ABSTRACT

Title of Document:	CAN STEM INITIATIVES BE SOCIAL JUSTICE ORIENTED: AN ANALYSIS OF URBAN SCHOOL REFORM VIA SMALLER LEARNING COMMUNITIES
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STEM is an acronym that stands for Science, Technology, Engineering, and Math. STEM academies are theme-based curricula that have gained considerable attention on the national level. The intended outcome of a STEM curriculum is to raise career awareness and increase college and graduate level enrollment in science and engineering in order to ultimately restore the United States' position as a worldwide leader in technological innovation. In 2008, a group of middle school teachers in Maryland designed a STEM academy to address the achievement gap between African American and white students at their school. The founding teachers used a combination of thematic curriculum and structural redesign via a process called "looping" to create a school-within-a-school model that focused on average-performing and at-risk students. This study explores the process these teachers underwent to implement a differentiated STEM program to a diverse student body in an urban middle school.

CAN STEM INITIATIVES BE SOCIAL JUSTICE ORIENTED:
AN ANALYSIS OF URBAN SCHOOL REFORM
VIA SMALLER LEARNING COMMUNITIES

By

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Introduction

STEM is an acronym that stands for Science, Technology, Engineering, and Math. STEM academies are theme-based curricula that have gained considerable attention on the national level. The intended outcome of a STEM curriculum is to raise career awareness and increase college and graduate level enrollment in science and engineering disciplines. National STEM initiatives seek to ultimately restore the United States' position as a worldwide leader in technological innovation. STEM education traditionally caters to advanced students. This study explores the creation of a non-traditional, differentiated STEM Academy at Leicester Middle School[1].

The Importance of STEM Education

National STEM initiatives in public education are rooted in international competition. In the Cold War era, Soviet innovation was a national security threat to the United States. When the Soviet Union launched the Sputnik satellite in 1957, one of the reactions of the United States was to make gifted and talented education a priority in order to enable future generations to remain academically competitive on the world stage. The *National Defense Education Act* of 1958 (NDEA) provided

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[1] All names of school personnel, schools, cities, counties, and other details that would identify participants have been changed to protect their confidentiality as they are still members of the faculty at the time of this writing.

funding for advanced students pursuing fields related to science, technology, engineering, and mathematics. NDEA drove the surge in gifted education that followed into the 1960s. (Jolly, 2009)

As the Cold War tensions relaxed, the global marketplace became the new competition field. The importance of STEM education evolved from a centerpiece of national security to an instrument of economic advancement. Today, competition for technological innovation is directly correlated to economic sovereignty. The United States did not maintain the momentum for STEM education initiated with NDEA and has fallen behind China and India in producing college graduates in STEM fields. (Pantic, 2007)

President Ronald Reagan's National Commission on Excellence in Education published "A Nation at Risk" in 1983 to address downward trends in student performance. The report, which detailed specific areas of decline and outlined suggestions for improvement in public education, inspired a wave of top-down education reform at the state level. "A Nation at Risk" marked a turning point in national perception of educational reform initiatives that culminated in standards-based federal oversight in the *No Child Left Behind Act* of 2001. (Hunt, 2008)

Traditional emphasis on the marriage of STEM and gifted education puts the STEM agenda at odds with *No Child Left Behind* (NCLB). NCLB realigned the primary objective of public education to meet a universal proficiency level in reading and math, thereby de-emphasizing gifted and talented education and shifting resources away from science curriculum. The purpose of NCLB was to increase the viability of the public school as a social justice resource and hold districts

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accountable for performance of the lowest achieving subgroups, including minority students, English language learners, and special education students.

STEM Initiatives for Social Justice

In 2008, Daniel Hatcher, the Coordinator of Secondary Initiatives for Chesapeake County Public Schools in Chesapeake County, Maryland, presented a framework for a grant funded STEM academy to a group of teachers at Leicester Middle School. The school district's motive was to use STEM as a theme to pique the interest of African American students at the school. African Americans are under-represented in science and engineering careers nationwide. Studies suggest that a stronger emphasis on these disciplines in urban schools could yield greater interest in STEM careers for underrepresented populations. (Moore, 2006) The STEM curriculum model was selected for use at Leicester Middle School to address two prominent issues: the achievement gap, and African American under-representation in science and engineering careers.

The purpose of this study is to analyze the process of implementing change in an urban school through an examination of the adoption of a theme-based smaller learning community. In order to fund the creation and development of "The STEM Academy," the individuals involved adapted a small scale STEM grant program to support a wider range of students beyond the traditional STEM focus on gifted and talented students, without sacrificing the rigor of the curriculum.

