passage rates (GHS GT), SAT scores, and general graduation and demographic data were collected for the high schools. During the third year of STEP, Georgia initiated its End of Course Test (EOCT) program<sup>37</sup>. Teacher reports of STEP's impact on the EOCT scores were reported, as relevant. STEP, a contained program, was not intended to impact school-wide test scores. However, the schools' scores provide contextual information about achievement levels and a school's particular needs.

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<sup>36</sup> Ideally, the text of these journals would be coded with the same nodes as the interview transcripts. Due to practical limitations, journals were not coded in this study.

<sup>37</sup> EOCT scores will count as final exam grades and 15% of a student's final grade for that course. Georgia's EOCT program was modeled after New York's Regents Testing program and is administered in core academic subjects. Some STEP Fellows served in core curriculum courses featuring End of Course Tests, e.g., Algebra I.

### **5.4.3 Analysis Techniques**

The recorded interviews with program participants were transcribed and saved as Rich Text Files. Using the NVivo qualitative analysis software, a small and purposive sample of transcripts was coded with “nodes” in an attempt to provide some additional measure of reliability. “Nodes are containers for ideas and concepts and hold references to the passages of document text [as coded] (Richards, p. 12, 1999).” Nodes for this study were subjectively defined based on goals and operational features of the STEP program. For example, one node was “action plan,” as the STEP Fellows were required to prepare a document entitled “action plan” mapping goals and priorities for the school year. Passages of interview transcripts that referred to an action plan were “coded” or marked with this node.

A Node Report was generated to view the different responses to a particular interview question or variations of particular elements of the program. A Node Report for “action plan” revealed the variation among Fellows and schools in how this document was created and used. This variation is important because collaborative planning with teachers is an important partnership behavior.

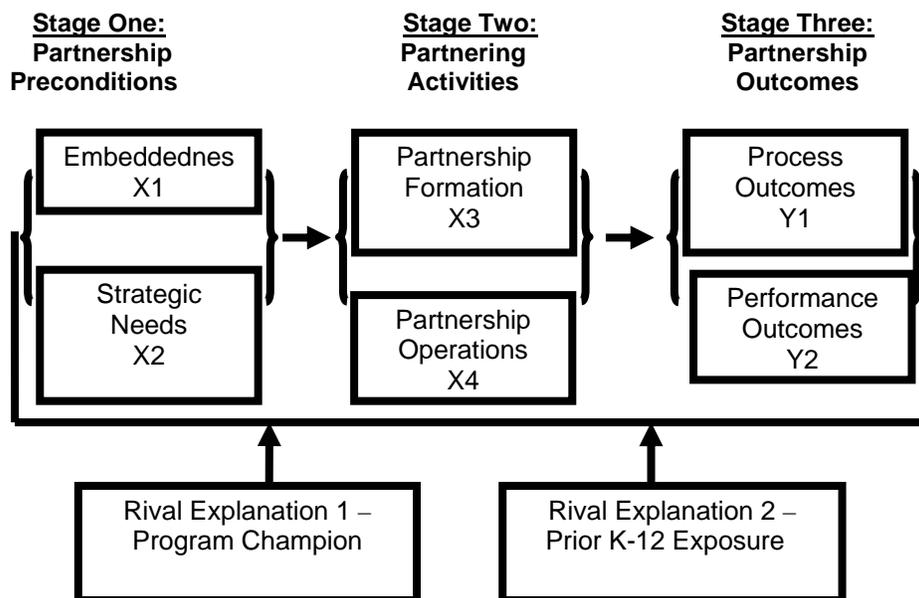


Figure 3: Partnership Variables in a Stage Model

#### 5.4.4 Variables

Kingsley & O’Neil (2003)<sup>38</sup> constructed a three-stage model of partnerships based on four key variables drawn from the study of other educational and social service partnerships: embeddedness of the partners prior to formal engagement, alignment of the partners’ strategic needs, aspects of the partnership formation and characteristics of the partnership’s operation. As shown in Figure 3, the first two variables working in confluence during the pre-conditions stage affect measures for the set of variables in the activities stage. Ultimately, all four variables affect two categories of partnership outcomes: process outcomes and performance outcomes.

*Independent Variables: Partnership Pre-Conditions and Operations*

<sup>38</sup> All variables and definitions taken from Kingsley & O’Neil (2002) “Alternative Approaches to Evaluating STEM Education Partnerships.”

The four independent variables represent characteristics of the relationship between the STEP program participants before and during collaboration. The school and university environments pose special conditions that somewhat qualify the measurement of these variables. For example, teachers typically have limited input into the strategic processes of need identification and goal setting for their schools. The organizational structure of a typical public school tends to relegate teachers to consumption of the partnership and not strategic level participation. In a similar vein, the STEP Project Officers influence the university community to a certain degree, but do not make strategic plans for Georgia Tech as a whole. Internal validity is maintained by qualifying the application of the term “strategic” in this way.

#### *Partnering Pre-Conditions (Stage 1) Variables*

*Embeddedness (X1)* describes the number and types of relationships that organizations have with one another prior to the development of a partnership. Embeddedness could be high or low and positive or negative. Both measures have to be included because the extent of prior collaboration is not likely to lead to a productive partnership if the interactions were negative.

*Strategic Needs (X2)* describes the types of resource and legitimacy needs confronting individual organizations prior to a partnership and whether there is a basic congruence or a synergistic complementarity in these needs.

#### *Partnering Process Variables*

*Partnership Formation (X3)* describes the types of agreements regarding the goals, resource allocations, and responsibilities of each party to the partnership. This concept captures the collective intent of the partnership. These can be documents such as contracts or memoranda.

*Partnership Operations* (X4) describe the actual behaviors in which the partners engage as they pursue the goals and duties of the partnerships.

*Dependent Variables: Partnerships Outcomes*

*Process Outcomes* (Y1) are qualitative and quantitative assessments of whether the partnership achieved its defining goals and duties.

*Performance Outcomes* (Y2) assess such improvements as in the working environments of the organizations, transfer of knowledge between organizations or increased ability to innovate in a timely manner.

#### **5.4.5 Predicted Effects**

X1: Embeddedness: Positive embeddedness is predicted to have a positive effect on the activities variables of formation and operation because it allows organizations to interact with each other under conditions of trust and familiarity. Collaborating in this state affords parties more time and energy to be directed towards the goals of the program versus getting to know each other. Thus, more risks are likely to be taken and more No embeddedness or negative embeddedness is expected to raise the transaction cost of working together because in this state parties want to invest in getting to know and trust each other.

X2: The degree of complementarity of the participants' strategic needs is expected to be positively related to beneficial partnering behaviors. An important caveat for the use of this variable is in order. The STEP program is an official function of only two offices within the whole of Georgia Tech as an institution. Furthermore, the strategic needs of high schools are defined by county level administration and to some degree by the school's administration; these

types of actors were marginally engaged. A large target group of the STEP program, high school teachers, did not have strategic input.

X1 and X2, the pre-conditions variables, are predicted to work in confluence to impact X3 and X4, the activity stage variables. Higher degrees of embeddedness and higher alignment of strategic needs is predicted to lead to less formal, more collegial formation of the partnership. The foundation of trust and respect between or among parties is expected to lead to interaction characterized by lower overall transaction costs.

X3: Agreements characterized by lower formality are interpreted as a demonstrating greater trust and mutuality. Thus, lower formality is predicted to positively affect process and performance outcomes.

X4: Higher interdependence, lower transaction costs, and mutual communication characteristics are expected to lead to better process and performance outcomes.

## CHAPTER 6

### BROAD ANALYSIS OF HIGH SCHOOL CASES

Table 2: Overview of the STEP Program at Participating High Schools<sup>39</sup>

School System	High School	Year 1	Year 2	Year 3
Marietta City	Marietta	-----	2 G Fellows in math lab; 10< math teachers	2 G and 2 UG Fellows; 4 > math teachers
Rockdale County	Rockdale Magnet	2 G Fellows; 4< science teachers	2 G Fellows; 4< science classrooms	2 G Fellows in 1 research class; 1 UG Fellow in physics class
	Rockdale High	2 G Fellows; 4< science teachers	-----	-----
DeKalb County	Cedar Grove	-----	2 G Fellows; 2 science teachers	3 G Fellows ; 4 < science/technology teachers
	Stone Mountain	2 G Fellows; 1 science teacher	-----	2 G Fellows; 1 science teacher and media center
	Dunwoody	-----	2 G Fellows; 4 < Science Teachers	-----
	Druid Hills	2 G Fellows; 4< teachers	-----	-----
Fulton County	Tri-Cities	2 G Fellows; 2< science teachers	2 G Fellows & 2 UG Fellows; 4< science/math teachers	3 G Fellows; 4< science/math/social studies teachers
	Westlake	-----	2 G Fellows; 4< science/math teachers	2 G and 1 UG Fellows; 4< science/math teachers
	North Springs	2 G Fellows; 4 > teachers	-----	-----

G = graduate Fellow UG = undergraduate Fellow

The Project Officers placed STEP in local high schools by communicating with administrative officials at four county school systems out of the approximately 10 counties that comprise the Atlanta metropolitan area: Fulton, the most populous county in the state, DeKalb,

<sup>39</sup> One graduate Fellow at Cedar Grove was an unpaid volunteer who worked approximately 5 hours a week; half of the 10 hours required of STEP Fellows. One graduate Fellow at Tri-Cities was a Public Policy student working in a social studies classroom.

the second most populous, Rockdale, a moderate-income area east of Atlanta and Marietta, a small, diverse city north of Atlanta. Table 2 shows the counties and schools that hosted the STEP program in the Atlanta metropolitan area.

## **6.1 Fulton County Schools**

Fulton County's science coordinator had an established relationship with STEP's Project Officers at Georgia Tech. She worked on the advisory committee of CEISMC's GIFT research experience program for teachers. Initially, she chose a north county school (North Springs) and a south county school (Tri-Cities) to participate in STEP. The northern portion of Fulton County is predominantly white and the southern portion is predominantly African-American.

North Springs is a racially diverse school located in north metro-Atlanta. Many students travel from all over the city to attend its magnet program. Tri-Cities is a predominantly African-American school in south Fulton County and features a performing arts magnet program. Both schools had experienced female teachers of approximately the same age working as STEP program coordinators. The third Fulton County school, Westlake, joined the STEP program in place of North Springs. Westlake is a pre-dominantly African-American school in an affluent, residential section of southwestern Atlanta. Westlake is about the same age and architecture as the other two schools and features a science and engineering magnet program. Westlake's initial STEP Coordinator was an experienced teacher near retirement and its second STEP Coordinator was an experienced male teacher.

The Fulton County schools experienced different outcomes. The STEP placement at North Springs suffered from a skewed sense of mutuality from its inception, yet the Project Officers continued to attempt relationship building at the school. When they were unable to

make plans with staff during the summer preceding Year 2, the decision was made between the county-level coordinator and the Project Officers to move STEP to Westlake.

Over three years, STEP has settled into core relationships with two Fulton County schools – Westlake and Tri-Cities. Both are predominantly African-American schools in south Fulton County, and concentrating on these core schools was in line with the Project Officers’ desire for STEP to have the most programmatic impact at schools with greatest need and least resources.

### **6.1.1 North Springs High School**

*First (only) Year at North Springs High School (STEP Year 1):* Two Caucasian Fellows were assigned to North Springs: a male, engineering master’s student and a female doctoral student in Chemistry. Neither had formal K-12 training, but the doctoral student had extensive experience teaching an undergraduate chemistry course. Neither had an overwhelming sense of personal mission, though the master’s Fellow was passionate about coming from a family of educators. Their action plan focused on creating hands-on learning experiences, developing websites for use in the science department and leading educational field trips to Georgia Tech.

Each Fellow had different experiences at the school. The master’s Fellow led a successful before-school tutoring program in addition to leading class sessions on a regular basis. However, the doctoral Fellow did not find as much success. She felt that she could not contribute to regular class lessons because of the unruliness of the students and a poor working relationship with her Cooperating Teacher. She reported that the Teacher called on her without advance notice to

elaborate on a lecture that was in progress<sup>40</sup>. She did not have satisfactory teaching experiences, and her relationship with the Cooperating Teacher lacked trust, mutual respect and communication.

The North Springs' Teachers seemed to think that that the Fellows could not contribute to meeting the school's strategic needs. They referred to STEP from the start as a service to the Fellows. The staff did seem interested in the physical resources and special funding available from being connected to Georgia Tech. The school had no prior relationship with Georgia Tech and did not develop one through STEP. Over the course of the year, communication among participants did not become more reciprocal and trust did not increase. The doctoral Fellow almost completely stopped interacting with teachers as she transitioned to her role in making web-based resources, which defies a fundamental objective of the STEP program.

This case is consistent with the logic model in that low embeddedness and low alignment of strategic needs between Georgia Tech and the school led to low communication and poor achievement of programmatic objectives. It also seems to support the importance of a positive Fellow-Teacher relationship.

### **6.1.2 Westlake High School**

*First Year at Westlake High School (STEP Year 2):* Two Fellows were assigned to Westlake in the first year: a Caucasian, doctoral engineering Fellow and an African-American master's Fellow pursuing a joint MBA/engineering degree. Both had experience teaching undergraduate courses but no prior K-12 training. The master's Fellow expressed a strong sense of personal

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<sup>40</sup> Both Fellows at North Springs were not comfortable with being referred to as external "experts." They felt that this perspective discounted their commitment to the school and need to "fit in" with the teaching staff. Fellows at other schools also registered this complaint.

mission in guiding youth, whereas the doctoral Fellow had more of a curiosity about working with the high school age group.

These Fellows developed an action plan tailored to North Springs, yet effectively made a last minute transition. The Fellows worked separately and had somewhat of a parting of the ways over their vision of their purpose at the school. They worked with varied levels of students and many teachers with varied levels of experience. The master's Fellow became very involved in extracurricular activities, starting a NSBE, Jr. chapter and encouraging teachers to pursue the GIFT program at Georgia Tech. The Fellows led several field trips to Georgia Tech and used resources on campus to enhance the technology program at the school. Trust grew among teachers and Fellows, and Georgia Tech and Westlake became more involved with each other in multiple ways. Communication increased and was mutual. Fellows and Teachers developed strong relationships independent of Coordinator involvement, further reinforcing the importance of the Fellow-Teacher working relationship.

*Second Year at Westlake High School (STEP Year 3):* Four Fellows were assigned to Westlake in Year 3, but one did not accept the Fellowship. Of the three Fellows who served, two were engineering graduate students (one male and one female) and one was a female, engineering undergraduate. All three Fellows were African-American. None of the Fellows had a strong sense of personal mission or formal K-12 training.

The undergraduate Fellow reported that she met her goal of teaching programming even though her co-op employer requested that she return to work full time in the fall. Though she was only able to work as an after school advisor to the NSBE Jr., she accomplished needed progress in this fledgling club. In the Spring, she participated in a regular class.

The male graduate Fellow worked with a Cooperating Teacher in two Topics in Engineering classes. He assisted with labs, delivered lectures, assigned homework, tutored and contributed to NSBE Jr. Though they cooperated successfully, both Fellow and Teacher indicated that more programmatic structure would have enhanced their accomplishments.

The female graduate Fellow enhanced an AP Physics class by providing study sessions on Saturdays and after school. She developed a rewarding relationship with the Cooperating Teacher, who kept her “in the loop” through e-mail communication and twice weekly meetings. The resources available at Georgia Tech enabled the AP Physics teacher to move beyond simplistic projects, increasing rigor and innovation. STEP’s Project Officers made it possible for some Westlake students and teachers to participate in the Siemens-Westinghouse competition at Georgia Tech.

Expectations based on previous Fellows resulted in some frustrations for the Year 3 Fellows, especially in relation to the growth of NSBE Jr. at the high school. All of the Fellows reported feeling some kind of frustration over the management of this club. An influential prior Fellow had essentially handled every aspect of NSBE Jr. at Westlake, and that created some miscommunication between teachers, interested students, and Fellows. The teachers seemed to expect the Year 3 Fellows to be as pro-active and detail oriented as the Year 2 Fellow, but none of the Fellows filled this role.

Westlake has local business partners that provide occasional free meals, but these partnerships were not comparable to STEP. In addition to classroom teaching, STEP helped this school to innovate through fostering greater communication with Tri-Cities, another STEP school in south Fulton County. These two Fulton County high schools are not far apart and could collaborate in the future.

STEP was not a new program in its second year at Westlake, which predictably reduced formality and transaction costs. The general duties for the second group of Fellows had been laid out by the first year, such as which teachers to work with and the continuation of NSBE Jr. Because trust and mutual communication had been built, the loss of one Fellow before the year began and scheduling problems with another Fellow did not damage the partnership. Though the Fellows' schedules forced them to work separately, they remained committed to school-wide goals such as encouraging NSBE Jr. participation.

Westlake's Magnet Coordinator, an experienced teacher, served as the STEP Coordinator for two years before her retirement. Her lack of direct involvement with the Fellows indicates that she was not a champion. The succeeding magnet/STEP Coordinator was an experienced teacher who had been involved with STEP from the beginning. His honest communication about the Fellows and the program indicates that he was not a champion either. Additionally, an experienced science teacher who had also worked with STEP became the science department chair at the end of year 3. These teachers advanced because of their promise and professionalism. Their influential positions still do not make them champions because they supported STEP before their advancement.

*Comparison Across Years of Operation:* Overall, the partnership at Westlake was considered a success. Positive features that continued into year 3 were the presence of minority role models, the continuation of productive working relationships with multiple Cooperating Teachers and the continuation of the NSBE Jr. chapter. In addition, one of the initial Fellows continued to have friendly contact with the Teachers he had worked with, demonstrating the level of commitment and genuine interest that increased trust and openness. Fellows in both

years mentioned insufficient planning time with teachers, yet they gained sufficient teaching experience overall.

Westlake's principal had connections with Georgia Tech, but he left at the end of STEP's second year to open the new Atlanta Tech High School. This turnover did not appear to significantly reduce embeddedness because of multiple, strong Fellow-Teacher working relationships. The AP Physics teacher commented that the Fellows themselves, though all different, built bridges between Westlake and Georgia Tech:

*For the school, hopefully, the partnership is building a pipeline for our students to see other students who are not just from Tech, but are Master's and PhD students from Tech. Not only did they make it through the first four years, but they kept going. It's important for our students to see [academically-achieved] young people who look like them, who aren't nerdy, who have a life, a car, an apartment, etc...*

Four math and science teachers completed GIFT during STEP's first three years. The Fulton County Science Coordinator had sent teachers e-mail invitations to GIFT for many years. However, the persistence of the Fellows led to the first two teachers participating. Additionally, word of mouth among teachers and outreach by STEP's Project Officers resulted in additional participation<sup>41</sup>. Also with the assistance of a STEP Fellow, Westlake offered its first AP Chemistry class. The school and Georgia Tech became more embedded over time and in different ways. By many accounts, the relationship produced mutually rewarding interactions. The examples of GIFT participation and incorporation of new ideas show how collaboration through the STEP program helped the school to improve itself.