Framework

The framework adopted for this study is a combination of social justice and complexity theory. Complexity theory is a framework for analyzing the multiple factors that influence and measure the efficacy of education reform. Through the complexity theory lens, singular reform measures must be seen as part of a greater holistic reform model taking all necessary measures into account. Complexity theory views a school as a non-linear system that cannot be reformed through linear methods, i.e. focusing on only one aspect such as test scores or discipline. Complexity theory takes a detailed look at the multiple criteria that constitute a "successful" academic program. (McQuillan, 2008)

From a social justice standpoint, the collective "success" of a student body is larger than measures of standardized test scores, discipline, and attendance. Combined with complexity theory, social justice oriented infrastructure and pedagogy must be holistic to include community development, individual identity development, and interest-based learning in order for standardized measures of efficacy to indicate a "successful" program beyond simply measuring student performance on a single test. (McQuillan, 2008)

The research questions in this study are:

What systemic factors discourage innovation in urban public schools with a history of racial achievement imbalance?

What type of bureaucratic obstacles stood in the way of implementing social justice initiatives in Chesapeake County?

Who were the key stakeholders in facilitating school change at Leicester Middle School?

How can different stakeholders resolve conflict and cooperate to create a synergistic and effective program?

The origin of a change initiative and its relationship to school board policy are an important consideration when developing a framework for school reform. The STEM academy at Leicester Middle School exemplifies teacher-driven versus policy-driven change in urban schools. James Spillane's (2002) study identifies common perspectives that support or resist teacher change. Spillane (2002) investigated three perspectives of teacher learning and change: the behaviorist perspective, the situative-sociohistoric perspective, and the cognitive perspective.

Spillane (2002) used these three perspectives to analyze how educators and administrators differ in their approach to reform efforts. From the behaviorist perspective, teachers view the process of teaching and learning as action-based (behavioral) but not interpretive. In this approach, information is transmitted in a linear sequence motivated by a cause and effect reward system. From the situative-sociohistoric perspective, learning is a social experience motivated by an individual's

desire to solve problems they have a personal interest in. From the cognitive perspective, problem-solving skills are central to the learning process.

Spillane (2002) determined that eighty-five percent of district level administrators in his study of nine school districts favored the behaviorist approach. The behaviorist perspective applied to school reform measures results in a top-down process whereby district level administrators issue guidelines for reform and direct teachers into formulated initiatives. Spillane's (2002) study is important because it demonstrates how ideological differences between district level administrators and teachers reduce the efficacy of reform efforts. The Chesapeake County Board of Education supported the STEM academy through a combined cognitive and situative-sociohistoric perspective. This bottom-up approach granted teachers the authority and autonomy to formulate their own initiatives tailored to the unique needs of their school community, thereby designing a program with intrinsic rewards for students generated by their personal interest in the curriculum.

Methodology

I was a participant observer employed at Leicester Middle School during the development and implementation of the STEM Academy. This study explores the process of implementing change to mitigate achievement discrepancies between African American and white students in a diverse, urban school through the creation of a STEM based smaller learning community.

Analysis of primary and secondary documents pertaining to the planning and implementation of the STEM Academy at Leicester Middle School formed the basis of the research. Primary sources include interviews with individuals who organized

and implemented the program from the teacher, administrator, and school board level, as well as document sources including minutes from meetings, grant proposals, curriculum proposals, scheduling documents, student demographics, application and selection criteria, and analysis of published studies that support various individual design aspects that were incorporated into the program. Many educators in Chesapeake County (including teachers at other schools, county level supervisors, and school board members) took part in STEM initiatives, however I used stratified purposeful selection to identify individuals who had a direct influence on the development and execution of the STEM Academy at Leicester Middle School for the interviews. (Patton, 1990) I classified an individual with "direct influence" as a stakeholder who designed, advocated for, or outwardly disapproved of, a structural or curricular aspect of the academy. I interviewed each stakeholder under assurance of their anonymity to gain insight into their personal motives and methodology for developing or facilitating the STEM Academy. I recorded my observations and personal interviews in an observation notebook. Some interviews were supplemented by email responses to specific questions, which were printed out and added to the notebook along with documents acquired from the school.

Bias from individual sources with a personal stake in the study presents a significant threat to the validity of their testimony as a source. To combat this source of bias, all stakeholders who had influence or authority over any aspect of the academy were interviewed in order to represent all parties involved. (Mills, 2000)

When possible, data gathered from interviews was triangulated by interviewing individuals from different levels of the school system and those with

differing opinions on issues. Personal testimonies were also compared to other indices including minutes of meetings, curriculum council proposals, grant RFPs (request for proposal), and student data. (Miles & Huberman, 1984) Political discourse and debate between individuals with dissenting opinions formed an integral part of the design process. The study details how certain aspects were included or omitted from the final proposals, who benefited from or detracted from these decisions, and how these compromises were orchestrated.

Research Analysis

The STEM Academy study focuses on the process of adapting existing STEM academy designs to meet the needs of urban and minority students, not a measurement of the efficacy of STEM curriculum in said environment. The STEM Academy is in its first year of a three year trial and such data, even if available, would be only preliminary and not subject to rigorous analysis until the conclusion of the three year study.

The goal of this analysis is to provide the reader with an example of successful methods for achieving school-based and countywide administrative support; local and national grant funding; and student, teacher, and parent cooperation for new and innovative ideas to radically change instruction.

Interviews and documents form the primary source basis for a narrative timeline of the preliminary and implementation stages of the STEM Academy as told from the perspective of the educators involved. The analysis portion of the thesis will

address solutions to overcome bureaucratic obstacles and ideological clashes in a proactive and cooperative manner without compromising the social justice agenda.

A five-year evaluation of the Bill and Melinda Gates Foundation school reform initiatives compared the efficacy of establishing smaller learning communities within schools to smaller whole-school models. (Shear et al., 2008) The evaluation reported inconclusive results on academic improvement by subject area between the aforementioned options. Shear (et. al., 2008) noted that variables including theme-based curriculum, student self-selection, and staffing changes during the experiments affected the validity of the studies. Particularly, when an academy or school emphasized a particular subject matter over another, standardized tests scores would increase and decrease accordingly.

As previously noted, the reading and math proficiency agenda of NCLB shifted focus and resources away from STEM. Logical deduction implies that reading and math scores will not improve solely resulting from the addition of a STEM curriculum. The objective of the STEM Academy was to develop student strengths across all core subject areas by utilizing STEM as a frame of reference for thematic curriculum in a smaller learning community. In this manner, the NCLB reading and math objective is preserved while simultaneously utilizing, rather than diminishing, resources for science education.

The smaller learning community model shares the ideal of smaller class sizes and stronger student-teacher relationships with the charter school model, however the smaller learning community model was a more viable option for Leicester Middle School because it was less disruptive to the infrastructure of the school system, it did

not require substantial reassignment of faculty, and it was the least expensive option to implement.

Chapter 2: Overview of the Research Site

A Brief History of African American Education in Leicester

The research site for this study was Leicester Middle School, located in the city of Leicester, Chesapeake County, Maryland. Leicester is the urban center of an otherwise vastly rural region in the state.

Leicester Middle School operates at the site of the former Leicester High School: originally Chesapeake County's segregated African American secondary school. Leicester High School was closed in 1964 in response to government pressure to implement the provisions of the 1954 *Brown v. Board of Education* ruling. The history of Leicester Middle School chronicles the birth, death, and rebirth of a historically African American public school.

Leicester High School was founded by an African American community fund-raising effort during the 1920s. Local African American educators sought to create a high school comparable to the schools available to white children, thereby broadening the secondary education opportunities for the African American students of Leicester. The African American community viewed Leicester High School as a means for future generations of Leicester's African American youth to achieve social mobility.

Leicester High School had a strong network of teachers, administrators, and students who lived in the same neighborhoods and participated in social circles

outside of the school. In essence, the culture of the school was a collaborative extension of the individual families it served thereby playing an integral role in student achievement through consistent and positive support at school, at home, in their neighborhoods, and in community centers and churches. (Morris, 2008)

As Chesapeake County's desegregation plan unfolded following the *Brown* ruling, Leicester High School was closed in favor of a redistricting plan that would send half of its students to Chesapeake High School (the white high school) and the other half, along with half of Chesapeake High School's students to a newly proposed integrated high school. Chesapeake County was progressive for the time in its attempt to redistribute the African American teachers in the county as an alternative to eliminating positions altogether, however the prevailing solution was to assign displaced African American teachers to clerical duties at the board of education, thereby undermining their qualifications as educators and diminishing their influence among African American students. (Mete, 2008, in author's possession.)

In 1954, African American educators in Chesapeake County were among the highest paid African American educators in the nation. Salaries reflected the high standards at Leicester High School. Desegregation efforts in Chesapeake County inadvertently undermined the quality of education at Leicester High School by ignoring the role of the community in the school, and by disenfranchising African American families as leading voices in parent/teacher organizations. (Mete, 2008, Interview with Leicester High School Alumni, November 21, 2008, in author's possession, Interview with former Leicester High School student during desegregation initiative, December 15, 2008, in author's possession.)

Renovation and Revitalization of a Community School

In 1999 the facility was renovated and reopened as Leicester Middle School. Leicester Middle School's student body is approximately sixty-two percent minority, (fifty-five percent African American). Statistics for African American achievement at Leicester Middle School reflect national underachievement trends and the school has an inconsistent record of meeting AYP requirements per the 2001 *No Child Left Behind* act. Leicester Middle School is located in a historically African American section of the city of Leicester and serves a diverse and high-need population. Half of Leicester Middle School's student body receives Free and Reduced Meals assistance. (http://msp.msde.state.md.us, 2009)

Many educators from a variety of positions both in the school and at the board of education played an integral role in the formation of the STEM Academy at Leicester Middle School. All of the educators involved in implementing the STEM Academy were white. The sole African American educator involved in planning STEM initiatives in Chesapeake County retired in the summer of 2007. (STEM Planning Grant Proposal, May 25, 2007, in author's possession.) Their personal experiences as educators combined with a variety of other career experiences and individual philosophies connecting education and social justice were integral to their unified vision of the STEM Academy.