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<sup>41</sup> Not all Teachers who completed GIFT hosted a Fellow because some Teachers were directly recruited by STEP's Project Officers. This type of outreach is another aspect of embeddedness made possible by the presence of the STEP program.

### 6.1.3 Tri-Cities High School

*First Year at Tri-Cities High School (STEP Year 1):* Tri-Cities is a Performing Arts Magnet School that has many partnerships with local businesses such as fast food restaurants. Though its standardized test scores are still below average in areas, Tri-Cities has earned national recognition for its overall academic improvement in recent years. Even though 40% of its student body lives at or below the poverty level, Tri-Cities was named a 2003 Georgia School of Excellence. The STEP Coordinator was also the chair of the science department when STEP joined the school. She expressed some reluctance about the STEP program at first, as she was unsure how Fellows could benefit teaching and learning<sup>42</sup>. However, STEP's initial year at this school brought benefit to all parties and resulted in the growth of respectful relationships and reciprocal communication.

Tri-Cities High School was initially assigned two African-American doctoral students, one male and one female. One of the Fellows had prior experience with tutoring youth. These Fellows worked as a team serving the Coordinator, an experienced chemistry teacher, and several other Cooperating Teachers. Their action plan focused on increasing the use of hands-on science labs and generally assisting in preparation for the GHS GT. This school had a 49% passing rate on the science section of the GHS GT and specifically wanted STEP to assist in increasing scores.

The Fellows created “fun” labs and academic theme days using resources from the internet and their labs on campus. The Fellows were not able to set up an official GHS GT tutoring program. However, their labs touched upon the content knowledge and science process

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<sup>42</sup> The Coordinator's initial reluctance may have been a little disheartening for the Fellows and Project Officers, but it allows for rejection of the rival hypothesis of the Coordinator acting as a program champion.

skills included on the science section of this test. Thus, the strategic needs of school and university were met through STEP, though not in the exact manner planned.

The Coordinator felt that the presence of successful graduate students who looked like the students did much for the students' motivation and esteem. Through their relationships with the students, the Fellows learned how to better interact with high school age students, through "respect, kindness, love", as well as how to relate technical, in-depth, scientific information to their students.<sup>43</sup> The Fellows and school staff were impressed and moved by what transpired, causing trust and respect to flourish despite initial confusion over the Fellows' exact role in the classroom. The Coordinator became increasingly convinced of the benefits STEP offered to the students and school. When she participated in the National Science Foundation GK-12 conference in the fall of 2001, she added another dimension of embeddedness that seemed to set the stage for successful collaboration over the two year.

*Second Year at Tri-Cities High School (STEP Year 2):* Two doctoral Fellows (an African-American female in engineering and a Caucasian male in earth sciences) and two engineering undergraduate Fellows (both Caucasian males) were assigned to the school in the second year. None had formal K-12 training or a strong sense of mission. One Fellow had enjoyed working with younger students as a Resident Advisor in his college dormitory. The other Fellows attributed their attraction to STEP to an interest in the general art of teaching or a desire to broaden their professional exposure.

The Fellows worked in pairs in year 2, though the graduate Fellows felt that it was somewhat of an extra burden to manage the undergraduates. Fellows made fruitful connections

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<sup>43</sup> Quote taken from STEP Year 1 Annual Evaluation Report prepared by Gordon Kingsley and Mackenzie Wood as internal evaluators of the STEP program. All data for STEP's year 1 is excerpted from this report. Data for STEP's year 2 is largely excerpted from the annual evaluation report for that year prepared by the same authors, with the author of this paper as a research assistant and contributor.

between Georgia Tech and the school through using resources from Georgia Tech in high school projects and conducting lab visits and other special trips to Georgia Tech for events such as the Lego Competition. With four Fellows working in multiple classrooms (with multiple teachers), the importance of the working relationship between Fellow and Teacher became apparent. By all reports, the quality of the Fellows' experiences was determined by this factor primarily. The undergraduate Fellows did not have a mutually satisfying relationship with the Teacher of the remedial GHS GT prep class in which they worked. This Teacher would sometimes turn the class over to the Fellows and become a passive observer. The Fellows were dedicated to their STEP duties at the high school; they wanted to be received as collaborating partners, not external experts. The teachers also wavered on increasing their extra-curricular involvement with Georgia Tech during the second year<sup>44</sup>.

*Third Year at Tri-Cities High School (STEP Year 3):* Tri-Cities returned to hosting only doctoral students in the third year. Two were female doctoral students in engineering (an African-American female and a Caucasian female). The third Fellow was an African-American male doctoral student in Public Policy, the first non-math or science Fellow for the STEP program at this school. The African-American doctoral Fellow expressed some sense of personal mission for her STEP service, and all of the Fellows expressed a genuine desire to grow as teachers while enhancing the education of the students. Some had tutoring experience, but none had formal K-12 training.

The engineering Fellows worked in separate classrooms but met frequently to brainstorm and support each other. The policy Fellow worked with one teacher in multiple sections of her 10<sup>th</sup> grade history class. The science Fellows continued the NSBE Jr. chapter that had been

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<sup>44</sup> Again, wavering dedication to STEP may have been disheartening for Fellows and Projects Officers, but it allows rejection of the rival hypothesis of a teacher acting as a program champion.

established by the prior Fellows and obtained math software for the school. The policy Fellow created original lessons called “Image Labs” that challenged students to think critically and write effectively. He also utilized a different form of expertise available at Georgia Tech; he arranged for a class swap between Georgia Tech and Tri-Cities and hosted an intellectual debate on social issues between himself and a Fellow from another school. The “Image Labs” would have likely been used over time by the Cooperating Teacher, but she left the teaching profession at the end of the year. Data from STEP’s fourth year of operation would reveal whether or not this Fellow’s original lessons were being reused.

*Comparison Across Years of Operation:* The partnership at Tri-Cities thrived despite changes in Fellows, Cooperating Teachers and classes. At first, Teachers were resistant to pursuing special events and professional development at Georgia Tech, but the Fellows’ enthusiasm and dedication eventually won them over.

Multiple teachers of varying levels of experience worked with the Fellows, including the Coordinator. Many teachers from the school have now completed the GIFT program. The social studies teacher was greatly inspired by the policy Fellow. She left the teaching profession at the end of the year to pursue a doctoral degree in education. Though STEP has experienced multiple instances of teacher and administrative turnover for various reasons, this particular outcome may indicate that increased collaboration with an IHE may inspire K-12 teachers so much that they “switch camps.” This outcome may also indicate that teachers more inclined to embrace aspects of higher education such as intellectual debate and analysis are more likely to have successful experiences with STEP Fellows versus the general teaching population.

## 6.2 DeKalb County Schools

The county level coordinator at DeKalb County Schools was comfortable working with Georgia Tech, but she felt that the placement of the STEP program should be rotated among north and south county schools each year to avoid the appearance of favoring one part of the county. The southern part of DeKalb County, like Fulton County, is predominantly African-American, while the northern portion of the county is predominantly Caucasian<sup>45</sup>.

In STEP's first year in DeKalb, the program operated at Druid Hills High School, a diverse school located in an affluent neighborhood near Emory University, and Stone Mountain High School, a predominantly African-American school in the southeastern portion of DeKalb. Due to the original plan to rotate STEP, the program left Druid Hills and Stone Mountain after the first year. In the second year of STEP, the program operated at Dunwoody High School, a diverse school in an affluent residential community and Cedar Grove High School, a predominantly African American school in a residential area of southwest DeKalb. There were positive outcomes of the STEP program at Dunwoody High School, which already offered special programs for advanced study such as International Baccalaureate. One teacher who was supportive of STEP wanted to stay in contact with Georgia Tech for the Robotics competition and notice of other special events, but that did not materialize.

### 6.2.1 Druid Hills High School

*First (only) Year at Druid Hills High School (STEP Year 1)*<sup>46</sup>: Two doctoral Fellows, a Caucasian female in Chemistry and an African-American male in engineering were assigned to

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<sup>45</sup> DeKalb and many other metro Atlanta counties are experiencing significant growth in their native Spanish-speaking population, though the implications of this trend for STEM education are not addressed in this study.

<sup>46</sup> Year 1 cases excerpted from STEP's Year 1 Evaluation report.

the school. One Fellow came from a family of educators and was very excited about teaching; he had taken a teaching course prior to STEP. The female Chemistry Fellow did not have prior K-12 training and did not express a sense of personal mission for service at the school.

The Fellows were to help teachers prepare 11<sup>th</sup> and 12<sup>th</sup> students who were at risk of failing the GHS GT and expose students to greater computer usage and math and science career ideas. The action plan was collaboratively developed between the Fellows and the Coordinator and its focus was multi-faceted.

The Coordinator at this school had a unique prior connection to Georgia Tech – she was an alumna. She was enthusiastic and expressed that the Fellows’ “shyness” prevented them from forging relationships on their own. She assigned Fellows to different math or science teachers on as-needed basis throughout the year. Thus, the Fellows were not able to develop their own relationships with teachers over time, keeping the transaction cost high by not reducing formality and building trust. Having the Coordinator as a “third-wheel” seemed to prevent the growth of Fellow-Teacher working relationships and keep transaction costs from lessening throughout the year.

The Fellows were unsure of their role, but proceeded to concentrate on developing Computer Based Laboratories for use throughout the science department. They found these labs to be inconvenient and actually less valuable than traditional science labs. They did not encourage the school, which had sufficient resources for its math and science courses, to use them in the future. The personal embeddedness that the Coordinator had with Georgia Tech did not benefit this partnership, and communication did not grow or become less formal because it all had to go through her. A lack of strong Fellow-Teacher relationships also characterizes this case.

### **6.2.2 Dunwoody High School**

*First (only) Year at Dunwoody High School (STEP Year 2):* Two African-American Fellows were assigned to Dunwoody, a male pursuing an engineering master's degree and a female pursuing an engineering doctoral degree. These two Fellows already had a collegial working relationship through their participation in the Black Graduate Student Association, but neither had previous K-12 exposure. The female doctoral Fellow expressed a strong sense of mission and service. The male master's Fellow thought that teaching might be a future career option and was looking for funding.

The Fellows worked primarily with an experienced chemistry teacher, who was also the STEP Coordinator. They helped with the school's science fair in the first portion of the year and then returned to classroom teaching, working with three teachers. They also formed collegial relationships with many more Teachers by eating lunch in the lounge.

The female Fellow started a "young women's initiative" which provided special mentoring opportunities for female students referred by faculty and worked in a math teacher's classroom. Overall, they had positive relationships with teachers, but they also reported a lot of passive observation in the classroom and being asked to give an expert lecture on the sport with no preparation.

The in-class efforts of these Fellows led to growth in teaching and communication skills. The female Fellow grew in leadership and seemed to thrive coordinating her special initiative, even if its focus did not capitalize on her STEM expertise. The Coordinator noted that the African-American students at the school had few minority role models on staff and she recognized the importance of STEP fulfilling that role.

The Fellows led innovative activities that can be repeated by the school, such as labs with food and theme days such as Pi day on March 14 (3-14). They connected Georgia Tech and Dunwoody through attendance at the Lego competition and the motivational speaker and brought in special speakers for career day at the school.

### **6.2.3 Cedar Grove High School**

*First Year at Cedar Grove High School (STEP Year 2):* Cedar Grove, located in the southern DeKalb suburb of Ellenwood, Cedar Grove student awards include 2<sup>nd</sup> Place for essays in the Southeasters Consortium for Minorities in Engineering (SECME) Mousetrap Car Competition. The school is supposed to be a prototype for Information Technology education.

Cedar Grove initially worked with two African American graduate students, 1 male and 1 female. The male Fellow was especially interested in working with African American males. He saw STEP as an opportunity to motivate students, just as someone had done for him. He did not have education training, but he had taught an undergraduate practicum. The female Fellow had tutoring experience and was interested in mentoring; she was especially interested in connecting with African American female students.

The first action plan focused on improving students' oral and written presentation skills and technological skills through the creation of web pages. Since the Fellows did not have an established baseline, they wanted to do "whatever we come up with that will add value." They started the year planning to participate in after school activities and quickly began working with the Science Olympiad and NSBE Jr. They primarily worked with two experienced teachers, one of whom was also the Coordinator. They worked apart and moved freely between classrooms, depending on teachers' needs. Because the Fellows worked in the same classes (at different

times), they were able to support each other. The Fellows performed a variety of activities reflecting their strengths. They taught regular lessons, GHS GT prep sessions and labs. They also mentored students working on science fair projects and college admission. The male Fellow taught students and teachers throughout the science department how to create personal web pages and assisted several students with applying to academic summer camps.

Both Fellows reported positive and productive working relationships with teachers and students and developed a new understanding of the teaching profession. They were, however, frustrated by the politics of the school and disagreed with many policies, especially the ones that seemed to allow failure. Student apathy and under-achievement was one of their greatest difficulties. As one Fellow noted, STEP was “frustrating at times, but I am very thankful for the experience ...” The personalities of the Cedar Grove Fellows were complementary and they “brought each other up on tough days.” The Fellows knew one another previously and their experience at Cedar Grove brought them closer. Fellows and teachers described challenging working conditions at the school and appreciated the extra support.

The Fellows at Cedar Grove brought lasting innovation to the curriculum through a new focus on computer literacy and hands-on physics activities, such as an Egg-Drop Competition and the use of models and language more easily understood by students. For example, one Fellow updated the old-fashioned “plum pudding model” of electrons by changing it to the “chocolate chip model.”

STEP increased the interactions between this school and Georgia Tech. The Fellows facilitated several activities for the Cedar Grove students at Georgia Tech, including summer lab experiences for students, arranging a Georgia Tech mentor for a student’s science project and attending special events on Georgia Tech’s campus. However, the Fellows did not bring many

materials for use in the labs at Cedar Grove. Cedar Grove has a few partnerships with local businesses, but these companies are not involved in daily classroom activities.

Performance outcomes included expansion in types and complexity of labs, more sophisticated science fair projects, a better understanding of the scientific method, improved process skills<sup>47</sup> and enhanced application of the scientific method. The Fellows also acted as role models for African-American students, providing advice on college application and career options. The Fellows had satisfactory experiences working with varied levels of students and multiple teachers because they felt that they got through to the students. One Fellow felt that working with difficult students helped her to develop a stronger personality. Both Fellows felt the pressure of balancing STEP and their graduate workload.

*Second Year at Cedar Grove (STEP Year 3):* Two graduate Fellows and one unpaid graduate volunteer joined Cedar Grove in STEP's second year there. The action plan for this year focused on expanding the program. The physics teacher, who had inherited the Coordinator role from a retiring teacher, tried to grow the program in the science department. He struggled at first, but found a productive inroad when he invited a female, African-American teacher to share the coordinatorship with him. The Fellows worked primarily in this teacher's class and branched out into the upcoming Co-Coordinator's class.

*Changes over Time:* The Co-Coordinator, who taught a variety of science courses, had met the first year's Fellows, but did not host one in her classroom until the second half of the second year. The Fellow's expansion to her classroom shows programmatic growth, as they remained just as potent in the Coordinator's classroom. The new Co-Coordinator appreciated the academic rigor and authenticity that Fellows brought to labs and lectures and recognized their impact on student learning and even standardized test performance. She shared, "you have to

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<sup>47</sup> Process skills comprise one-third of the science portion of the GHS GT.

teach critical thinking. You can't just test critical thinking and expect them to do well. If you haven't asked those kids to synthesize and evaluate, you cannot perform at that level." There was also a sense of mutuality between the Fellows and Teachers, with teachers participating in professional development at Georgia Tech while Fellows were invited to teacher conferences.

#### **6.2.4 Stone Mountain High School**

*First Year at Stone Mountain High School (STEP Year 1):* Stone Mountain is a majority African-American school in east DeKalb County that features a low completion rate and high drop out rate. Stone Mountain is somewhat unique among cases in that several teachers had completed the GIFT program before STEP, establishing some embeddedness with Georgia Tech. Two African-American Fellows were assigned to the school in year 1, a male master's student and a female PhD student. Even though neither Fellow had prior teaching experience, the Coordinator took a background approach to managing their experience at the school.

The Fellows worked as a team in one Teacher's 11<sup>th</sup> and 12<sup>th</sup> grade sections of honors Physics. This Teacher had only a few years of experience and wanted to infuse the standard curriculum with hands-on laboratories and critical thinking. The Fellows provided the innovation that he desired, and they developed a very productive working relationship. Additional goals for the Fellows included encouraging students' interest in higher education, especially math and science majors, and generally increasing the students' in-class performance. The Fellows brought students to Georgia Tech for special events but did not share advanced physical resources, partially because the school did not offer a science fair. From the creation of the action plan to the end of the year, there were high degrees of mutuality and productive collaboration between Fellows and the Cooperating Teacher. The Fellows were extremely dedicated and spent more

time than required at the school, including weekend sessions to prepare for Science Olympiad. Their dedication and contributions to the classroom won the trust of the school faculty, who were sad to lose the program to DeKalb County's rotation plan.

*Second Year at Stone Mountain (STEP Year 3):* Two graduate fellows joined Stone Mountain when STEP returned in the third year – an African American female doctoral student and a Caucasian male master's student. They both worked primarily in the Coordinator's science classes, although the master's Fellow was recruited by the media center teacher to teach him how to use iMovies on the school's Apple laptops. The Coordinator was pleasantly surprised by the relationships that evolved between Fellows and students. She commented, "it was not a forced situation." The relationships were positive all around despite challenging working conditions.

The Coordinator did not feel that STEP was a time burden and enjoyed interacting with the Fellows and Project Officers. She indicated great mutual respect and encouraged the Fellows to "bring ideas to the table" and participate in the decision making process. She felt that her investment as Coordinator "can't [be] equated to dollars.... It's just been beneficial to do so many more labs, so many more activities.... I would have never been able to do [Toshiba] Explor-a-Vision, because that required a lot of research."

*Changes over Time:* STEP was able to flourish at Stone Mountain despite an uncommunicative initial Coordinator (who was replaced early on by the young, female Coordinator/Teacher) and a year away from the school due to DeKalb County's initial rotation plan. One downfall of STEP was that it did not grow beyond the Coordinator/Teacher's classroom, except for the involvement of the media center teacher. In this way, the Coordinator/Teacher functioned as somewhat of a program champion. The STEP program followed this teacher to a new DeKalb County school, Miller Grove, at the start of the fourth

year, completely exiting Stone Mountain High School for a second time. However, the benefits to the media center teacher who will remain at the school are increased technological skills in general and better ability to utilize the school's existing resources (the rolling cart of Apple laptop computers). Through STEP, the Coordinator/Teacher became more intertwined with Georgia Tech over time, participating in professional development and providing summer training to Fellows.