Educators as the Catalyst for Change

The following educators were key stakeholders in facilitating school change at Leicester Middle School. I classified these stakeholders into three categories of *"non-traditionalists," "modificationists,"* or *"organizationalists"* based on their positionality and role in initiating or withstanding change via the STEM Academy. It is important to note that none of the stakeholders opposed the overarching ideal of reform initiatives to boost minority achievement, but disagreements emerged over the nature of the reforms and the implications they had over the operational structure of the school system and their deviation from the standard educational practices in Chesapeake County Public Schools. The classification of these stakeholders into the following categories indicates their positionality with respect to the STEM Academy initiative, not necessarily their views regarding other areas of educational philosophy or their daily practices.

"Non-traditionalists" sought to use the STEM Academy as a radical reform measure that employed new philosophies and non-standard practices. They were the most vocal advocates of change and the key organizers of the STEM Academy at Leicester Middle School. "Non-traditionalists" believe that the current standard middle school model does not adequately serve the needs of all students equally nor does it maximize the potential learning experience for marginalized students.

"Modificationists" generally sided with the "non-traditionalists" regarding the design aspects of the academy, but were less active in advocating for systemic change mechanisms. The "modificationists'" primary objective was to develop the theme-based cross-curricular aspect of the academy. "Modificationists" are agents of

compromise and have lesser personal stakes in the administrative decisions of the academy.

"Organizationalists" viewed the STEM Academy as a pedagogical innovation, not a structural or curricular reinvention. "Organizationalists" resisted large-scale change to the schedule design of the middle school and did not approve of deviations from the standard curriculum due to equity issues, budget concerns, and overall school and resource management. Most of the stakeholders in positions of authority shared the "organizationalists" stance, which despite a unified common goal was at odds with the visions of the other two groups. However, the power balance was tilted in favor of the "organizationalists" therefore their support was vital to the implementation and viability of the program.

Mr. Gary Novak

Mr. Novak teaches science at Leicester Middle School. Mr. Novak began advocating for scheduling redesign at Leicester Middle School in 2004. Mr. Novak researched alternative schedule designs that allowed increased instructional time with students. He was concerned about the amount of instructional time lost during the first and last months of the school year under the traditional model. Mr. Novak's first STEM initiatives were theme-based events to promote specific areas of science. Two initiatives he started with Ms. Montgomery were an annual "Night Under the Milky Way" to support astronomy and a "Crime Scene Investigation" night to demonstrate forensic science in an interactive environment. These programs have high attendance

and parental involvement, and are recognized throughout Chesapeake County as effective community engagement initiatives.

Mr. Novak serves as a co-chair with Ms. Ness on Leicester Middle School's school improvement team. Mr. Novak's experience with faculty leadership and community outreach initiatives made him a prominent voice for the STEM Academy teachers at Leicester Middle School. Mr. Novak is a "non-traditionalist" who advocates for radical changes to the middle school model, particularly with respect to scheduling practices. Mr. Novak has taught at Leicester Middle School for nine years. (Interview with Mr. Novak, February 17, 2010, in author's possession.)

Ms. Jennifer Montgomery

Ms. Montgomery is Leicester Middle School's media specialist. Ms. Montgomery served as a meeting leader, curriculum organizer, and liaison between teachers, administrators, and supervisors during the planning and implementation of the STEM Academy. Ms. Montgomery's educational background includes teaching music, math, and science. Her experience teaching multiple curricula founded her support for a thematic cross-curricular initiative.

Ms. Montgomery is a "non-traditionalist" who views the STEM academy as a vehicle for social justice. Ms. Montgomery focused her efforts on researching and organizing site visits during the formative stages of the academy. She is a proponent of grouping students with the same teachers for

multiple years and believes smaller learning communities can reduce the achievement gap. Ms. Montgomery tracked student demographic data during the application process to monitor the effectiveness of our goal to attract African American students to the academy. Her analysis of student interest was an important factor in how we marketed the program to students and parents.

Ms. Montgomery's role as a media specialist enabled her to support the STEM teachers by organizing resources and assisting with cross-curricular lesson planning. Ms. Montgomery has taught at Leicester Middle School for ten years. (Interview with Ms. Montgomery, March 31, 2010, in author's possession.)

Mr. Robert Purnell

Mr. Purnell teaches technology education at Leicester Middle School. Mr. Purnell worked for twenty-five years as a construction supervisor before deciding to become a teacher in 1999. Mr. Purnell student taught at Leicester Middle School while finishing his teaching degree in 2001, and was offered a job at Leicester Middle School beginning August 2002.

Mr. Purnell first learned about STEM initiatives while completing his master's degree in career and technology education. Mr. Purnell inquired about STEM opportunities at Leicester Middle School in 2006 and attended a STEM education conference at Johns Hopkins University with Daniel Hatcher in 2008.

Mr. Purnell is a "modificationist-organizationalist." Mr. Purnell believes that vocational education and industrial arts are essential components of career education. He further believes that the public school system does not provide adequate structure for students at all levels, from a pedagogical and disciplinary standpoint. These ideals inspired his involvement with STEM academy at Leicester Middle School.

Mr. Purnell advocated for a minimally intrusive, gradual phase-in of the STEM Academy. He remained decidedly neutral and non-confrontational on issues such as drastic scheduling changes and extensive cross-curricular initiatives, preferring to adapt STEM curriculum to the existing middle school model. Mr. Purnell has taught at Leicester Middle School for seven years. (Interview with Mr. Purnell, February 16, 2010, in author's possession.)