### **6.3 Rockdale County Schools**

Rockdale County is a predominantly white, middle-income community located 30-45 minutes east of Atlanta. Unlike a suburb 30-45 minutes north of Atlanta (the north Fulton county/Alpharetta area), Rockdale County does not feature the same level of affluence or professional employment opportunities. Rockdale is also experiencing growth in its Hispanic population. The Rockdale County central office did not have much interaction with STEP's Project Officers after the initial placement of STEP at Rockdale County High School's regular program. However, a productive and mutually rewarding relationship developed between Georgia Tech and this school's magnet program, which is housed within the school. After an unfruitful initial year characterized by unreciprocated contact with the county, STEP exited the regular program at Rockdale County High, but remained with the magnet program.

#### **6.3.1 Rockdale County High School**

*First (only) Year at Rockdale County High School (STEP Year 1):* Two Caucasian graduate Fellows, a male doctoral student and a female master's student, were assigned to one teacher for the duration of the year at this school. Neither Fellow had prior K-12 exposure.

Apparently, the Cooperating Teacher was unaware that she was going to be working with Fellows and felt that STEP had been forced upon her. Communication remained very limited and unproductive. For example, the Fellows and Cooperating Teacher reported different versions of the same events and rarely seemed to be on the “same page.” When this teacher did reach out to Georgia Tech, it was to register dissatisfaction with STEP’s Project Officers without first speaking to the Fellows. (It does not appear that she tried to communicate directly with the Fellows.) This Teacher taught primarily freshman or older students who were struggling in chemistry and physics, and the needs of these students added to the Fellows’ frustration level. The Fellows received very limited and unfulfilling teaching experiences and ties did not grow between Georgia Tech and the Teacher or the school. In this case, the passage of time did not lead to greater embeddedness, as attempts to achieve reciprocal communication with the Teacher and county officials were not successful.

*The Rockdale Magnet High School and Marietta High School cases are presented and analyzed in detail in Chapter 6.*

#### **6.4 Cases and Outcomes**

As defined earlier, process outcomes are the qualitative and quantitative assessments that measure whether the partnership achieved the goals and duties of operation. The process outcomes for this study are fulfillment of the objectives of the STEP program.

STEP Program Objectives Assessed as Process Outcomes:<sup>48</sup>

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<sup>48</sup> The 7<sup>th</sup> objective concerning creating curriculum for Rockdale Magnet High School is not specifically addressed because it was not prioritized in interviews with Project Officers. The Project Officers collected information from all schools that could be used at any school.

- Fellows effectively communicating standards-based science and mathematics to high school students and teachers from varying backgrounds
- Fellows experiencing effective teaching methods and real-life teaching challenges
- Fellows practicing science and mathematics pedagogy, classroom management strategies and inquiry-based instruction in regular classes and extracurricular activities. The first three outcomes are collectively referred to as “teaching experience” in this paper.
- Facilitating knowledge transfer from Georgia Tech to the high schools through interaction with Fellows and professional development of teachers. This outcome is manifested through Fellows inducing innovation and increased use of technology. The elements of this outcome are referred to as “innovation”, “technology” and “teacher development” in this paper.
- Facilitating mentoring relationships between Fellows and students and between teachers and university students and faculty, encouraged through field trips, class visits, tutoring and electronic communication. This outcome is manifested through the introduction of faculty to serve as research advisors to students and/or teachers through formal programs such as GIFT or through informal projects, lab demonstration visits, admissions advisors visiting the school, and Fellows consulting with students outside of class by e-mail. In some cases, this type of relationship looked like more traditional mentoring, such as a young women’s initiative led by one Fellow. In other cases, a Fellow successfully coached one student through the college application process. This outcome is commonly referred to as “mentoring”.

The objectives of the STEP program can be summarized in three outcomes which were evaluated in the case studies: 1) opportunities for Fellows to effectively communicate STEM concepts and skills to a high school audience, 2) opportunities for Fellows to exhibit leadership

by managing a project or fostering a new relationship and 3) enhancement of the high school environment as observed or reported by teachers or students.

Performance outcomes assess such improvements as in the working environments of the organizations, transfer of knowledge between organizations, or increased ability to quickly innovate. Performance outcomes for this study are participants' self-reports of improved teaching, learning and professionalism in the high schools<sup>49</sup>. The STEP program offered opportunities for improved teaching and learning through better use of content knowledge and teaching methodologies, especially innovative use of manipulatives, scientific supplies, and technology. Knowledge transfer can occur through interaction with the Fellows or other formal and informal professional development programs at Georgia Tech. Improvements in the high school environment due to the STEP program includes attitudinal enhancements for teachers and students, such as an increase in curiosity, perseverance in the scientific method or overall motivation to be a part of STEM education.

#### **6.4.1 Dyads Most Successful in Process Outcomes**

Dyads successfully achieving process outcomes are cases in which the objectives of the STEP program were met, based on the preponderance of interview data from the Fellows, the Project Officers, the Coordinator and the Cooperating Teachers at the high school. Thus, in dyads where STEP was most successful, there were reports of STEP encouraging academic rigor, innovation and/or better use of technology, creating mentorships and development opportunities for students and teachers and simultaneously providing Fellows with opportunities to plan, teach and communicate. These cases include Marietta High School in the first year of

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<sup>49</sup> Only participant reports of performance outcomes are used because the STEP program was not intended to affect standardized measures such as class or school test scores or grades. Therefore, this study prioritizes process outcomes.

hosting STEP, Westlake and Tri-Cities High Schools for all years, and Stone Mountain and Cedar Grove High Schools for all years. Rockdale Magnet High School was also highly successful, though the extent to which activities could be repeated without paid Fellows is unclear. These schools provided Fellows with sufficient and satisfactory teaching experiences overall, though there were scenarios in which a Fellow was over-utilized or underutilized by a particular teacher.

#### **6.4.2 Dyads Moderately Successful in Process Outcomes**

In high school environments where STEP was moderately successful, the Fellows added somewhat to teaching and learning, but not necessarily through functions that required their scholarly experience or STEM expertise. These cases are STEP's second year at Marietta High School and Dunwoody High School. In addition to losing STEP due to rotation throughout the county, Dunwoody High School was in the process of developing a new partnership with Northside Hospital, a prestigious hospital close to the school's campus. This new relationship would have likely lowered the need for a partner such as Georgia Tech. The majority of participants at Dunwoody were satisfied with the partnership, yet the Fellows and the Coordinator did not fully capitalize on STEM expertise or resources. In one example, the Dunwoody Coordinator did not spend her STEP supply budget to enhance her teaching during the course of the year. In another example, the female Fellow's mentoring of young females did not exclusively focus on academic success and advancement to higher education.

In the second year at Marietta, the Fellows did not fully utilize their STEM expertise, as they were mostly serving as second teachers in basic Algebra I courses. In these classes, they primarily delivered the curriculum as written. It was not clear if what the Fellows provided for

students was markedly different than what another adult not “exceptionally qualified” could have provided. Communication with the Coordinator actually decreased and Georgia Tech and the school did not become connected through faculty mentorships or the NSBE Jr. club. Instead of achieving a stable relationship with one or a few Teachers and then branching out, the Fellows rotated through Teachers in an attempt to find mutually satisfactory placements. This pattern continued throughout the second year and, for the majority of Fellows, teaching experiences were insufficient and/or not mutually beneficial.

#### **6.4.3 Dyads Least Successful in Process Outcomes**

The least successful Georgia Tech - high school dyads are the cases of North Springs High School (Fulton County), Druid Hills High School (DeKalb County) and Rockdale High School (Rockdale County). These cases are categorized as least successful, as opposed to unsuccessful, because they offered worthwhile experiences for many participants, such as students who were inspired or motivated by a Fellow. However, out of all of the dyads, these cases were least successful at achieving or sustaining STEP programmatic objectives.

In these cases, the STEP program had the potential to simultaneously serve the needs of the school, Fellows and Teachers, but a productive and mutually beneficial exchange was not sustained. Thus, the partnership did not reach its full potential for mutual reward.

In Fulton County, STEP did not lead to a lasting collaboration with North Springs because of the lack of reciprocity in communication. There was never a sense of mutuality and Teachers did not become more embedded with Georgia Tech personnel or programs. Though the first year was less rewarding than ideal for one Fellow, the collaboration ultimately ended due to one-way communication. This pattern was repeated at Rockdale County High School.

In DeKalb County, STEP failed to produce a lasting collaboration between Georgia Tech and Druid Hills because of the county’s decision to rotate schools. However, as with Dunwoody, other factors may have worked against success. Druid Hills’ Coordinator was young and not overly influential. The implementation model at that school featured high transaction costs because the Fellows were starting anew with different teachers and their specific needs throughout the year. It seemed that STEP had steady footing with the Coordinator only, who left the teaching profession at the end of the year. The other Teachers did not become embedded with Georgia Tech and did not have contact with the university after STEP left.

Table 3: Rating of Cases on Pre-Conditions (Stage 1) Variables at Introduction of STEP

Pre-Conditions Variables	Highest	Moderate	Low
X <sub>1</sub> embeddedness	Rockdale Magnet	Stone Mountain Druid Hills Cedar Grove Westlake	Dunwoody North Springs Rockdale County Marietta Tri-Cities
X <sub>2</sub> complimentarity of strategic needs	Westlake Tri-Cities Stone Mountain Cedar Grove	Rockdale Magnet Druid Hills Dunwoody Marietta	Rockdale County North Springs

Based on the groupings in Table 3, Rockdale Magnet High School should have had the easiest time with formation and operation of the partnership, as the pre-conditions of this relationship set the stage for operations characterized by low transaction costs. Though Westlake, Tri-Cities, Cedar Grove and Stone Mountain were new to Georgia Tech, the high complimentarity of strategic needs between Georgia Tech and these schools should have set the stage for working together and becoming embedded over time. According to case study logic, if one trend produces one result, then the opposite trend should produce the opposite result. Therefore, Rockdale County and North Springs should have had the roughest time with

partnership formation and operations. The data supported this prediction. Druid Hills, the only case with a moderate rating on both pre-conditions variables, was subject to be influenced by other factors. The Coordinator’s over-involvement, the disappointing computer-based labs and DeKalb County’s rotation plan may have had less effect if this dyad’s preconditions for successful partnership were stronger.

Table 4: Relationships Between Pre-Conditions Variables and Process Outcomes

Pre-Conditions Variables	Most Successful Cases	Moderately Successful Cases	Least Successful Cases
X <sub>1</sub> embeddedness	most prior contact of all cases	low or no prior contact or short history of working together	low or no prior contact, did not become more embedded over course of year
X <sub>2</sub> complimentarity of strategic needs	highest of all cases, except Rockdale Magnet, which does not fully meet Tech’s legitimacy needs due to low numbers of minority students in the magnet program	decreased over time or compromised by county policy	low

Table 4 shows relationships between schools’ ratings on pre-conditions variables and process outcomes. The most successful cases featured the highest embeddedness of prior relationships and the highest alignment of strategic needs between Georgia Tech and the school at the introduction of STEP and from year to year of operations. This finding is consistent with the logic model.

Embeddedness (X1): At the inception of the STEP program, the majority of high schools did not have an embedded relationship with Georgia Tech, much less extensive prior contact. The parties to the dyad have to interact with each other more and in more ways to become more embedded. The STEP program featured a full array of opportunities for the high school and the university to become more embedded over time - e.g., special programs and the formation of

new relationships. However, in some cases, embeddedness did not necessarily increase within one year or over multiple years of STEP's operation. This trend is predicted to hinder operations and lessen process outcomes.

In one example, according to STEP's year 2 annual evaluation report, the county level administration at Rockdale made no effort to interact with STEP's Project Officers. Though interview data is not available as to the motivations for not communicating, this scenario demonstrates one way in which two parties did not become more embedded over time though the presence of the program. Possible reasons for this outcome are lack of trust and prior history of short-lived or low-value university interaction. In another example, the DeKalb County central administration initially chose to rotate the placement of the STEP program among north and south county high schools to avoid appearing to favor one part of the county over another. Though this decision may have been politically sound, it shows how the county school system was not approaching STEP participation with the same ideas about developing meaningful and abiding relationships between school and university over time.

Complimentarity of Strategic Needs (X2): Strategic needs can be congruent when 2 or more parties need the same resource, such as STEM education personnel. In this scenario, parties may compete for the same resources. The strategic needs between Tech and the high schools are better described as complimentary, which means that needs may or may not be the same, but they can be met simultaneously through the STEP program.

There are two main types of strategic needs identified in this study: resource needs and legitimacy needs. Resource needs refer to the tangible resources such as scientific supplies for conducting experiments and lessons and intangible resources such as the development of scientific habits of mind including perseverance in the scientific process and comfort with its ups

and downs. Legitimacy needs refer to an organization's social and political standing and reputation.

Georgia Tech - high school dyads varied in the degree of complementarity of their strategic needs, and variance was also observed from year to year of operation at a particular school. Georgia Tech needed a context in which to provide Fellows, likely future professors, with real-life teaching experiences in which their ability to manage, communicate, and respond to diverse learning needs could be developed. The public high school environment, with its range of backgrounds and ability levels among teachers and students (who are also not practicing "scientists") provides the ideal environment for this need.

Georgia Tech's legitimacy need is to be viewed by the public and the state and local government as a contributing participant in the community at large. Georgia Tech also has a goal of maintaining its reputation as a leading producer of minority engineering graduates, which requires effective minority outreach. Finally, Tech must meet the second general criterion for National Science Foundation funding, which requires demonstration of value to society for funded research projects. The high schools' legitimacy needs are to be associated with a prestigious university such as Georgia Tech. The schools' exact resource needs varied. Outside of advanced classes, the schools posted below average scores on standardized math and science tests. Some schools lacked textbooks and supplies for basic experiments required by the curriculum. Overall, the need for supplies and ideas to improve STEM educational achievement among the participating high schools was pervasive.

Table 5: Activities (Stage 2) Variables for High School Cases

Activities Variables	Most Successful Cases	Moderately Successful Cases	Least Successful Cases
x <sub>3</sub> formation: agreement (action plans)	varied in level of early collaboration with school	varied in level of early collaboration with school	varied in level of early collaboration with school
focus	varied; ranged from academics in a course to mentoring out of class	Marietta - in classrooms Dunwoody – in classrooms and out of class mentoring	classrooms
x <sub>4</sub> operations: interdependence	high	medium to low	low
transaction costs	decreased over time as parties became more familiar with one another	did not decrease over time; parties did not become more familiar	did not decrease over time and may have increased
communication	mostly frequent and reciprocal between Tech and school and between Fellows and teachers; at Rockdale magnet between Fellows and students	not always reciprocal	Mostly one-way from university

As shown in Table 5, informal formation characteristics and interdependent program operations with reciprocal communication characterizes the more successful cases. Formation characteristics refer to the formality of the agreement allowing the STEP program to operate at a high school. Higher formality is predicted for participants with low embeddedness, as they are new to each other. The focus of the program refers to which aspect of high school education each year’s Fellows addressed at each school. For example, some teams of Fellows have addressed the development of extracurricular versus regular classroom activities. The focus of the program at each school was determined in different ways. In some cases, as in Marietta, the school defined the focus. In other cases, the Fellows saw a particular need and addressed it in an original way,

such as after school tutoring or special lessons on college preparatory skills. Expanded focus indicates overall growth; in these cases, new functions were added while initial duties were continued. Varied focus indicates that a new function was started at the cost of another; in these cases, there was a trade off of one task for another, not overall programmatic growth.

Table 5 also depicts the relationships between operational characteristics and process outcomes. Operational characteristics include the degree of interdependence between partners, the extent of transaction costs required to operate the program and the nature of communication among participants. Interdependence refers to the degree to which each party had to rely on the other to accomplish the goals of the STEP program. At schools where there was less embracing of the overall intent of STEP, there was a tendency for Fellows and/or the school faculty to simply “go through the motions” of complying with the minimal operational requirements. In these scenarios, neither party depended on the other to accomplish operational goals. In an opposite scenario, a school may depend on Fellows too much instead of learning how to internally produce what the Fellows contributed.

Transaction costs refer to the expenditure of tangible (money, supplies) and intangible (time, energy) resources to implement the STEP program at the high school. Parties who are positively embedded and/or more similar to each other are predicted to have lower overall transaction costs.

Communication characteristics are the modality, directionality and the frequency of communication. Most communication was by e-mail, though in some cases, high school teachers did not use e-mail as much as Fellows, creating somewhat of a lag in communication. Timing was also important feature of modality. The high schools typically indicated that they needed more advanced notice of special events at Georgia Tech due to the permissions and planning

required for a high school field trip. Teachers indicated that they needed more planning time to implement a Fellow's idea and, likewise, Fellows indicated that they needed more advanced notice to lead or contribute to a lesson. Most communication originated from the STEP Project Officers, though some teachers and students developed independent lines of communication with Tech faculty. The word of mouth of the STEP Fellows resulted in additional Fellow applicants and, in some cases, peer contribution to a STEP project.

The cases of Rockdale Magnet High School and Marietta High School are presented in greater detail in the following chapter for three reasons. First, the volume of data involved in presenting highly detailed case studies for each school is too great for a useful analysis. Second, examining the two selected cases in greater detail allows potentially unexplored variables to be identified. Third, the two schools examined in detail are not majority-minority schools. The majority-minority status of the other four core STEP schools is a special context that deserves treatment in a paper focused on the present and historical implications of that status.

## CHAPTER 7

### DETAILED ANALYSIS OF TWO HIGH SCHOOL CASES

#### 7.1 Rockdale Magnet High School – Hypothesis Accepted

##### 7.1.1 Stage 1: Pre-Conditions – Embeddedness and Strategic Needs

Students must perform strongly to gain admittance to this school's scientific research - based magnet program. Those admitted must continue to excel. Magnet students achieve high honors in secondary science and technology, including awards from the Intel International Science and Engineering Fair, the U.S. Patent Office, and the Siemens Westinghouse Competition in Math, Science, and Technology. The continued advanced achievement of these students is greatly enhanced by the expertise and resources of an institution such as Georgia Tech. These students have advanced mathematics, science, and technology courses and college-level research opportunities through a curriculum created in conjunction with Georgia Tech and high-tech industries. The Teachers and the Coordinator exuded a high level of enthusiasm for this unique magnet school, which probably benefited the STEP program.

By its third year, the magnet program operated in grades 9-12 with a maximum of 40 students in each class. The Magnet student body of 115 is comprised of 60% male, 40% female, 76% white, 14% black, 3% Hispanic and 6% Asian students.<sup>50</sup> Though not majority-minority, the minority students in the program could benefit from role models and mentors in the form of Fellows or university students or faculty.