Ms. Emily O'Leary

Ms. O'Leary teaches history at Leicester Middle School. Ms. O'Leary's interest in social justice initiatives began while studying the *Brown v. Board of Education* case in law school, which subsequently inspired her to become an educator. Her law school background influenced the development of her view that an educator's role is to foster informed citizens that understand both their rights and responsibilities in society.

Ms. O'Leary's experience working at the national office for National History Day shaped her belief that project based learning (cognitive approach) is more beneficial to students than lectures and tests (behaviorist approach). Ms. O'Leary is a "modificationist" who views the STEM academy as an

instrument to inspire students to take an active role in their education through immersion in a focused area of study. She views the academy as a model for discovery-based learning rather than theme-based curriculum. Ms. O'Leary has taught at Leicester Middle School for four years. (Interview with Ms. O'Leary, March 4, 2010, in author's possession.)

Ms. Tallulah Jackson

Ms. Jackson teaches Language Arts at Leicester Middle School. Mr. Novak and Ms. Herschel recruited Ms. Jackson to join the STEM Academy in the spring of 2009. Ms. Herschel felt that Ms. Jackson's successes motivating students with academic and behavioral difficulties would be an asset to the STEM Academy. Ms. Jackson was hesitant to the idea of being involved in an academy structure at first, because she was concerned that the structure of the program would reduce her ability to work with a large number of students.

Ms. Jackson believes that social justice initiatives can be achieved through building relationships with students through engaging lessons, sympathy, and compassion. Ms. Jackson was initially an "organizationalist." Ms. Jackson had personal successes reaching a large student population within the status quo scheduling arrangement prior to joining the STEM Academy, and was wary of radical deviations to the established system. As Ms. Jackson got more involved with the design aspects of the academy, including the benefits of looping and her contributions to thematic units her positionality shifted to "modificationist."

Ms. Jackson views the STEM Academy is an opportunity for middle track students to excel. She joined the project with a primary objective to increase involvement for girls and African American students because of their under-representation in science and engineering careers. Ms. Jackson has taught at Leicester Middle School for ten years. (Interview with Ms. Jackson, March 4, 2010, in author's possession.)

Ms. Victoria Ness

Ms. Ness teaches language arts at Leicester Middle School and serves as a co-chair for the school improvement team with Mr. Novak. Ms. Ness believes that the behaviorist influence of NCLB has decreased student engagement in active learning. Ms. Ness sees the STEM Academy as a means to fund student programs that are multi-disciplinary, hands-on, and project based rather than textbook based.

Ms. Ness is a "non-traditionalist-organizationalist" who supports looping students and cross-curricular planning but does not want STEM initiatives to interfere with the balance of operations in the school system. To this end Ms. Ness worked to orchestrate compromises between "non-traditionalists" and "organizationalists." (Interview with Ms. Ness, March 4, 2010, in author's possession.)

Mr. Kevin Jefferson

Mr. Jefferson teaches science at Leicester Middle School. Mr. Jefferson also sponsors Leicester Middle School's "Destination Imagination" team with Ms. Ness. Mr. Jefferson is a "modificationist" interested in the idea of a smaller learning community as a way to enrich the science curriculum. Mr. Jefferson would like to see Leicester Middle School adopt more theme-based academies based on a variety of disciplines in order to reach more students. (Interview with Mr. Jefferson, March 31, 2010, in author's possession.)

Mr. Daniel Hatcher

Daniel Hatcher was hired in 2007 to serve as the Coordinator of Secondary Initiatives for Chesapeake County Public Schools. Mr. Hatcher's role is to develop secondary education support initiatives, particularly smaller learning communities. Mr. Hatcher's background included careers in the private sector, politics, and higher education. Mr. Hatcher came to Chesapeake County to develop thematic academy programs, which he feels are an effective way to connect academics with student interests through tangible project-based pedagogy.

Mr. Hatcher served as a liaison between the teachers at Leicester Middle School and the Chesapeake County Board of Education. Mr. Hatcher applied for grants to fund the program and orchestrated the countywide STEM initiative to both satisfy the MSDE K-12 requirements of the grant and

provide ample resources for the academy at Leicester Middle School. Mr. Hatcher is positioned as a "non-traditionalist-organizationalist." Idealistically, he supports the concept of an autonomous academy that operates outside the traditional middle school structure, however his position in the school system requires maintaining balance and cooperation between stakeholders at all levels. (Interview with Mr. Hatcher, March 4, 2010, in author's possession.)

Ms. Chelsea Taylor

Ms. Taylor left retirement to serve as the STEM Site Coordinator at Leicester Middle School. Her previous experiences included teaching biology at the secondary and undergraduate level, coordinating continuing education for professionals, and coordinating non-credit adult education. Ms. Taylor's position was created from grant funds acquired by Mr. Hatcher. Her responsibilities include planning school-wide STEM initiatives such as the Lego League and STEM Saturdays, as well as STEM Academy student workshops with community volunteers, and field trips.