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<sup>50</sup> Official demographic information from Rockdale Magnet School Administration.

### *The Fellows: Background, Motivations and Needs*

*Year 1:* Two doctoral Fellows were assigned to the school - an African –American female and a Caucasian male. They seemed to have envisioned serving students who appeared to be in greater need of mentoring. At first, they questioned their purpose and potential impact at the school. However, as the year progressed, they both concluded that they were meeting their original desire to serve students in need while gaining teaching skills.

*Year 2:* Again, two graduate Fellows were assigned to this school – an African-American, female Master’s students and a Caucasian, male doctoral student. Neither Fellow had educational training prior to STEP. Both Fellows wanted to grow as teachers through STEP.

*Year 3:* Three Caucasian Fellows were assigned to Rockdale Magnet in Year 3: a female engineering doctoral student, a male engineering master’s student and a male undergraduate in Computer Science. The undergraduate Fellow was the first at this school and an alumnus of the high school. He enjoyed his experiences as a Teaching Assistant and looked forward to returning to his hometown high school. His younger sister, a magnet student, told him about the STEP.

The female, doctoral Fellow wanted to explore the idea of teaching. She did not have any prior experience or education courses, but she had selected her advisor based on his reputation for community outreach. The male, master’s Fellow was curious about teaching and had participated in a GK-12 program at his undergraduate institution. He enjoyed working with kids and desired student interaction. He chose to delay graduation by one semester to pursue STEP and take more classes.

The Research I class was taught by a veteran science teacher with a geology background. After two successful prior years of working with STEP Fellows, she was eager to put the Year 3 Fellows to work. Interestingly, because STEP started at Rockdale Magnet when she did, this

teacher has never taught the research class without STEP Fellows. A high level of trust in both the STEP program and the Fellows proved to be especially important in year 3, as this teacher was absent for a month-long research project in the South Pole. This teacher has also led summer training sessions for STEP Fellows on Tech's campus, which adds another dimension to the embeddedness between Georgia Tech and this school.

### **7.1.2 Stage 2: Activities - Formation and Operational Characteristics**

*Year 1:* The Action Plan assigned the Fellows to assisting students with their individual research projects in the Research I (Freshman), Research II (Sophomore), and Research III (Junior) classes. These classes teach students the scientific method and related analytical skills and require them to conduct original scientific research. The students' research projects are regularly presented in local and regional science fairs. The Fellows were expected to mentor and tutor; teach research design and methodology; teach proper laboratory procedures; demonstrate oral presentations of research; and judge research symposia.

Most of these objectives were met in the first year. Both Fellows provided assistance with student research projects and enhanced lab skills. Depending on the expertise required, the Research I students were assigned to either the Teacher or one of the Fellows to receive individual instruction and assistance on their projects. The Fellows also taught whole class lessons on conducting and presenting scientific research.

Early in year 1, there was some confusion about the role of the Fellows because they were viewed as 'student teachers.' They were expected to lead the class, which they were not prepared to do. Once their role in the classroom was established, the Fellows focused solely on helping the students with their research and teaching them how to 'present science'.

The first year's Fellows formed a strong bond with the Cooperating Teacher in Research I. All aspects of their pairing seemed to create a special synergy that set a high standard for future Fellows. Both year 1 Fellows worked well above what was expected. They spent a substantial amount of time working with the students in and out of school. Because of this dedication, the Cooperating Teacher was comfortable with giving Fellows flexibility to make up time when a Fellow was particularly busy at Georgia Tech.

This year is characterized by the development of interdependence from early in STEP's placement. The Research I Teacher could not replace the individual attention or the range of content knowledge that the Fellows gave the students. The close relationship temporarily reduced trust between the Teacher and the second year Fellows, who began the year as strangers.

**Year 2:** The Teacher was entering her second year of working with Fellows in the Research I class. The focus in this year narrowed to 9<sup>th</sup> grade only, as opposed to working with research classes at all grade levels. She expressed that the Fellows were well utilized in this position because the Freshman year of the Magnet Program is “the biggest change. [The students] go from middle school to high school, and go from, for lack of a better word, an easy curriculum to a much more rigorous curriculum. They are not allowed to do projects like volcanoes; they have to come up with real scientific research.”

Developing competitive projects for local, state and regional Science Fairs was again a primary objective. The graduate students led their 9<sup>th</sup> grade students in the Research I class through the entire Science Fair process. Initially, Fellows helped the students choose their research topic, plan experiments, collect materials and perform experiments. Through this process, the graduate students became highly involved in the students' projects and did a lot of outside work on their behalf. For example, many students needed special materials for their projects that Fellow brought from labs at Georgia Tech. The Fellows also used community resources; one Fellow brought bacteria samples to a local hospital to be radiated for a project. The Fellows monitored the students' progress very closely and felt considerably concerned if a student was procrastinating and/or not on track to finish a quality project on time.

The Fellows worked with small groups of students, encouraging them to stay on track through the research process. Both Fellows formed close, one-on-one relationships with their

assigned groups of students and recorded the experiences of specific students by name in their journals. Although the Fellows consistently worked very hard help students with their Science Fair projects, they note that students sometimes were not as appreciative as they should have been. The students were very comfortable with asking for help from the Fellows, and the Fellows were often "bending over backwards" to help them get their projects done. Fellows and students were also in constant e-mail contact.

The Fellows maintained focus on their roles and objectives throughout the year. In the spring, the Coordinator noted, 'the Fellows ... are still working intensely with the students; they have not wavered.' Though the demands of the students' projects were intense, the Fellows remained motivated and interested throughout the year.

Fellows assumed mentor roles with the students, though these were mainly academic in nature. The students looked up to the Fellows for their research skills and knowledge. There were opportunities for more personal mentoring as well. One Fellow found that "the kids [in his class] have issues to deal with and may not want to talk about science every time that you are there." He concluded that being open with the adolescent students was an effective way to communicate.

Additionally, Fellows instructed students on organizing data into explainable displays and presenting their findings to judges in Science Fairs. The students practiced translating scientific data into presentations in class through PowerPoint presentations. Through their evaluation of the student projects, the Fellows 'tried to raise the bar' and challenge the students to complete more rigorous and authentic research projects.

In year 2, the Fellows initially feared that working with accelerated students in a magnet program would be "a waste of time" because they are less in need of role models and academic

help than average or struggling students. However, the consensus by the end of the year seemed to be that”...they are just kids... They needed us and really worked at understanding what we had to say.”

**Year 3:** By year 3, the Coordinator felt that the Fellows had mastered conveying research skills to the Research I Teacher. Thus, the focus expanded to involving other teachers while continuing to be a resource in Research I. The undergraduate Fellow successfully served in a physics class while the graduate Fellows continued in Research I.

During the most labor-intensive point in the research process, both graduate Fellows reported spending a minimum of 20 hours a week at the school, not to mention the time that they spent at Georgia Tech on behalf of the students. For many weeks, the graduate Fellows met the freshman researchers at the school on Saturdays. The empty hallways of the school on Saturday provided the ideal environment for the construction and use of equipment that might have resulted in injury to a passerby during the regular school day.

The female engineering Fellow recorded in her journal, “I looked up, and there were experiments going everywhere! It was great!” The students’ projects spanned scientific disciplines, but they commonly featured rigorous and replicable methods. In one corner of the room, school lunches were being composted; in another corner, a tank of roaches awaited trials of a supersonic bug-repelling device. If the Fellows were not familiar with a specific content area, they utilized the supplies and expertise of their colleagues on campus. The female engineering Fellow, though unfamiliar with Biology herself, obtained shuenella bacteria on campus for a student’s biology project. One student worked with a professor at Georgia Tech. A graduate student personally recruited by female Fellow mentored an African-American student.

Year 3 Fellows also taught the students (and teachers) basic statistics and data analysis skills to analyze research data. Using this kind of analysis with 14-year-old students and unfamiliar teachers posed some “roadblocks” that the Fellows creatively overcame. The female Fellow created a user-friendly ANOVA template in an Excel spreadsheet and prepared statistics lessons that did not depend on advanced mathematics. She also presented an ANOVA lab using M and M candy pieces. The Coordinator reported that the Physics teacher was pleased with the fresh ideas and energy of the undergraduate Fellow.

The undergraduate Fellow was aware that his schedule and placement differed from the graduate Fellows, so he prepared a separate Action Plan. He felt that as a CS major, focusing on incorporating technology was the best way to leverage his skills. He intended to bring as much technology into the classroom as possible, yet he also recognized the practical limitations of the high school. He worked with a male, 11<sup>th</sup> grade Physics teacher. Since physics was not his area of academic specialty, he reviewed major physics concepts in preparation for this assignment. In this scenario, a mismatch of Fellow’s content expertise to the class benefited both the Fellow and teacher; the Fellow’s own knowledge base grew and he was still beneficial in the classroom.

The undergraduate Fellow reported that the teacher let him “take it and run.” On the days that he was present, the Fellow was free to utilize the entire 2-hour class period to lead the students through laboratory experiments. He liked that his Cooperating Teacher allowed him so much professional leeway. He commented, “You need space to develop your own teaching skills.” Working with the Teacher, he prepared labs based on curricular requirements. Since there were approximately 10-12 days between each lab, the Fellow planned with the teacher mostly through e-mail. The undergraduate Fellow discovered that technology did not improve every lesson, although he felt that his best teaching day was his presentation of a computer

simulation tool called “Working Model.” He had worried that physics subject matter would be beyond his comfort zone or usefulness. However, he found that the few hours he spent reading a physics text and the summer microteaching sessions sufficiently prepared him. He did not report any bureaucratic problems with using technology at the school, and the teacher was able to use the software application that he introduced.

In year 3, the male master’s Fellow attended students’ sports events and characterized being with the students as a stress-reliving break from his other academic activities. The female doctoral Fellow was in constant e-mail communication with the students as they worked on their projects at night and on the weekends. The graduate Fellows seemed to respect the freshman students as up and coming scientists. The female ME Fellow was impressed with a female student’s hard work and called her “a true engineer.”

***Comparison Across Years:*** Both Year 1 Fellows worked well above what they were expected to do, and year 2 and 3 Fellows were expected to do (and did) the same. Over three years, the Fellows exposed the magnet students to a range of STEM academic programs and career paths. Year 3 Fellows provided particularly good exposure to lesser-known fields within STEM, such as acoustics. During a unit on STEM careers, a year 3 Fellow shared his thought processes as he chose to forgo an engineering graduate program to enroll in medical school.

Rockdale Magnet High School was pleased with the Fellows’ performance and level of commitment. Overall, the working relationships among Coordinator, Teachers and Fellows were very positive. Each set of Fellows and the main Cooperating Teacher worked well as a team and respected each other as professionals. A Year 2 Fellow noted, “[the teacher] is fun to work with, even though at times she seems to be a little disorganized, she is very open to new ideas.” Open

channels of communication and collaborative planning characterized all three years. Frequent interactions with the program Coordinator gave the Fellows a chance to ‘touch base’ and discuss any problems or concerns. The Coordinator expressed that she wished she had more time to tap into the Fellows’ expertise.

The graduate Fellows enjoyed being at Rockdale Magnet and felt like colleagues of the school’s faculty. They frequently joined Teachers and the Coordinator for lunch and/or social events. The relationships seemed to become more personal over the years. The school staff placed a great deal of trust in the Fellows and engaged in open, reciprocal communication. The Fellows reported spending some time every day planning with the Teacher or Coordinator in person, by phone, or through e-mail.

The Fellows reported that the Teachers and Coordinator appreciated them and respected their boundaries. In year 3, a student lost the privilege of working at Georgia Tech because of poor behavior. The Teacher and Coordinator quickly responded so that the Fellows were not burdened by an inappropriate problem. When a Year 3 Fellow expressed concern over projects not progressing, the Coordinator reminded him that he was not personally responsible for the students’ success.

All of the Fellows reported great satisfaction overall. The Fellows helped the students do many kinds of research projects. For example, one year 3 project tested the acoustics of different kinds of baseball bats. This project required obtaining bats constructed of different materials, bolting a swinging device from a door overhang and recording bat and ambient noise. The noise data from multiple readings were then analyzed.

Typically, in the Spring, after the research projects were complete and science fairs were over, the Fellows did not lessen their contributions or teaching experience. In year 3, through the

cooperation of many Teachers, they presented a forensics unit in which the students had to solve the murder of a Fellow. The Fellows brought innovation to Rockdale Magnet in many ways. Their advanced project ideas and the know-how to make the research process physically possible enabled the students to do far more than they could have done without a Fellow. The Fellows, with their years of research experience and scientific self-confidence, helped the students borrow or build an impressive range of equipment that translated research ideas into actual experiments.

The Fellows found working with their students a very positive experience because of the enthusiasm and skill level of the students. The Fellows could introduce very complex and advanced concepts to their students. Over the years, the Fellows tried to shape and encourage certain students with poor social and/or coping skills.

However, the Fellows' experiences were not without rough spots. Earlier Fellows expressed doubt over their purpose and potential benefit at the school. Year 3 Fellows were surprised to encounter social and behavioral issues, as the magnet students were not considered "at-risk." In Year 3 alone, one student committed plagiarism and then tried to triangulate the Fellows in the discipline process; the master's Fellow intervened in a conversation about underage drinking; and one student suddenly withdrew to attend military school. This event affected the female doctoral Fellow, who had tried throughout the year to positively shape this student's behavior.

### **7.1.3 Stage 3: Process Outcomes – Teaching, Relationship Building and Innovating**

All of the participants felt that the effects of the STEP program could be seen in the students' performance in the classroom and in competitions. For example, one Fellow noted of the students, 'they've come a long way in their ability to communicate science to each other'. The Fellows consistently noted having very enjoyable experiences, and the Coordinator was consistently satisfied with the STEP program.

The Fellows enhanced academic quality in many ways. They gave interesting, yet realistic, ideas for projects, ordered relevant supplies, built needed equipment, guided experimentation and data collection and helped the students to analyze their results. They provided access to equipment and supplies at the university. In Year 3, the master's Fellow secured the donation of an \$8,000 Carbon Dioxide incubator for growing tissue cultures that his lab did not need.

The performance outcomes for this case were science project quality. During year 2, over half of the 17 freshman students competing in the Regional Science Fair went on to the state competition and one student advanced to an International Science Fair. The Coordinator commented that the long-term impact of having been taught by a Fellow was evident in projects in future grades. Though Fellows almost exclusively worked in the freshman Research I class, many alumni of this class are applying what they learned in higher grades. Thus, having been exposed to the Fellows seems to be better preparing these students to advance in college.

For the magnet students, test scores and general academic achievement are not areas that need improvement. In this case, the Fellows impacted the ability of these students to go all the way through the STEM pipeline by providing ideas, motivation, and inspiring real life examples. The Coordinator appreciated that the Fellows "put a face with scientists and engineers - one

that's not 70 years old with frizzled out hair like Einstein. Public education in general has stereotyped scientists and engineers as being nerds...but [the Fellows] are like normal, well-balanced people. I think the biggest impact is that my students understand now that you can be a scientist and be a normal person.”

None of the Fellows enjoyed the discipline aspects of high school teaching. The graduate Fellows had to engage in more classroom discipline when the Teacher was absent, and they disliked the experience. In Year 3, the undergraduate Fellow concluded that he preferred college teaching in order to avoid “counseling and discipline versus just pure teaching.”

Over three years, the STEP program fulfilled the Coordinator's goal of increasing the connections between Rockdale Magnet and Georgia Tech. The year 3 Fellows hosted the entire magnet student body, approximately 70 students, for an overnight visit to campus. During this visit, the female engineering Fellow gave them a tour of the acoustics chambers that she utilized in her research. The male graduate Fellow did not have the same easy access to a lab since he was not writing a thesis, but he participated in this visit. He also sent out an email to faculty explaining the STEP program and asking for mentors and lab space.

The graduate Fellows connected university faculty and other graduate students to the high school, resulting in mentoring of students, guest speakers visiting the school and the exchange of equipment and supplies. One professor guided a student through a research project from start to finish. An African-American graduate student who was a colleague of a Fellow mentored one of the few African-American magnet students, building equipment for experiments and providing encouragement. This scenario reveals a different aspect of addressing minority needs through the STEP program. Though Rockdale Magnet may not have a large minority population, the few minorities in the program have a real need for role models that would otherwise not be met. The

Coordinator relished these connections and requested a list of faculty and graduate students willing to be involved at Rockdale Magnet.

Many Fellows reported feeling the strain of the Fellowship and their studies, yet they consistently seemed to be energized by the experience. None reported significant delay or poor academic performance due to STEP.

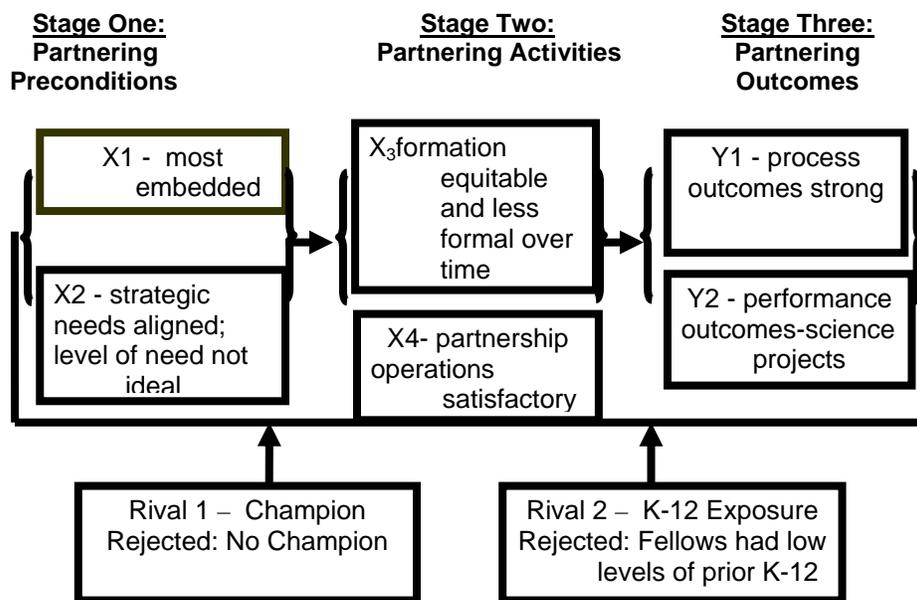


Figure 4: Model of Rockdale Magnet High School Case – Hypothesis Accepted

#### 7.1.4 Rating of High School Case on Variables

**X1: Embeddedness** High. The Magnet/STEP Coordinator had a good working relationship with Georgia Tech’s College of Engineering. STEP caused embeddedness to grow over time. For example, the Research I Teacher completed the GIFT program and taught at STEP’s summer training sessions on campus.