Ms. Taylor is a "modificationist-non-traditionalist" who used her position to provide instructional and extra-curricular resources to the teachers as well as administrative support for Mr. Hatcher during the planning and implementation phases. Ms. Taylor is the STEM Academy's primary record keeper. In addition to writing minutes of meetings, Ms. Taylor tracks data pertaining to student demographics, performance, and participation at school

wide STEM events. (Interview with Ms. Taylor, March 31, 2010, in author's possession.)

Dr. Benjamin Armstrong

Dr. Benjamin Armstrong was elected superintendent of Chesapeake County Public Schools in 2008. Dr. Armstrong is a strong supporter of STEM initiatives and oversaw a STEM magnet elementary school in Minnesota where he served as an assistant superintendent. Dr. Armstrong believes that school reform should be teacher initiated in order to be both effective and permanent because of the inherent uniqueness of every school and the community it serves. He believes that an incremental, systems-based approach to education reform whereby a group of educators implement a series of deliberate and organized changes over a period of time is larger than the sum of the individuals that initiated it. In this way, the momentum of the reform will continue independently of its members. Dr. Armstrong is centrally positioned among the three stakeholder categories. (Interview with Dr. Armstrong, March 19, 2010, in author's possession.)

Ms. Rebecca Anderson

Ms. Anderson is the Director of Secondary Education for Chesapeake County Public Schools. Ms. Anderson oversees curriculum and materials used in Chesapeake County Public Schools. Ms. Anderson took an "organizationalist" approach to the STEM Academy in order to ensure that the

academy would serve as a model that could be readily adapted to other schools in the county, without creating special-case scenarios at odds with the Code of Maryland Regulations (COMAR) requirements.

Ms. Anderson envisioned the STEM Academy as a pedagogical innovation that encourages autonomy for teachers in the classroom provided they remain connected to the existing curriculum standards. Ms. Anderson did not support curricular reinvention because the curriculum approval process has implications for all schools in the county and would set precedent for future STEM Academies at other schools. According to Ms. Anderson, the strength of the academy structure is its freedom to be unique to each school, not follow previous examples.

Ms. Evelyn Herschel

In 2008, Evelyn Herschel was appointed principal of Leicester Middle School. Ms. Herschel's teaching experience was in the special education field, including both self-contained special education and resource teaching. Ms. Herschel was eager to bring the STEM Academy concept to Leicester Middle School in order to incorporate students that would not normally take part in an advanced course of study, particularly average-performing on-level students and special education students. Ms. Herschel advocated for an even ratio of white to minority and male to female students in the program with a strong emphasis on differentiated instruction and inclusion for special education students.

Ms. Herschel is an "organizationalist" who strongly supports the STEM Academy's social justice initiative, but not at the expense of the organizational structure of the school at large. Ms. Herschel's decisions regarding the STEM Academy had to consider the implications on both the STEM teachers and the rest of the faculty at Leicester Middle School. As such, Ms. Herschel did not support proposals that potentially displaced non-STEM teachers or students or broke up the cohesive grade-level teaming structure to which she attributes the positive climate at Leicester Middle School. (Interview with Ms. Herschel, March 19, 2010, in author's possession.)

Mr. Ryan Mete (author)

My perceptions of equity in the public school system began with my own observations as a student. I attended high school in a rural but well resourced school system in Virginia. My high school experience exposed me to a rigidly defined social structure determined by socioeconomic status and race. Social status was reinforced by academic classification in a three-tiered tracking system that typically mirrored students' socioeconomic status. (Rodgers & Oakes, 2005)

I studied business administration in college and worked in sales and marketing prior to deciding to become an educator. I left the private sector after discovering my interest in teaching through volunteer work I did at an urban high school in Annapolis, Maryland during 2005 and 2006. I was hired

at the aforementioned school in the summer of 2006 to teach a work-based learning program for low achieving students. Every student in the program was African American.

I had no formal training in education prior to accepting the position and as such, I found myself very apprehensive as I prepared for the beginning of the school year. My fear of the unknown, specifically in my yet unproven ability to engage students effectively and remain sensitive to our cultural differences quickly became the commonality from which we built a classroom community that valued trust and mutual respect. (Comer, 2004) In this manner I grew more aware of systemic inequities in the public education system and became an advocate for minority and urban students. I relocated to the Leicester area the following year and began teaching computer science at Leicester Middle School.

In my four years of experience teaching I have observed that relationships are a powerful vehicle for student enrichment, a belief supported by many urban educators. (Hill, 2009) During the course of an average school year, a teacher at Leicester Middle School teaches between ninety and one-hundred-eighty students per year. This student to teacher ratio equates to a maximum of one half to one whole day per student of individual instruction. I feel that this is insufficient time to overcome the fear, apprehension, and mistrust that many disadvantaged students enter the classroom with at the beginning of the year. Furthermore, relationships between students and teachers that develop over the course of the year are unable to continue in the

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same capacity when a student changes grade level. I view this as a systemic limitation to the standard middle school schedule that disservices students.