**X2: Strategic Needs** The strategic needs of the high school and Georgia Tech were complimentary. The high school needed to make a strong investment in the academic quality of its faculty, curriculum and student projects. Fellows serving in this capacity gained teaching and communication skills as specific teaching and learning goals at the school were furthered. There was extensive value added through mentorships arranged between faculty and high school students and Fellows' peers and high school students.

**X3: Partnership Formation** The formation of the partnership between Georgia Tech and this high school featured a high degree of mutuality. The Magnet/STEP Coordinator and STEP's Project Officers had mutual input into the decision to keep STEP at the school.<sup>51</sup> The focus on academic enrichment through more authentic scientific experiences and lessons remained consistent even as the STEP program involved more Teachers.

**X4: Partnership Operations** STEP joined this school in its first year of grant funding and the relationship grew positively over 3 years. Communication among Fellows, Teachers and Coordinator became less formal and more collegial as trust and understanding grew. Interdependence was the highest among all cases.

**Y1: Process Outcomes** The Georgia Tech-Rockdale Magnet dyad consistently met all of STEP's programmatic objectives over the first three years of operation. The Fellows brought innovation and rigor to the classroom. They informed and inspired Teachers, students and the Coordinator.

**Y2: Performance Outcomes** Students showed strongly in science fair competitions, yet the degree to which these results could be achieved without Fellows is not clear. The school is

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<sup>51</sup> The high school being analyzed in detail is a typically sized high school for metropolitan Atlanta, but it is part of a small school system. It could be reasonably predicted that size of the school system plays some part in partnership formation and operation that should be studied further. For example, it may be easier to have teacher input at a strategic level when a system is smaller.

better able to improve its programs after exposure to the Fellows' range of content knowledge and methodological skills, such as statistical analysis. However, incorporating everything that the Fellows offered may be difficult without external support.

The hypothesis is accepted for this case because this dyad featured the highest levels of embeddedness among all cases, moderate to high alignment of strategic needs and subsequently met all of the process outcomes of the STEP program. One weakness in alignment of strategic needs is that Rockdale Magnet is not a majority-minority school, which lessens Georgia Tech's legitimacy need for minority outreach. However, though majority white, the surrounding Rockdale County High School is part of a low to moderate-income community. There are minority students attending both the regular and magnet programs.

A strong case could be made for the Coordinator functioning as a champion, and the Project Officers actually held this view. However, the interest (and reported jealousy) of the Teachers not hosting Fellows shows buy-in to STEP not dependent on the Coordinator. Furthermore, the Fellows, especially in year 3, enjoyed engaging in collegial contact with the Teachers outside of the school.

## **7.2 Marietta High School Case – Hypothesis Accepted**

### **7.2.1 Stage 1: Preconditions – Embeddedness and Strategic Needs**

Marietta High School did not have a prior relationship with Georgia Tech, but it did have established relationships with another local university. The school brought a specific need to the table when forming the partnership - building a strong math foundation in its freshman students as a school-wide goal. The Coordinator thought that the Fellows could assist in this endeavor just as well in the regular classroom as in the math lab. The first year's math lab provided innovative, hands-on lessons that were enjoyed by teachers and students and established baseline expectations for the next year's Fellows.

***Year 1:*** Marietta High School worked with two male, graduate engineering Fellows in STEP's first year at the school (2001 -2002). One Fellow was an African-American doctoral student, and the other was a Caucasian master's student hoping to pursue a doctoral program. The doctoral Fellow pursued the STEP Program to learn more about teaching and to gain some practical teaching experience. Although he had not taken any formal education classes, he expressed interest in a career as a high school or middle school teacher. The master's Fellow did not have prior K-12 training. He was attracted to STEP for many reasons - helping students, gaining teaching experience and developing inter-personal skills. He saw the STEP program as an opportunity to improve his communication skills, which would help him excel in an industry career.

***Year 2:*** Four Fellows were assigned in STEP's second year. Two were male, doctoral Fellows in engineering - an African-American Fellow in Mechanical Engineering (ME) and a Caucasian Fellow in Biomedical Engineering (BMED).

The graduate Fellows met each other for the first time through the STEP program and were not able to work together because of scheduling conflicts. The undergraduate Fellows started the year together in one classroom, but eventually worked individually. Some of the Fellows had tutoring experience, but none had extensive K-12 exposure.

In the summer preceding the second year, the ME Fellow's enthusiasm to improve student performance manifested through a scientific approach to learning. He explained his developing plans in his summer journal. "Today I brainstormed about the idea of looking at ways to measure a student's improvement and being able to integrate that into a student's grade. I was interested in rewarding (academically), students that get behind (but trying still, of course), then modifying what they are doing to improve their learning. I think such a thing should be attempted to be measured and integrated into a student's grade." His summer journal reveals that he thought deeply about teaching and learning styles in preparation for the school year, and he set a personal goal of using more visual aids to teach math. He also planned to set up an online interface for high school students to request individual tutoring from the Fellows.

The BMED Fellow did not have prior teaching training or experience. He was studying computer assisted mathematical modeling of neurons and had not had any research assistant or teaching assistant positions at Georgia Tech. He enjoyed both being around children and explaining information to his peers. He became aware of the STEP program by interacting with previous Fellows at Tech. The stipend was attractive, but it was not a dramatic change from his prior employment. His advisor was supportive and not overly concerned that STEP might slow his overall progress in his doctoral program. In his fall interview, he expressed that his first few weeks at the school left him feeling "struck by what it takes to be an effective teacher." He

appreciated the realistic preparation provided by the microteaching experience during the summer training. He felt that more microteaching should be added to the summer training.

The other two were female undergraduates in Industrial Engineering (one African-American and one Caucasian). The two undergraduate Fellows were attracted to STEP for the general professional experience, the potential for personal growth, and a desire to be involved in mentoring. They expressed that the being outgoing and having good communication and leadership skills could help them in any employment setting. They both considered the funding to be a bonus, but not their primary motivation for doing the program. Neither of them had served as a teaching assistant. One undergraduate had actually investigated the feasibility of doing a joint undergraduate program while at Georgia Tech that would lead to teaching certification. To her disappointment, this program had been discontinued. Both had considered K-12 teaching as a career option. As undergraduates, neither had research experience, and they were aware that this set them apart from the graduate Fellows. As undergraduates, they also had little contact with an advisor. Their peers thought of their STEP service as everything from neat to strange and wondered if they had to worry about being mistaken for a high school student.

### **7.2.2 Stage 2: Activities - Formation and Operations**

*Year 1:* The first year's action plan reflected the Fellows' interests. The Fellows met with the Coordinator several times for planning during the summer and began the year with "clear goals". Marietta also established the first out-of-class implementation model among STEP schools. This model was chosen because both of the Fellows and the Coordinator were "strong advocates of using manipulatives (hands on activities to explain concepts) in the classroom [and wanted] to see more teachers using them." The Coordinator felt that having the Fellows demonstrate hands-on math activities would result in incorporation of these activities into regular classroom teaching. The Coordinator considered the STEP program to be a promising vehicle to encourage best practices. In this way, the high school was capitalizing on the ability of STEP to introduce innovation.

The first year Fellows had above-average working conditions - two separate workstations, a private office for planning and a full classroom for use as the math laboratory. The Fellows were ready to jump into the classroom right away, but the Coordinator had them observing and planning for the first few weeks of school. When they finally interacted with students, they found themselves better prepared. Interactions with the students were limited toward the end of the year because the Fellows changed focus to technical training for the teachers. While initially nervous, the Fellows found the first few classes to be a pleasant surprise. Of their first lab class, the Master's Fellow notes, "this was our first interaction with a class and we had a blast. The kids seemed very interested in what we had to say and were on their best behavior. I hope that most of the other classes we will work with will be so well behaved and attentive."

During the first semester of year 1, they worked exclusively with Algebra I teachers (9th and 10th grade students), finding some more receptive than others to their hands-on math approach. Teachers could schedule times for their classes to visit the Fellows for a lab that would complement the classroom curriculum. Out of seven Algebra I classes, four to five teachers regularly scheduled their classes to visit the Fellows' lab.

By the second half of year 1, teachers from throughout the school were interested in having their students perform math labs, and the program was opened up to include other classes, e.g., Algebra II and Calculus. Before they began these new modules, the Fellows and the Coordinator paused for additional planning and conducted "lots of brainstorming and meeting with teachers from the various subjects." The Master's Fellow expressed excitement about working with more students and more subjects, but he was also concerned about being able to handle an increased workload (and decreased planning time).

The Fellows introduced the high school teachers to a math-based software program designed to enhance computer usage in mathematics, tutored students and worked with the school's Math Team. They worked as a pair throughout the year and always attended the school together.

The Coordinator acted as the Fellows' main contact when they needed to obtain supplies or just "touch base." She was not involved in scheduling lab sessions. The Fellows were fond of the Coordinator, as expressed in the following journal entry by a Fellow: "I learned so much from [our Coordinator]. I learned how to implement new ideas in a political environment. She taught me quiet leadership. She not only teaches well, she knows how to help others teach at her level without, telling them to do it. She leads by example and uses the necessary resources to let others see her genius." The Coordinator worked hard to make the Fellows feel comfortable,

initially contacting them regularly and visiting their laboratories at Georgia Tech. She also provided continual support throughout the year. The Coordinator likewise praised the Fellows and reflected fondly on brainstorming with them in her office. She felt professionally engaged by the Fellows, and she started to think that she should share their wealth of inspiration and information with other teachers in the coming years.

During the first year, the Fellows were concerned about being accepted by the Teachers. Becoming a regular part of high school life seemed like a challenge from the vantage point of the lab versus a regular classroom. The Master's Fellow stated in his summer journal that, "I am worried that we might encounter some resistance from the teachers as well as the students". The Fellows also worried that their affiliation as graduate students and the novelty of the math labs may form a barrier between themselves and the rest of the school.

However, the Fellows found that most of the teachers embraced the math lab lessons. The teachers' acceptance helped the Fellows to think of themselves as an important part of the high school environment. Several teachers included questions from the Fellows' lab experiments on their tests. The Fellows were pleased, as they did not want their contributions to be considered just extra activities. The Fellows also found that "placing emphasis on these labs in terms of grades ... makes our labs much more comfortable for us to conduct since the students are motivated."

By the second half of the year, several teachers (mostly regular visitors to the math labs) were performing the Fellows' activities in their own classrooms, without the Fellows' assistance. The Master's Fellow was impressed to "see the teachers starting to warm to the idea of using hands-on activities as a learning tool." The Fellows felt that their activities gave the teachers an important new teaching tool and hoped that the new practices would continue over the years.

The Fellows were impressed with the teachers' ability to control their classes and establish rapport with students. They were surprised by the career diversity among the teachers, with lawyers, scientists and engineers teaching in the classroom. The Fellows' formed special bonds with certain teachers and found it exciting when their classes would return for additional labs. The doctoral Fellow noted early in the year that one of the most enjoyable aspects of the STEP experience was "learning all the different teaching styles and seeing how the students take on the teacher's personality. Some teachers are actually trying to incorporate labs (which I never had in Algebra), do more than lecture, which is good for the students who have a hard time catching on to the lecture style." The Fellows learned by observing the teachers who attended their labs and sought to keep the lines of communication between themselves, teachers and students open.

The first year Fellows ran staff development projects on the incorporation of hands-on activities in the classroom. They used the last few weeks of the year to show the teachers how to use software packages and multimedia tools useful in math classes. Often, the teachers embraced the subject matter presented by the Fellows, while, on occasion, the teachers were 'as bad as the kids', and seemed forced to be there. Marietta was the only school to use STEP for organized teacher professional development.

The first year Fellows enjoyed working with the students. It was very important to them that they provided something useful. The Master's Fellow was concerned that students not only enjoy themselves, but also understand "the big concepts" from the labs. The Fellows found that student feedback "greatly affects how we present the same ideas to different classes."

The Master's Fellow noted in the follow up interview that one of the most profound moments working with students was, "when you see the light come on in the student's mind

during an activity and they suddenly realize that math is an applied subject. It makes this experience incredibly satisfying. We had several of these ah-ha moments today with our classes.” The Fellows especially enjoyed their experience when the students embraced the concepts underlying the labs. They also found it particularly rewarding when students got excited about a lab experiment or expressed interested in science and math.

The first year Fellows agreed that the worst part of their STEP experience was having a group of students who were so difficult to work with they could not get through their planned activities. The instances of unruly classes decreased as the Fellows’ teaching experience increased. The doctoral Fellow initially feared that his quiet personality would make it difficult to keep the students’ attention, but this was only an issue in a fraction of classes.

Both Fellows regretted not being able to form close relationships with students because they worked with so many different classes. The doctoral Fellow expressed a desire to have more contact with students in a mentor capacity as an African-American male role model. Although he did not work closely with individual students, he expressed that the students respected him and the other Fellow.

STEP allowed the Fellows to ‘get a taste’ of teaching without having to handle a whole class independently. They gained confidence in their ability to relate to the students and found that the more confident they were, the better the students responded to their activities. They were concerned early on about developing a method for obtaining feedback from teachers and students to measure the effectiveness of their labs. They created and administered “a feedback form” to give the students after the completion of a lab. The results indicated that almost 90% of students felt the lab activities helped them better understand classroom curriculum.

The Fellows spent a lot of time planning their activities and putting materials together. They found it rewarding when their experiments worked well; they wanted their experiments to convey core Algebra concepts while still being fun.

The first year Master's Fellow summed up his STEP experience this way:

*I have thoroughly enjoyed my experience as a STEP Fellow. I have accomplished all that I set out to during my year at MHS. I was able to teach (during lab lectures) in a class setting, work with students in small groups (during labs) and individually (tutoring), and I would like to think that we did a good job of making math seem more 'real' to the students. Would I have liked to have done more (more class teaching, etc.), probably, but I am quite content with how this experience went."*

All participants in the second year reported some degree of dissatisfaction with communication. The most common complaint was a lack of collaborative planning time. Fellows reported not having enough time to plan with their Cooperating Teachers, who reported the same. The Teachers and Coordinator noted that invitations to special events at Georgia Tech were not sent far enough in advance to obtain required permissions or to make transportation arrangements. Most communication between Fellows, Teachers and the Coordinator was through e-mail. However, communication lessened between Fellows, Teachers and Coordinators in year 2.

The management of the dissatisfaction with one Fellow also reveals weaknesses in the communication patterns at this school. The Coordinator did not fault the STEP program but indicated that this Fellow's performance would have been treated more seriously if she were a student teacher preparing to have her own classroom. Thus, the school did not assert its position as strongly as it would have because it viewed STEP as a special program. One Teacher underscored that this scenario was only an isolated experience with one Fellow, but memories of these incidents came through strongly in interviews at the start of the Step Up program. The

Coordinator noted that the second year's implementation model placed her in a novel role - being the manager of the relationship between Teachers and Fellows. She expressed that this new role resulted in reduction in time for planning how to use the Fellows for academic purposes.

*Year 2:* STEP's second year at the school was characterized by new dynamics from the start – the focus changed, the Coordinator's job title changed and the number of Fellows doubled. At the opening of the second year, the Coordinator introduced the Fellows to Teachers at a math department meeting and explained how they could be a resource in the regular classroom. She then visited Teachers individually to confirm their commitment to hosting a Fellow. In the second year, she maintained her background role, but also took on the duties of being a mediator between Fellows and Teachers and a sounding board for both. In the second year, she had to monitor many more Fellow-Teacher relationships and respond to the newly developing dissatisfaction among the Teachers. She commented that interacting with the Teachers concerning STEP, not the STEP Fellows or the STEP program, was the main administrative time burden of being Coordinator.

The second year Fellows spent the summer planning together and reflecting on differences in their nascent teaching styles. Despite the changes from year 1, they did not have formal planning with school officials over the summer. The goals for these Fellows included the following:

- Starting a NSBE Jr. Chapter (that would meet after school)
- Enhancing the tutoring program and improving the number of participants
- Hosting a College Fair and/or Career Fair
- Using the Fellows' webpage to collect data from students

- Teaching study skills through tutoring
- Providing links to applications for summer programs and colleges on the webpage

As opposed to the first year, differing schedules forced the Fellows to work separately.

An early excerpt from the ME Fellow's fall journal entry revealed that the reality of being at the school had set in. He wrote:

*I have begun the 2<sup>nd</sup> week ... and things have gone pretty well, so far. The teachers exhibit a lot of excitement about the Fellows. [We] have been separated as a result of our different schedules this semester. I have noticed the Fellows' ability to work on our team objectives have easily been diminished by this result. Communication only happens with email, and that means delays with our communications. We are going to have to make extra efforts to fight this, in order to successfully accomplish our objectives. Otherwise, it may only be more feasible for us to work on our individual goals at the high school.*

The Coordinator reported that the Teachers started the second year eager to host Fellows, but that they really did not know what to do with them. She noted, "this year we tried to meet different interests and different needs, but twice as many Fellows is a bit of a challenge." She still expressed enjoyment with working with the Fellows and did not have a strong preference for either an in-class or an out-of-class implementation model. She expressed strong approval of the consistence and dedication that characterized the way the BMED Fellow started his Fellowship.

The second year Fellows did not have as much contact with the Coordinator, partly because she was out of the building many days attending to duties at a nearby middle school. The BMED Fellow reported that he went to her only when a Teacher could not sufficiently answer a question or concern. Even though she was spread thin by multiple commitments, she continued to dedicate what time she had to interacting with the Fellows. The undergraduate Fellows reported that the Coordinator encouraged them to look into a teaching career and was enthusiastic about helping them apply to teach full-time at the high school. The undergraduate

Fellows reported no significant interaction with the Coordinator, other than when she encouraged them to apply for a teaching position. Neither undergraduate Fellow followed up on this offer.

The BMED Fellow commented in his fall interview that the action plan did not seem relevant or important once the year was in progress. He knew that the school had set an increased passing rate in algebra 1 as an objective for STEP's second year, but the Fellows were not yet actively assessing this measure. As was typical with other STEP schools, all of the Fellows at this school reported that the daily relevance of the Action Plan quickly diminished once the school year was in progress. However, the overarching goals of improving and innovating teaching and learning guided their plans and actions.

The second year Fellows experienced different dynamics with the Teachers due to being in their classrooms. All of the Fellows reported that their primary experience was acting as an additional teacher, leading small groups or giving help to individual students. Occasionally, the Fellows lectured or led an activity, but there were rarely deviations from the standard curriculum.

The ME Fellow was frustrated by not being taken as seriously as he would have liked. He reported that a Teacher repeatedly "forgot" scheduled meetings with him after-school. This Fellow was only able to get the Teacher to give extra credit, not a standard grade, for making a web page with him. The Fellows' typical experience in year 2 was assisting in the delivery of standard curriculum, not leading an original lesson or having the students be graded for work assigned by them.