I was first exposed to STEM while participating in a weeklong professional development program called Teachers and Engineers for Academic Achievement (TEAACH), sponsored by Northrop Grumman in Baltimore, Maryland in July of 2008. The TEAACH program introduced me to a variety of hands-on science and engineering activities to use with my students that were both engaging and demonstrative of concepts such as physics, electricity, and problem solving skills.

I believe that disadvantaged students need a structured classroom community environment that appeals to their personal frame of reference in order to achieve their highest potential. (Delpit, 1995) To this end I developed a course for eighth grade students that combined C++ programming with algebra support that was later incorporated into the STEM curriculum proposal presented in May 2009.

I view the STEM Academy as an opportunity to redefine the student to teacher relationship by maintaining classroom communities for multiple years. I theorize that through consistent classroom environments and maintaining the same group of students for multiple years, STEM Academy teachers will have the ability to build strong relationships with disadvantaged students thereby increasing their personal stake in the learning process. (Delpit, 1995)

I classify myself as a "non-traditionalist." I advocated for the STEM academy to operate independently from the middle school model, particularly

with respect to tracking. Tracking is inherently discriminatory against lower income students from a social justice standpoint, and has an adverse effect on student performance regardless of interventional resources available. (Hallinan, 1994)

I work closely with students who cope with the stigma of being tracked into self-contained special education classrooms for emotional disabilities through my volunteer work with the Chesapeake Mentoring Project. The main objective of my work with these students is to develop social and behavioral skills that will enable them to participate in mainstream classrooms when they enter high school. I view the STEM Academy as an opportunity to circumvent the tracking practice in order to create a more egalitarian classroom for disadvantaged students. (Oakes, Rogers, & Lipton, 2006)

Figure 1: STEM Academy Stakeholders
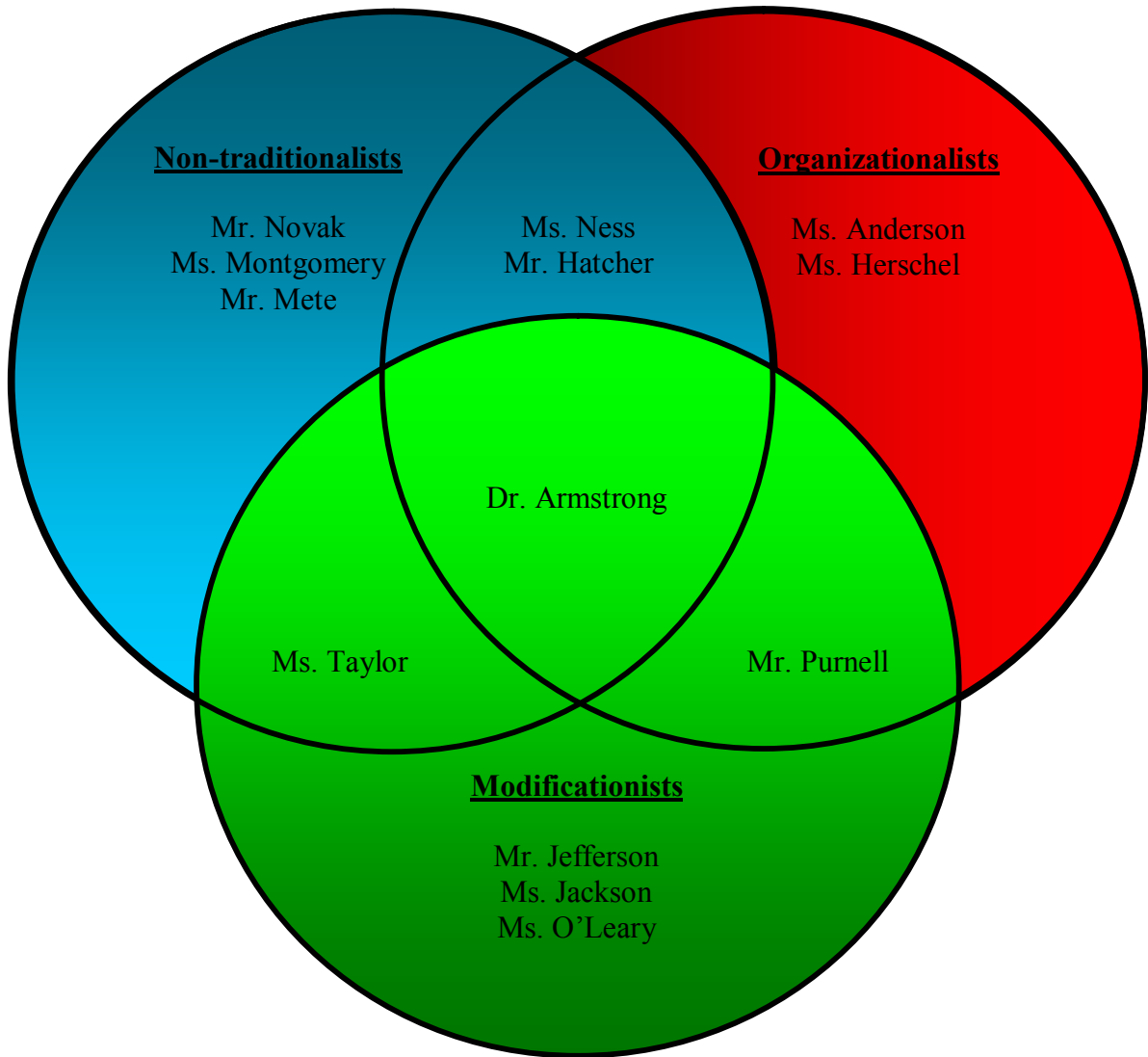
Chapter 3: The Origins of STEM in Chesapeake County