The undergraduate Fellows seemed to go back and forth between being underutilized and having too much expected of them. One undergraduate commented about her relationship with the teachers, "we're like friends, like I'm there to help. I think I'm seen as someone just there to help." This relationship is a departure from the role of the Fellow as an exceptionally qualified

resource. On the other hand, the other undergraduate Fellow related that it was too easy to expect too much from her. She explained her relationship with one cooperating teacher this way: “I feel like he thinks I’m a genius. I don’t want to put him down... He wants me to put all this Industrial Engineering in Algebra. A lot of principles in Algebra II just don’t have any correlation... It add a little pressure.” The other undergraduate Fellow found herself in a similar situation when she worked in a chemistry class in the second semester. She commented, “this [assignment] has been a little strange. I feel like I’m not adding a lot to the class. This is an International Baccalaureate class and they are really bright. And I haven’t taken Chemistry in a while.” She indicated that this scenario made her more like a student teacher in that class, because she was not able to add much content knowledge or rigor. The Cooperating Teacher for this class confirmed this interpretation.

The second year Fellows did not lead staff development activities or introduce the teachers to new technologies or practices. They reported minimal, if any, use of the previous year’s CD or notebook of activities. They enjoyed working with the Teachers, but they did not report the level of admiration and respect that the first year’s Fellows reported. The BMED Fellow formed a friendly relationship with his primary Cooperating Teacher and kept in touch with her after the year ended. This teacher was able to show the Fellow how hard it is to be a teacher; however, instead of exchanging classroom skills for STEM expertise, they seemed to go through the year together as co-teachers.

Interestingly, the year 2 Fellows had more individual contact with students but did not engage in mentoring. Only the BMED Fellow was reported by a Teacher to have acted as a mentor to students. The other Fellows had more rotation through various classrooms throughout the year, which worked against the formation of the continuous relationships necessary to make

an impact. The female undergraduate Fellows disappointed the school's expectations for mentoring, but they did provide role models for underrepresented groups. Though the undergraduate Fellows did not engage in intensive mentoring or out-of-class contact with the female students, they were real examples of intelligent young women excelling in a STEM field.

The BMED Fellow started the year determined to make a difference in the students' lives. After meeting the students in an all-male algebra 1 class, he opened his fall journal with the sentence "even though everyone says that you can't help them all...I think I can." As the year progressed, he became very involved in after-school tutoring. He devised an innovative plan to use after-school tutoring to reach the neediest of students. He wrote about it in his journal this way "[the teacher] gives a lot of detentions. I can't tutor them if they are all serving detention in the cafeteria. I tried to talk her into letting them serve detention in the classroom, but she doesn't like that idea. I'm going to keep trying to convince her...I think I can." The teacher finally agreed to his plan, though he noted that it "wasn't an easy battle to win." At first, this plan worked well, and many struggling students received individual or small group attention.

The ME Fellow was frustrated by what seemed to be insurmountable odds stacked against students in a system desensitized to these factors. He wrote in his fall journal:

*The gross lack of concern on the part of the students as well as the families and the lack of preparation are enormous factors, and it appears as though these factors are not addressed at all by the course. The background deficiencies play a big part in the children's ability to not only grasp the material, but to feel comfortable doing so. They get too intimidated and respond with fear instead of telling themselves that they are capable of rising to the challenge. They are ruling themselves out of the competition on their own. The strong presence of these things in the classroom is difficult to combat through a single fellow and a single teacher.*

This Fellow experienced somewhat of a reprieve when he transferred to two advanced classes in the second semester. His increased enjoyment seemed to come from the relevance of the material in the IB track Physical Science and AP Physics classes to the Fellow's course of

study at Georgia Tech. He also more strongly identified with the AP Physics teacher, who was himself a physical chemist. The Fellow appreciated the way that the teacher conveyed physics concepts at the “atomic level.” In this placement, instead of indicating feelings of no efficacy, the Fellow thought of himself as contributing to the academic rigor of the classroom. He commented in his journal, “As a mechanical engineer, I feel that I bring a good macroscopic balance to the classroom topics...”

During their spring interviews, all of the Fellows expressed regret over not being able to provide the students with more exposure to Georgia Tech’s campus. They reported being limited by a lack of time to plan these kinds of special events. The two undergraduate Fellows indicated an additional limitation unique to them. They shared that they would like to bring the school and university into greater contact, but that they did not have the close working relationships with faculty or the access to laboratories that characterizes a graduate student’s program. The Project Officers encouraged them to approach two female engineering faculty at Georgia Tech with whom they were familiar, but this initiative did not form into anything solid at the school during year 2.

The undergraduate Fellow who struggled and rotated placements at first found more of a niche in the second semester. This allowed her to interact with students in ways that were more rewarding. She wrote in her spring journal:

*I think that my greatest accomplishment being a STEP Fellow was being able to have an impact on the older kids in [the algebra II repeater] class. These students were either juniors or graduating seniors working towards higher education so I served as somewhat of a guidance counselor and mentor to them, making them aware of scholarships available, SAT/ACT deadlines, and information on local colleges.*

In the second year, the BMED Fellow’s Cooperating Teacher reported that he projected sincere interest in the students. Other Teachers and the Coordinator echoed this sentiment and

were very pleased with his dedication and consistency. The primary Cooperating Teacher commented that it was a good idea to have a male role model in an all-male class. This Fellow expected the maximum amount of effort and good behavior from the students at all times, but he did so with personal interest and encouragement. When the Teacher lamented over low turnout at after-school tutoring, the Fellow stepped in and offered regular tutoring sessions. The teacher was pleasantly surprised at the turnout for these sessions, and the Fellow offered to be “on-call” for students needing after school tutoring on other days. This Fellow also attended student football and basketball games, where he became known by the parents. During the regular school day, he was comfortable speaking sternly to disruptive students in the hallway. In one such incident, the student replied that the Fellow was the only adult who had simultaneously disciplined him and told him that he was smart.

In another class, he instructed the students to read their notes during lunch to prepare for an afternoon class. Though prepping for class over lunch may be typical for a graduate student, the high school students were stunned by this idea. Though only some of the students complied with his request, they (and the teacher) were at least exposed to this aspect of scholarship.

The BMED Fellow was moved by the struggles of many students, and he became sensitive to the role that these factors play in academic outcomes. In his journal, he recorded his experiences with trying to reach one at-risk young man: “There is one guy [who] is a problem. He has an attitude problem, talks back to the teacher, doesn’t do any work or homework, fails the test, and doesn’t have the basic math skills to do this class. I’ve tried to ‘reach’ him but he just acts like he hates me. [The teacher] said she thinks he is living with another [student] because his [parent] is in jail right now.” After many efforts, including using a rap song in a lesson, this

student warmed up to the Fellow and began to show some more positive behaviors in the classroom.

The high school went through its first negative experience with a Fellow in the second year. Several Teachers expressed dissatisfaction and reported incidents such as the Fellow being stopped in the hallway for non-compliance with the school's dress code, tardiness to a morning class and lack of preparation for class activities. This Fellow was juggling coursework, a job search, and multiple outside engagements during her tenure as a Fellow. Her journal reveals that she had always been a successful time manager until she met the special challenges and tasks of the STEP program. The Coordinator indicated that this Fellow missed opportunities for mentoring by moving among classrooms too much. This Fellow indicated in her journal that she was not that different from the other undergraduate Fellow and felt somewhat singled out. In the second semester, she found a rewarding placement with older, remedial students in an Algebra II class. She indicated that she felt that she was engaging in "mentoring" of these students by generally talking with them about college admission requirements, but the Teacher did not report that level of depth in her relationship with them.

The other female undergraduate Fellow was able to arrange a more consistent schedule with certain teachers. This Fellow discovered a mutually rewarding niche in an all-female "Discovering Algebra" Algebra I class. She served as an additional teacher in this classroom and effectively reduced the student: teacher ratio for the small group work involved in the unique Discovering Algebra curriculum. The classroom teacher reported that the girls in this class formed a strong bond with the Fellow and worked very well with her. This Fellow did not undertake any explicit mentoring with any of the female students who took to her so well, yet she provided a real example of a highly achieved young female. This Fellow also did not have a full

opportunity to develop classroom management skills because of the small group nature of the “Discovering Algebra” class.

In an earlier block of this teacher’s Algebra I class, the ME Fellow had a different experience with a mixed-gender, “Discovering Algebra” class. This class was large and rowdy, and the Fellow struggled to talk over the students. He served as a second teacher for small group work and walked around the classroom helping students as they worked. One lesson that this Fellow did present involved entering data into an Excel spreadsheet. The data entry took a while, and the students became restless. The teacher suggested that the Fellow display the data entry on an LCD Projector to aid the students’ comprehension and occupy their attention. However, since he rarely presented lessons, he did not have an opportunity to try this kind of activity again or generally improve his classroom management skills.

***Comparison Across Years:*** Fellows from both years worked with both general-level math students and higher-level math students, which exposed them to a range of behavioral and academic levels. The first year Fellows discovered that more advanced classes were a change of pace from working with mostly 9th grade Algebra I students. A year 1 Fellow observed, “it does make quite a bit of difference in the quality of our interaction with a class when the students are motivated to do well.” The older students and students in more advanced classes were typically more motivated.

Three important contextual changes occurred at the high school between STEP’s first and second year there. These contextual changes likely had some impact upon the outcomes of the new, in-class implementation model. The first was the introduction of the End of Course Test, which was required for Algebra I. The Coordinator shared that teachers, feeling the pressure of

accountability through student testing, might be more reluctant to give up instructional time to a Fellow. The second was that the Coordinator was out of the building every other day for the training of new teachers at a nearby middle school. This removed her from observing the Fellows as much as she would have liked and put her in a position where she could not extensively guide the teachers on how to best use the Fellows. She commented:

*[last year] I had more direct supervision and I could look at an activity or how it was presented and make suggestions and give them feedback. This year, I feel very removed, and I'm trusting that the teachers they are working with are giving [the Fellows] feedback and using them appropriately.*

The third change was the introduction of new curricula and practices while still trying to find the best way to use the STEP Fellows. In his fall journal, the ME Fellow commented:

*implementing several new 'experimental' strategies in conjunction with the STEP Fellows has so far proven to be a frustrating, unfulfilling experience. Hopefully, we can turn this around quickly. In retrospect, I believe it would have been better ... to set up a program or implement programs where we all work together ... We can have something like an after-school program where we can address issues with students like tutoring, study skills, and maybe even small research opportunities, etc. I'm not suggesting that we do not work in the classroom, because the relationship building is essential, and it gives us a better view to select students that we feel could benefit from our efforts and programs. I think a more focused effort by all the Fellows would have stronger impact than divided efforts without support from other Fellows, like we currently have in place. I believe dividing our efforts would be more effective with seasoned Fellows, but of course, we are not really. It varies from Fellow to Fellow even.*

The implementation model for STEP's first year at this school was based on an innovative concept of bringing lab experiments to Algebra I classes to create a more hands on course. The desire for the Fellows to provide innovation continued in the second year. While it took the initial Fellows some time to formulate the appropriate types of activities, they entered the year with the desire "to deliver some innovative and effective methods for helping the students improve their math skills," the Master's Fellow noted in his journal. They quickly

began creating devices constructed from normal household materials to demonstrate Algebra I techniques, such as the following:

- a homemade scale for balancing equations made of Styrofoam dishes and marbles
- software that enabled students to utilize quadratics, collect data and analyze the design of a ski-ball game

The Fellows compiled their activities onto a CD-ROM with notes and other tools to encourage the teachers to incorporate applied mathematics into future lessons. They noted that some of the higher-level math classes began to implement their activities independently during the spring of the first year.

The second year Fellows faced some challenges with providing the same level of innovation. They were not in a separate laboratory, they had less planning time, they worked separately, and they had to work within the curricular constraints of the classroom teacher's regular lessons. The BMED Fellow presented some of his equations from biological modeling in class. Though there were not many other specific overlaps between his area of study and algebra 1, he felt that all math was relevant in STEM higher education.

The Teachers using the Discovering Algebra curriculum for the first time while hosting a STEP Fellow felt that they had to “stick to the book” versus incorporating original activities from the Fellow. However, this curriculum does offer opportunities for hands-on activities or use of teaching technology. According to the publisher's website<sup>52</sup>, “Discovering Algebra integrates the traditional algebra curriculum with statistics, data analysis, functions, discrete mathematics, geometry, probability, and trigonometry. Students work with data-rich, real-world situations and applications in a curriculum that places algebra in an applications-based context and where investigations precede the introduction of formulas and expressions. From topics like fractals,

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<sup>52</sup> Discovering Algebra is published by Key Curriculum Press. See [www.keypress.com](http://www.keypress.com).

iteration, and self-similarity to technology-accessible techniques like the use of the graphing calculator to do statistical analysis, students participate in cutting-edge mathematics as well as time-honored topics and concepts.”

The first year’s Fellows were largely apart from the regular school environment and practically all of their needs could be handled through the Coordinator, who had sufficient time to spend with them in the first year. The new dynamics of the second year set up a situation in which more communication amongst more participants became necessary for more reasons. In a confounding coincidence, the Coordinator was stretched thin in the second year by multiple commitments.

### 7.2.3 Stage 3: Outcomes – Teaching, Relationship Building and Innovating

The Coordinator identified the following performance indicators for the STEP program:

- A resource book of Algebra I activities for teachers including teacher notes, worksheets, equipment lists, and possibly results from earlier approaches.
- Increased use of computer labs and classroom computers
- Improved attitude among students
- Increased staff morale

The Coordinator noted during the first year that many of the improvements were based on ‘soft data’ and could not be fully captured in test scores. This sentiment was prior to the introduction of the End of Course Test. She also noted during the first year that future connections between the high school and Georgia Tech would be an interesting development to monitor. Indicators of increased collaboration were not included in the school’s Action Plan, though the coordinator indicated this development would be enjoyable, as feasible.

The year 1 Fellows conducted survey assessments to measure student interest in their labs. They found that many students enjoyed and benefited from the labs. The year 2 Fellows did not conduct any official assessments of their impact, but they were very reflective about their classroom time and wanted to know that they made a difference to the students. Teachers interviewed in the second year reported that hosting a Fellow probably improved student performance through extra teaching and through the presence of role models. The Coordinator reported that she spent one hour after school with a Fellow talking about ways of knowing that you are impacting a student. The Fellows were unsettled by the frequency of poor grades among the students they taught and tutored. However, the Coordinator pointed out to them that many of the students in Algebra I had been struggling with math for many years and that the importance of the Fellow working with that student might not be apparent in the short term.

The graduate BMED Fellow pursued what the Coordinator and Teachers thought was the best version of an in-class model; he was present in one freshman, Algebra I classroom many times per week for the duration of the course. This Fellow continued to keep in touch with the teacher after the school year ended. However, this Fellow reported that dedicating so much time to the classroom contributed somewhat to having to repeat his qualifying exams. If this Fellow had failed his qualifying exams a second time, he would have to leave his doctoral program. Both the BMED Fellow and his partnering teacher experienced the birth of a child during the year. This life event seemed to have heightened this Fellow's interest in youth.

#### **7.2.4 Rating of High School Case on Variables**

*X1: Embeddedness* Low; no prior interaction. The Coordinator was approached by a Project Officer who was familiar with the school and the community. However, this high school did have a pre-existing relationship with the School of Education at another state university that is located nearby. This university has been placing student teachers at the high school for years. Teachers and other participants may have compared the relationship with Georgia Tech to the relationship with this university.

STEP caused Georgia Tech and this high school to become more embedded in different ways, but there was not an overall increase in embeddedness due to the loss of the close relationship with the Coordinator. An increasing number of Teachers hosted STEP Fellows, and there was an increase in the number and kinds of connections between the high school and Georgia Tech. Ten out of 18 math teachers and one out of 13 science teachers had hosted a Fellow at least briefly over STEP's two years at the school.

Four math teachers at this school had completed the Georgia Industrial Fellowships for Teachers (GIFT) professional development program by the end of STEP's second year at the school.<sup>53</sup> Of these four, two had hosted a STEP Fellow. Thus, though the Fellows did not take full advantage of the resources on Georgia Tech's campus, the GIFT program seemed to compensate in this area.

**X2: Strategic Needs** The strategic needs of the high school and Georgia Tech's STEP program were complimentary, but to a limited degree. The high school wanted the Fellows to enhance the teaching of Algebra I by exposing teachers and students to interesting, hands-on lessons. This focus was to allow Fellows to grow in teaching skills while math education at the school was being enhanced. In the end, this focus detracted from the alignment of strategic needs, as Fellows did not have the teaching and mentoring experiences that they desired.

**X3: Partnership Formation** The formation of the partnership between Georgia Tech and this high school featured higher degrees of equality and mutuality than other dyads. The Coordinator had several years of teaching experience at the school and was involved with strategic planning from the start. The Coordinator interacted with the principal and county level officials during the process of bringing STEP to the school.<sup>54</sup> The Coordinator also planned with the Project Officers and Fellows to transition from the laboratory implementation model to the in-class implementation model.

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<sup>53</sup> GIFT is an authentic research experiences program that places teachers in university or industry labs for several weeks over the summer. Teachers are paid a stipend for participation.

<sup>54</sup> The high school being analyzed in detail is a typically sized high school for metropolitan Atlanta, but it is part of a small school system. It could be reasonably predicted that size of the school system plays some part in partnership formation and operation that should be studied further. For example, it may be easier to have teacher input at a strategic level when a system is smaller.

***X4: Partnership Operations*** STEP only had two years of experience with the school before entering the Track 2 phase of the program. The first year left the Fellows wanting more teaching experience. Interdependence did not increase from year 1 to year 2, as the majority of Fellows were add-ons in the classroom. Though the BMED Fellow made a strong impact, teaching and learning overall did not depend on Fellows' input. Transaction costs did not lessen as familiarity and trust were only achieved in the example of the BMED Fellow. Less than ideal performances of the majority of Fellows during the second year left the high school Teachers and Coordinator with dubious impressions of the Fellow's value in the classroom.

***Y1: Process Outcomes*** The year 1 Fellows underwent noticeable personal development because of their STEP experience. These men, who were initially described as shy and tentative, became better able to relate to the students as the year progressed. The doctoral Fellow noted, "this experience has shown me how much I really enjoy teaching despite the shyness in my personality. The joy of seeing a student learn supersedes my insecurities." The school staff noticed this change. Not all of the second year Fellows had sufficient teaching experience to achieve the same personal growth. In the first year, limitations on interaction were due to the nature of the math lab; Fellows were special presenters while the teacher was present. In the second year, limitations were due to the small-group pedagogical approach of the "Discovering Algebra" curriculum. The lack of time for planning with the teacher, especially for the advanced reservation of equipment, also seemed to limit teaching experiences.

Evaluation of STEP program objectives at the high school:

*Train Fellows to effectively communicate standards-based science and mathematics to students and teachers from varying backgrounds.* The Fellows enjoyed the summer training but did not necessarily rely upon it. As was typical, undergraduates did not fully attend the summer training.

*Pair Fellows with master teachers such that they can experience effective teaching methods and real-life teaching challenges.* Paired relationships occurred in every year. However, the creative research class may not give Fellows skills that are generalizable to more standard, lecture-based lessons.

*Provide Fellows with rewarding practicum experiences during which they can practice science and mathematics pedagogy and classroom management strategies by engaging in direct inquiry-based science content instruction during regular classes and in extracurricular activities.* This dyad met this objective in all three years, though the research classes were not regular classes in terms of curriculum and classroom management.

*Facilitate knowledge transfer from Georgia Tech through Fellows and professional development activities.* Each group of Fellows drew the university and school closer together through various mentoring relationships and professional development opportunities.

*Facilitate the development of constructive mentoring relationships between Fellows and K-12 students and between teachers and university students and faculty, encouraged through actual and virtual field trips, class visits, tutoring and mentoring and electronic communication.* The STEP program led to very meaningful mentorships between members of the Georgia Tech community and members of the high school community.

*Support the unique partnership between Georgia Tech's College of Engineering and the Rockdale County School System in the development of a model School for Science and Technology. Curriculum units and laboratory exercises developed for the engineering and information technology-based curriculum will be disseminated to all other participating school systems.* This outcome only applies to Rockdale Magnet High School. The STEP program generated a useful knowledge base on how Georgia Tech students and faculty can be effective in the high school classroom. Overall, the STEP schools had relatively little interaction with each other, although Fellows, Teachers and Coordinators expressed an interest in greater collaboration.

### ***Y2: Performance Outcomes***

The school faculty credited STEP with contributing to student performance in the second year. The Coordinator noted of the BMED Fellow, "He really did it right. It turned out all those kids passed the End of Course Test. So, that was a good experience."

Overall, Teachers were exposed to the idea of providing students with more innovative, hands-on activities as an important part of math instruction. The math lab was closed, but the idea of greater innovation was planted and a resource notebook exists for assistance. One freshman math teacher was inspired by GIFT; she recalled her summer activities working on a public policy research study as what a "real" researcher does. She planned to pursue a doctoral degree to conduct education research.

The BMED Fellow's main Cooperating Teacher shared that she learned patience from observing him interact with the students. Ironically, the Fellow encouraged the Teacher to remember just how young the students are and how much they need to learn.

The Coordinator indicated that professional development could occur in less obvious forms. Overall, she felt that the STEP program's biggest impacts were in real-life exposure for Fellows and in encouraging teachers to try practices in and out of the classroom. She felt that STEP was 'having a pretty significant impact on the Fellows and their awareness of what is going on in public education now. They've gotten a good dose of what it's like. I really think that they are reaching some kids that would not be reached. I don't know that our teachers are getting much, but that's OK. Our teachers are getting things from other parts of the Tech partnership. [For example,] this NASA speaker that's coming out ... or participating in the GIFT program in the summer. We have had 4 teachers doing that, and they seem very pleased.' The STEP program may not have provided teachers with the extent of direct STEM knowledge and skills development as was hoped, but having STEP forced teachers to talk about their teaching and share ideas. She felt that this outcome benefited the teachers' professionalism and should contribute to improved teaching and learning.

The second year of STEP had a different kind of impact on the school. The level of innovation established in the first year was not maintained in the classrooms, though many teachers received rewarding professional development through GIFT. As the Coordinator commented, having STEP at the school motivated and focused the faculty to critically reflect on internal teaching and learning issues that they "already knew were there." Thus, even though the year 2 Fellows did not introduce innovative ideas and practices, they continued to serve as a stimulant to teaching and learning. The Coordinator commented that the compilation of the first year's math lab activities "is a contribution even though it is not being used right now."

### **7.3 Comparison of Logic Model to Narrative Case Studies**

Marietta High School and Georgia Tech did not have an embedded relationship. The two parties had to get to know each other over time through STEP. The first year left the school wanting to become closer to Georgia Tech, but that did not materialize during the second year for a variety of reasons. Neither cohort of Fellows arranged extensive cross-campus interactions, such as field trips to labs, and the NSBE Jr. chapter, which could have received support from Georgia Tech's NSBE chapter, was not formed. Furthermore, during the two years observed, some coincidental events occurred that stressed each party's ability to trust and respect the other.

Though negative events can be hard for any partners to overcome, they can be more damaging to a relationship when the two parties do not have a positive baseline relationship. None of the shortcomings in year 2 was fatal, but the high school staff was not able to communicate needs in a way that produced the results they wanted. In this dyad, not knowing each other beforehand appears to have posed high transaction costs for working together that were exacerbated by unfortunate coincidences.

The strategic needs of Georgia Tech and this high school did not feature the full range of specific complementarities. This high school does not have a majority-minority population and just recently benefited from an injection of physical resources with the opening of its new building. Though the Fellows interacted with minority students, the school does not have the same needs profile as the four majority-minority schools participating in STEP. Thus, the analysis of the first two variables, embeddedness and strategic needs, is consistent with the logic model. Low embeddedness and limited complementarity of strategic needs led to the parties not growing closer and more comfortable with each other. The second set of variables, partnership formation and operation, presents some inconsistency with the logic model. The formation of

this partnership was relatively more equitable among the dyads because the Coordinator, a practicing teacher, was involved from the formation. The operation of the partnership endured some negative experiences, but nothing that was ostensibly worse than the operations at any other site.

This dyad ranks low in mentoring, innovation (year 2 only), technology use and teaching experience for the Fellows. However, this analysis does not suggest that the program had no benefits. Many students, especially those coached and tutored by the BMED Fellow, benefited greatly by all accounts. Many teachers, even those who did not host Fellows, benefited in knowledge, morale, and resources from participating in the GIFT program. The Coordinator stated that hosting STEP encouraged teachers to think about reform and improvement.

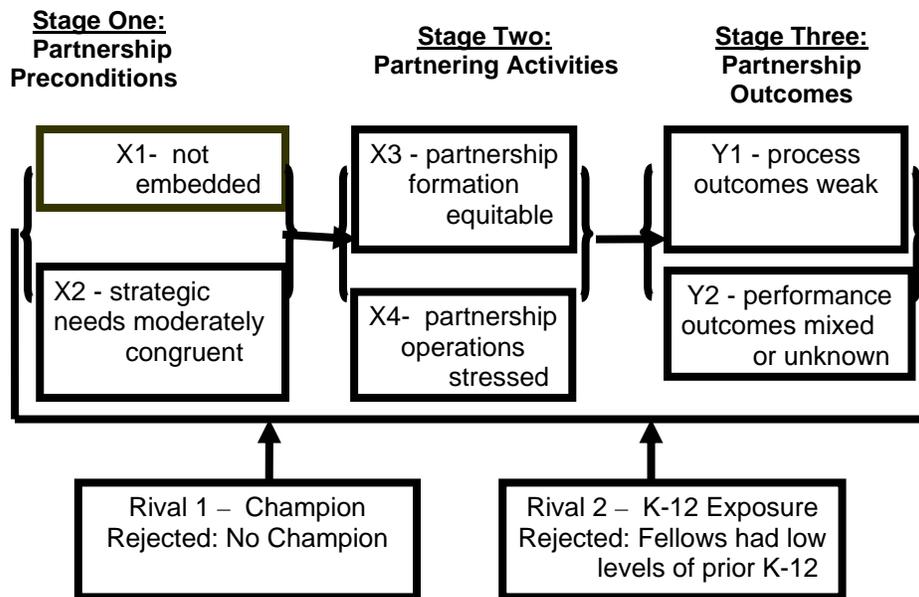


Figure 5: Model of Marietta High School Test Case – Hypothesis Accepted

## 7.4 Discussion

In both cases, the hypothesis was accepted, but for varying reasons. In the Rockdale Magnet High School case, the hypothesis was accepted because the case featured high embeddedness and alignment of strategic needs and satisfied all of STEP's programmatic objectives. The positive working relationships among Fellows, the Coordinator, and Teachers also contributed to positive process and performance outcomes. A case could be made for the operation of the rival hypothesis of a champion at Rockdale Magnet. STEP's Project Officers indicated that the Coordinator could be acting as a program champion in her attempts to develop the unique educational program at Rockdale Magnet. However, evidence of interest and enthusiasm on the part of Fellows, the primary Cooperating Teacher and other Teachers contradicts this hypothesis. The school is not majority-minority, yet the minority students there have a real need for role models.

In the Marietta High School case, the hypothesis was accepted because the first year of operations successfully met most of STEP's programmatic objectives despite no embeddedness and limited alignment of strategic needs<sup>55</sup>. One conclusion that can be drawn from the comparison of the Marietta High School case to the logic model is that embeddedness, especially when it is positive and extensive, may be a more powerful and/or more independent predictor of outcomes than the other three variables. The structure of the stage model already shows that the other three variables are partially determined by embeddedness. For example, communication characteristics recorded as part of X3, partnership operations, could simply follow the template of previous communication patterns in an embedded relationship. Embeddedness appears to be an important factor that should inform future K-12 outreach and collaboration on the part of Georgia Tech.

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<sup>55</sup> The objective of Fellows gaining teaching experience was limited, yet met.

## CHAPTER 8

### CONCLUSIONS

#### 8.1 Results of Case Comparisons

Figure 4 displays the ratings that each case had on each pre-condition variable in a Cartesian coordinate plane. The coordinate plane represents both differences among cases and changes within each case over time. Slope lines illustrate directional trends over time in the relationships between the schools and Georgia Tech. The magnitude of difference (both among cases and across years) is mostly a feature of the graph and is not as representative as the direction of the slope. Both magnitude and direction are based on narrative analysis of the case studies and are not tied to a metric.

In the Marietta case, the alignment of strategic needs decreased from year 2 to year 3 as it became evident that mutually rewarding exchanges were not materializing in the majority of Fellow placements.<sup>56</sup> Despite increased time working together through the STEP program, there was very little increase in the depth or type of embeddedness between the school and Georgia Tech. Thus, the direction of the slope is negative. Predictably, Marietta had weak process outcomes at the end of year 2.

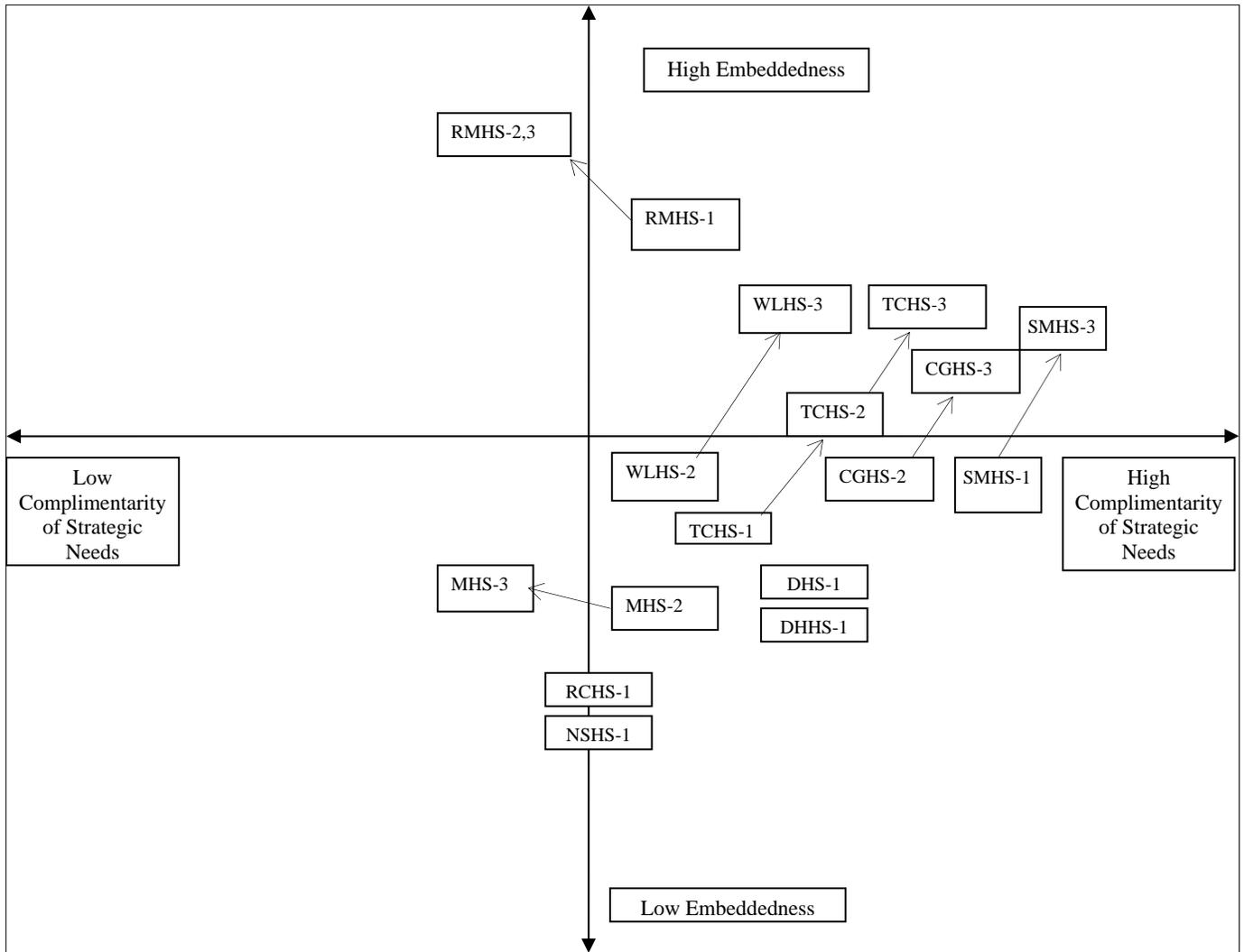
In the Rockdale Magnet case, the dyadic relationship became more embedded as the primary Cooperating Teacher began to participate in professional development on campus and mentorships were established between students and faculty from various schools at Georgia

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<sup>56</sup> STEP was not present at Marietta High School in its first year of operations. Alignment of strategic needs decreased as it became clear that rich teaching and mentoring experiences, especially those benefiting minority students, were not occurring as had been expected.

Tech. However, STEP's Project Officers began to express reservations over the alignment of strategic needs because Rockdale Magnet is not a majority-minority school. The school also receives strong community funding and social support. The Project Officers felt that the Magnet/STEP Coordinator served as a program champion, though this author's analysis does not concur. The negative direction of the slope indicates the perceived decrease in alignment of strategic needs over time. However, embeddedness increased in number and type. An administrative decision by the Project Officers will ultimately affect the long-term viability of this partnership, though positive embeddedness and productive activities have led to positive process outcomes in the first three years.

In the cases of Stone Mountain, Tri-Cities and Westlake, there was a steady increase in embeddedness through growth in program participation and relationship formation between Georgia Tech and the schools. The alignment of strategic needs increased over time. Fellows became more important to teaching and learning, gained instructional experience and served as bridges between Georgia Tech and these majority-minority schools. The direction of the slope lines for these cases is positive. Overall, this set of cases showed an increase in the alignment of strategic needs and an increase in the number and type of embedded relationships over time. Predictably, these trends led to greater achievement of process outcomes at these schools.



RMHS = Rockdale Magnet High School      RCHS = Rockdale County High School  
 TCHS = Tri-Cities High School            WLHS = Westlake High School  
 SMHS = Stone Mountain High School      DHS = Dunwoody High School  
 MHS = Marietta High School                CGHS = Cedar Grove High School  
 NSHS = North Springs High School        DHHS = Druid Hills High School

Number indicates year of STEP program operations (Year 1, Year 2, and Year 3)

Figure 4: Pre-Conditions Variables over Three Years of Program Operations

## **8.2 Future Research**

Future research on the STEP program should investigate certain issues suggested by this study. Foremost, the impact of the Fellow-Teacher relationship should be examined, as this relationship was positive in all cases with positive outcomes and negative in cases with less positive outcomes. Since the Fellows were both an outcome and a treatment, a potential feedback loop should be explored. There may be personal attributes or practices of the Fellows, beyond those recorded by this study, that influence programmatic outcomes. Finally, longitudinal study of the impact of participation in STEP should be examined for returns to all parties.

## **8.3 Additional Issues**

There are additional issues relevant to the long-term success of STEP or a STEP-inspired partnership between Georgia Tech and local high schools. The most fundamental issue is sustainability of collaborative activities independent of grant funding. Sustainability is most likely to be accomplished through campus-wide integration of K-12 outreach whereby campus groups commit their own resources. The verbiage of the GK-12 policy proposes broad potential benefits to an audience already a part of the NSF grant-seeking community. University – school partnerships would likely receive broader social and financial support if the complimentary nature of the K-12 schools’ and the IHE’s strategic needs was recognized across both campuses.

### *Sustainability of the Program*

Aspects of the STEP program that would be difficult to perpetuate independent of grant funding are largely financial in nature. The Fellow stipend is the largest example. As a potential remedy, STEP’s Project Officers have proposed that Fellows be granted course credit for

working at a local high school. Other possibilities include using GRA funds to support a Fellow's work at a high school and sponsoring a less-intensive teaching intern program at Georgia Tech.

Many potential Fellows having varying personal motivations for being present in a K-12 school. Over the years, some African-American Fellows have shared a desire to give back to the community and/or provide a role model with which minority students can identify. To this end, the Black Graduate Student Association (BGSA) could continue to function as a powerful recruitment tool and disseminator of the idea of K-12 outreach. Other Fellows have communicated personal interests in science education, youth and community service. The word of mouth recruitment of Fellows from BGSA and other sources reveals a baseline of interest in a program like STEP. Future studies should explore the interest level of the university's faculty and strategic level decision makers.

K-12 partnership participants have traditionally been recipients of resources, but they are capable of contributing a degree of existing resources to fund collaborative projects. K-12 schools have Title II and other funds available for teacher professional development and are often looking to spend these funds wisely. Georgia Tech may be able to provide superior professional development opportunities for Atlanta-area STEM teachers. Cross-sectoral collegial relationships and professional mentoring would be likely to spillover from this kind of interaction.

### *Articulating Benefits for All Participants*

Mutual benefit distinguishes a partnership from other forms of collaboration. Data from the operation of the STEP program has demonstrated or suggested benefits to various

participants in a partnership. Yet, benefits are not uniformly recognized. Campus-wide support for STEP or a STEP-inspired program may be enhanced by clearly articulating benefits for the campus participants. For the undergraduate Fellows especially, STEP can help to inform their general career path - i.e., ascertaining compatibility with a helping career such as teaching or nursing. Many Fellows reported that speaking in front of an audience of students or being treated as a colleague of the Teachers increased their self-confidence and communication skills. Students who have completed the STEP Fellowship are likely to be better teaching assistants in college courses, and eventually, better professors.

Academic schools and faculty at Georgia Tech could also benefit from incorporation of the STEP program into campus life. The NSF has always expressed a concern with the broader societal impacts of funded projects, and in 1995, began requiring documentation of community outreach as a requirement of grant funding. Educational outreach can be a potent investment for the university, which already has the required intellectual resources. At some IHEs, the importance of K-12 outreach has gained so much prominence with decision makers that it is used as a criterion for promotion or tenure. If more IHEs encouraged or required K-12 outreach, others might follow suit. The same prediction can be made for academic departments and offices within an IHE.

The potential benefits of STEP or a STEP inspired program are not limited to Georgia Tech and the high schools<sup>57</sup>. The federal Department of Education recently embarked on a major nation-wide initiative sponsoring Math and Science Partnerships that could be informed by GK-12's experience. State departments of education could also learn from NSF's experiences with GK-12. The state of Georgia, like many others, faces lackluster test scores and unequal

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<sup>57</sup> The STEP program itself does not target participants beyond the particular staff at the high schools who become involved. The conclusion section offers speculation on the potential impacts of a larger scale program like STEP.

achievement in science and math. Though the STEP program is limited to one university and a few high schools in Atlanta, similar programs at Georgia IHEs could cumulatively enhance STEM teaching and learning across the state. The GIFT program for teachers is already expanding its reach beyond Atlanta by involving teachers from middle Georgia.

Effective communication skills are a desired - and sometimes required - professional skill for engineering and other types of STEM employment. STEP alumni applying for jobs may receive more returns for their participation as similar programs grow in notoriety. The Project Officers are attempting to collect more alumni communication to inform the development and evaluation of the STEP program. One e-mail from an alumni indicates the benefit a Fellow felt he received: “It turns out that STEP has helped me here in the corporate world – I am responsible for providing training to new members in my group, so all of that work on conveying information to people with varied backgrounds has been a life saver.” Though he moved out of state, this Fellow indicated that he kept in touch with his former school Coordinator by e-mail.

### *A Noble Experiment*

Georgia Tech, as an institution, does not have K-12 outreach written into its core mission. Likewise, STEP program high schools do not typically rely on local institutions of higher education to teach math and science. There are multiple modes of collaboration that could be mutually beneficial to Georgia Tech (and its composite schools and offices) and the STEP high schools. These include mentoring of high school students and teachers by Georgia Tech students and faculty, encouragement of admissions applications from underrepresented schools and rewarding teaching experiences for university students that could not have been experienced on campus. Increased attention to how school-university partnerships such as STEP are created,

operated and evaluated should help these collaborations to reach their full potential for all participants.

#### **8.4 Policy Implications**

The successes and failures of the current generation of IHE/K-12 partnerships (or partnership-like relationships) could promote ideas about working together that will influence future attempts at partnership. The K-12 and IHE parties in a STEM educational partnership are already on uncommon ground because they are from different sectors. They differ in the make-up of their personnel, operating legalities and professional cultures. The addition of a business or a non-profit organization to a particular partnership increases these differences. These differences have contributed to a mediocre track record for educational partnerships thus far.

The recently created federal Math and Science Partnerships could mark the beginning of an upward trend in K-12-IHE partnerships. As the literature and the results of this study demonstrate, the way in which partnerships are built and maintained affects the outcomes of the partnership. Current experiences could affect the long-term viability of partnering as a policy option in education. Future attempts at partnership should pay attention to the pre-conditions to partnership analyzed in this study.

Specifically, being positively embedded prior to attempting a partnership appears to be critical to success. Organizations can thus be advised to invest in becoming familiar with one another before attempting to achieve a full partnership. Accordingly, it is recommended that parties who are strangers to one another not attempt a partnership unless the alignment of strategic needs is strong enough to compensate for the lack of familiarity. This recommendation applies to parties seeking a grant and external parties that would fund a grant, such as the NSF.

## APPENDIX A: SCHOOL PROFILES

### *Rockdale County High School (RCHS) and Rockdale Magnet High School (RMHS)*

Rockdale Magnet is part of Rockdale County High School. 68% of Rockdale’s 11<sup>th</sup> graders passed all sections of the GHSGT upon initial attempt, an improvement from 57%. 74% of graduates earned diplomas with a combined college prep/vocational endorsement. Of those earning college prep diplomas, 60% were female and less than 9% were Black. The school also awarded 20 Certificates of Attendance. The school’s average SAT score is 975, with the average score for students earning college preparatory diplomas being 944. Table 6 presents GHSGT passage rates for Rockdale County High School. Scores for students are included in the scores for Rockdale County High School. Rockdale County High School somewhat lags the county and state in overall achievement.

**Table 6: Rockdale County and Magnet High School GHSGT Passage Rates**

Year	All Subjects			Language Arts	Math	Social Studies	Science	Writing
	School	Rockdale County	State					
2001	57%	69%	65%	94%	92%	72%	61%	95%
2002	68%	76%	69%	95%	89%	82%	73%	86%

Data for Grade 11, first time test takers.

GHSGT passage rates are for Rockdale County High School. Magnet scores are averaged into the school’s scores.

*Marietta High School (MHS)* serves 1,950 grade 9-12 students in a newly constructed facility. It was chosen to participate in the STEP program for the first time during the 2002-2003 school year. It is the only high school in the small, city school system of the city of Marietta. Its diverse student population is comprised of 45% Black students, 38% White students and 12% Hispanic students. The remainder of the students are Asian, multi-racial, and Native American. About one-third of the students qualify for Free or Reduced Price Lunches, which is less than the system's average. Well over half of Marietta seniors graduate high school (65%) with a drop out rate of 6%. In 2001-2002, 71% of 11<sup>th</sup> graders passed all sections of the GHSGT at the first attempt, an improvement from 67% in 1999-2000. The average SAT score is 1051.

Table 7 shows uneven trends in math and science achievement at Marietta High School long before the STEP program was introduced at the school.

Table 7: Marietta High School GHSGT Passage Rates

YEAR	Language Arts	Math	Science	Social Studies
1998	94%	90%	80%	82%
1999	96%	87%	67%	81%
2000	96%	93%	75%	86%
2001	96%	90%	76%	84%
2002	97%	92%	77%	89%
2003	96%	93%	74%	86%
2004	96%	95%	71%	86%

Data for Grade 11, Regular Program, First-Time Test Takers  
(writing scores and overall scores not available)

*DeKalb County*

In the DeKalb County public school system, 67% of 11<sup>th</sup> graders initially passed all sections of the GHSGT in 2002. The initial passing rates for the subject sections are as follows: 95% - English/Language Arts, 89% - Math, 82% - Social Studies, 70% - Science, and 85% - Writing. The average SAT score in the county is 935. The system’s high school completion rate for the 1998-2002 class is 71%. The system-wide drop out rate is 6%. 56% of students qualify for Free/Reduced Price lunches.

*Dunwoody High School (DHS):* DHS serves 1231 students in grades 9-12. The student body is 44% African-American, 40% White, 7% Hispanic, 7% Asian, 2% Multiracial and 1% American-Indian. Only 14% of students qualify for Free/Reduced Price lunches; the dropout rate of 2% is below the county’s average of 6%; and the 85% completion rate is above that of the system and the state. Of the 234 diplomas awarded in 2002, 219 had college preparatory endorsements. The school’s average SAT score is 1051. The school offers National Academies programs, an International Baccalaureate program and a Model United Nations team. It was designated a Georgia School of Excellence in 1986 and 1990 and a DeKalb County School of Excellence in 2002. *Newsweek* recently ranked Dunwoody among the top 4% of American public high schools. Table 8 shows that Dunwoody High School’s overall achievement is on par with the state except for strong math scores. Dunwoody’s science scores are markedly below its math scores.

Table 8: Dunwoody High School GHSGT Passage Rates

Year	All Subjects			Language Arts	Math	Social Studies	Science	Writing
	School	DeKalb County	State					
2001	77%	77%	65%	96%	93%	87%	79%	94%
2002	76%	77%	69%	96%	95%	88%	78%	89%

Data for grade 11, first time test takers.

*Druid Hills High School (DHHS)* serves 1,216 students. Its dropout rate of 6% is slightly lower than that of the county, and 42% of its students receive Free/Reduced Price lunch as opposed to 53% for the county. Table 9 shows that science is *Druid Hills High School's* weakest area of achievement.

Table 9: *Druid Hills High School* GHSGT Passage Rates

Year	All Subjects			Language Arts	Math	Social Studies	Science	Writing
	School	DeKalb County	State					
1999	78%	96%	65%	98%	91%	84%	82%	93%
2000	74%	67%	69%	98%	96%	89%	75%	88%

Data for grade 11, first time test takers.

*Cedar Grove High School (CGHS)* serves 1585 students in grades 9-12. Nearly all of *Cedar Grove's* students are African American (99%). Over 75% of the senior class graduated in 2002 (a slightly higher number than the county or state average) with a 6% drop-out rate. Almost half of students qualify for Free/Reduced Price Lunches. In 2001, *Cedar Grove* had 65% of their 11<sup>th</sup> graders pass the Georgia High School Graduation Test (GHSGT) on the first try, and 71% passed the science section. Their science scores have improved in recent years, up from 66% first time passage in 1999-2000. The school's average SAT score is 884. Table 10 shows that *Cedar Grove's* science scores are its weakest area of achievement.

Table 10: *Cedar Grove High School* GHSGT Passage Rates

Year	All Subjects			Language Arts	Math	Social Studies	Science	Writing
	School	DeKalb County	State					
2001	59%	62%	65%	96%	90%	71%	69%	90%
2002	65%	67%	69%	96%	87%	77%	71%	88%

Data for grade 11, first time test takers.

*Stone Mountain High School* is in southeastern DeKalb County, just inside Atlanta city limits. This school's enrollment of 1257 students is 85% black, 5% white, 3% Hispanic, 6% Asian, and 1% Multi-Ethnic. Stone Mountain High School has a completion rate of 55%, which is considerably lower than the county average of 66%. Its dropout rate of 5.5% is on par with the county average. 58% of SMHS students passed the science portion of the GHSGT upon first attempt.<sup>58</sup> Table 11 shows that science is the weakest area of achievement.

Table 11: Stone Mountain High School GHSGT Passage Rates

Year	All Subjects			Language Arts	Math	Social Studies	Science	Writing
	School	DeKalb County	State					
2001	52%	62%	65%	93%	90%	69%	58%	90%
2002	61%	67%	69%	96%	89%	79%	64%	86%

Data for grade 11, first time test takers.

### *Fulton County Schools*

*Tri-Cities High School (TCHS)* educates 1893 students in grades 9-12 drawn primarily from the three southwestern Atlanta communities of East Point, College Park, and Hapeville. The school is located in East Point, an urban neighborhood with a predominantly African-American population. The student population is 86.9% Black, 6.5% Hispanic, 3.3% Caucasian, 2.4% Asian. Tri-Cities' 72% completion rate is slightly less than the system rate, yet it has almost no drop out rate compared to 2% for the county. Nearly half of its students qualify for Free/Reduced Price lunches compared to the 32% county average. 53% of 11<sup>th</sup> graders initially passed all sections of the GHSGT and 55% passed the science section on the first try. The

<sup>58</sup> Georgia Department of Education web site <http://techservices.doe.k12.ga.us/reportcard/>.

school's average SAT score is 868. Tri-Cities science scores are its weakest area of achievement and lowest among STEP schools.

Table 12: Tri-Cities High School GHSGT Passage Rates

Year	All Subjects			Language Arts	Math	Social Studies	Science	Writing
	School	DeKalb County	State					
2001	48%	77%	65%	89%	89%	77%	49%	86%
2002	53%	77%	69%	92%	80%	79%	55%	86%

*Westlake High School* is located in a growing, middle-class suburb in southwestern Fulton County and the majority of the students are African-American (98%). This school has an 85% completion rate and less than one percent drop out rate, noticeably better percentages than rest of the county. About a third of students qualify for Free/Reduced Price Lunch, which is on par with the system average. 58% of 11<sup>th</sup> graders initially passed all sections of the GHSGT, and 62% passed the Science portion on the first attempt in 2002 (up from 58% in 2000). The school's average SAT score is 898. Table 13 shows that Westlake's science achievement lags the state.

Table 13: Westlake High School GHSGT Passage Rates

Year	All Subjects			Language Arts	Math	Social Studies	Science	Writing
	School	DeKalb County	State					
2000	57%	77%	65%	91%	84%	86%	58%	93%
2001	58%	77%	69%	93%	88%	79%	62%	94%

*North Springs High School* is located in north suburban Atlanta. It educates 1339 students in grades 9-12 and offers the only Arts and Sciences Magnet Program in Georgia. Its student body reflects the cultural, geographic, and economic diversity of Atlanta. The student body is 36.6% Black, 52.7% White, 3.1% Hispanic, 3.5% Asian and 3.8% Multi Racial. North

Springs students exhibit high academic success overall, with a 96% graduation rate and an 81% first time passage rate on the science section of the GHSGT.<sup>59</sup> The dropout rate (1.4%) is low, the number of students receiving Free/Reduced Price Lunches is below half of that for the county and the average SAT score is 1078. Parents have a very active volunteer program at the school.

Table 14 shows very strong math and science test scores for this school.

**Table 14: North Springs High School GHSGT Passage Rates**

Year	All Subjects			Language Arts	Math	Social Studies	Science	Writing
	School	Fulton County	State					
2001	78%	77%	65%	98%	93%	92%	81%	98%
2002	79%	77%	69%	97%	95%	90%	81%	93%

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<sup>59</sup> School and test data taken from the Georgia Department of Education web site at <http://techservices.doe.k12.ga.us/reportcard/>.

**APPENDIX B: PRE-CONDITIONS (STAGE 1) VARIABLES  
FOR SCHOOL CASES**

Table 15: Pre-Conditions (Stage 1) Variables for High School Cases

Variable	1 MHS	2 SMHS	3 DHHS	4 DHS	5 CGHS	6 NSHS	7 WLHS	8 TCHS	9 RHS	10 RMHS
X1	no prior contact; limited increase	prior contact**; increased	no prior contact*; did not increase	no prior contact; did not increase	some prior contact; increased	no prior contact	some prior contact; increased	no prior contact; increased	no prior contact; did not increase	most prior contact
X2	decreased over 2 years	increased over 2 years	decreased within 1 year	stable over 1 year	increased over 2 years	decreased over 2 years	increase over 2 years	increased over 3 years	decreased within 1 year	decreased over 2 years

\*The coordinator at DHHS was an alumnus of Georgia Tech, but there were no other reported instances of embeddedness.

\*\*Prior teacher participation in GIFT was not reported in interviews a factor that pushed the partnership forward.

Table 15 compares the degree of embeddedness (X1) and alignment of strategic needs (X2) that characterized each school case over the period of time that the STEP program was in operation. Most schools did not have prior contact with Georgia Tech. However, within the most successful dyads, the degree of embeddedness increased within each year of program operations and/or over multiple years of program operations. The degree of alignment of strategic needs could have increased or decreased from year to year.

## APPENDIX C: ACTIVITIES (STAGE 2) VARIABLES FOR SCHOOL CASES

Table 16: Activities (Stage 2) Variables for High School Cases

Variable	1 MHS	2 SMHS	3 DHHS	4 DHS	5 CGHS	6 NSHS	7 WLHS	8 TCHS	9 RHS	10 RMHS
<sup>x<sub>3</sub></sup> formation: agreement	no decrease in formality	less formal over 2 years	no decrease in formality	no decrease in formality	less formal over 2 years	no decrease in formality	less formal over 2 years	less formal over 3 years	no decrease in formality	less formal over 3 years
focus	change in focus from 1 <sup>st</sup> to 2 <sup>nd</sup> year	consistent focus over 2 years	consistent focus within 1 year	consistent focus within 1 year	expanded focus over 2 years	varied foci within 1 year	expanded foci over 2 years	expanded focus over 3 years	unclear focus within 1 year	expanded focus over 3 years
<sup>x<sub>4</sub></sup> operations: inter- dependence	declined over 2 years	increased over 2 years	too little data to determine	too little data to determine	increased over 2 years	declined within 1 year	increased over 2 years	increased over 3 years	declined within 1 year	increased over 3 years
transaction costs	increased over 2 years	decreased over 2 years	higher due to status of coordinator	mixed due to mixed responses	decreased over 2 years	increased within 1 year	decreased over 2 years	decreased over 3 years	increased within 1 year	decreased over three years, but too a lesser degree
communi- cation	originated by university; low between Fellows/ teachers; not diffused	reciprocal; not diffused	reciprocal; not diffused	reciprocal; not diffused	reciprocal; diffused through change in coordinator	reciprocal; not diffused	reciprocal; diffused	reciprocal; diffused	originated by university	reciprocal; diffused

Table 16 presents the raw data for the high school cases on formation (agreement and focus) and operational (interdependence, transaction costs, and communication) variables.

**APPENDIX D: OUTCOMES (STAGE 3) VARIABLES FOR SCHOOL CASES**

**Table 17: Outcomes (Stage 3) Variables for High School Cases**

Variable	1 MHS	2 SMHS	3 DHHS	4 DHS	5 CGHS	6 NSHS	7 WLHS	8 TCHS	9 RHS	10 RMHS
Y1	+ teacher / Tech - teacher / Fellow  - teaching experience	+ teacher / Tech  - low # teachers  +teaching experience  + mentoring and role modeling for under- represented groups	+ teaching experience	+ teaching experience  + mentoring and role modeling for under-  represented groups	+ teaching experience  + mentoring and role modeling for under- represented groups	+ teaching experience  + use of technology	+ teaching experience  + teacher / Tech  - teacher / Fellow + mentoring and role modeling for under- represented groups	+ teacher / Tech  + teaching experience  + mentoring and role modeling for under- represented groups	+ teaching experience	+ teaching experience  + teacher / Tech  - teacher / Fellow  + isolated mentoring and role modeling for under- represented groups
Y2	innovation in use of math labs; isolated EOCT prep	teacher development and renewal	teacher exposure	teacher exposure	teacher development and renewal; enhanced science dept.	teacher exposure	teacher development and renewal; enhanced science dept.	teacher development and renewal; enhanced science dept.	teacher exposure	teacher development and renewal; enhanced science dept; student competitions

Table 17 presents the raw data for the high school cases for process (Y1) and performance (Y2) outcomes. Process outcomes included professionally rewarding relationships between Fellows and Georgia Tech faculty, teaching experience for Fellows, mentoring and role modeling and the improved use of STEM educational resources, such as technology at the school. This study only captured performance outcomes through secondary data – reports by Teachers and Fellows of improved STEM teaching and learning.

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