The STEM Grant

The first smaller learning community initiative in Chesapeake County began with the implementation of the Freshman Academy in 2004. The Freshman Academy was designed to support students transitioning from eighth grade to high school by providing smaller class sizes and individualized support. The objective was to increase student achievement and lower the dropout rates in the district's high schools. In an effort to expand the reach of smaller learning communities, an advisory committee at the Board of Education researched idea of subject-based academies to provide specialized student based learning initiatives. (Interview with Mr. Hatcher, February 19, 2010, in author's possession.)

The state of Maryland offered the first STEM grants in 2006. The Chesapeake County Board of Education did not initially pursue this initiative for a number of reasons. The grant programs as implemented in other counties did not align with the goals of Chesapeake County, specifically the aim to boost achievement among minority students. When Mr. Hatcher was hired, he shared the board of education's initial reservations. Mr. Hatcher was concerned about the contingencies and implications of accepting grant money for STEM education, specifically regarding how the money would be spent and whether it could be apportioned to

students outside the gifted and talented range. Mr. Hatcher sought clarification to ensure that Chesapeake County would not be restricted in their use of the money by the precedent that had been set elsewhere in the state. (Interview with Mr. Hatcher, February 19, 2010, in author's possession.)

Examples of other academies in Maryland served high-achieving student groups via magnet programs or charter schools. The Chesapeake County Board of Education perceived that these programs were an inappropriate fit for student groups in high-poverty situations and predominantly minority communities, and did not have any plans for secondary level magnet programs. Mr. Hatcher's "non-traditionalist" vision for STEM funding included an academy (as did other counties) however he also wanted to ensure that funds could be used for community outreach efforts aimed at larger student populations, such as Mr. Novak's community engagement initiatives at Leicester Middle School. (STEM Planning Grant Proposal, May 22, 2007, in author's possession.)

Reaching Beyond the Smaller Learning Community Model

In 2007 Mr. Hatcher applied for a $10,000 planning grant to fund research and development of STEM initiatives. Mr. Hatcher believed that through a combination of broad-based community outreach programs and a STEM academy at Chesapeake High School, the program could increase minority participation in science and technology based programs of study at the college level. (STEM Planning Grant Proposal, May 22, 2007, in author's possession.) Mr. Hatcher's request for proposal (RFP) outlined his vision of a broad-based program and a smaller academy for students of all achievement levels. Mr. Hatcher's RFP was intentionally designed to

satisfy the K-12 requirements of MSDE while providing explicitly designated funds for programs that would improve minority achievement. (STEM Fiscal Year 2008 Request for Proposals, April 9, 2007, in author's possession. STEM Grant Proposal , May 28, 2008, in author's possession.)

Mr. Hatcher believed that targeting a small student population or using a magnet model for high-achieving students ignored the need for stronger parent and community involvement in Chesapeake County Schools. Mr. Hatcher wanted to use a layered approach to implement STEM that extended beyond the reach of the smaller learning community to include STEM themed co-curricular programs that would be open to all students regardless of whether or not they were enrolled in the STEM Academy. (Interview with Mr. Hatcher, February 19, 2010, in author's possession.)

"STEM Saturdays" would feature community volunteers to host Saturday workshops on STEM subjects including video game design, graphics, web development, and others. The grant would also sponsor students to participate in the Engineering Expo, and the Lego League engineering and robotics program. These initiatives would be accessible to all students, not just those enrolled in the STEM Academy. (2009 STEM Grant Initiative Abstract, May 19, 2009, in author's possession. Local newspaper article, in author's possession)

Mr. Hatcher's original location for the STEM Academy was Chesapeake High School. (STEM Grant Proposal, May 28, 2008, in author's possession.) Despite a strong initial interest, he determined in the September of 2008 that there were not enough teachers interested in the project to support the teacher-driven academy model he envisioned. Mr. Hatcher proposed the STEM Academy to Leicester Middle

School because he wanted to pilot the program at a site with more enthusiasm for the project. Leicester Middle School had a strong group of teachers eager to adopt the STEM Academy initiative. (Interview with Mr. Hatcher, February 19, 2010, in author's possession.)

A New Direction: Middle School Academies

Leicester Middle School's faculty had the characteristics Mr. Hatcher desired for the program: enthusiastic teachers from a variety of subjects including science, history, language arts, technology education, computer science, and the school's media specialist, as well as support from the administration. Ms. Herschel had worked with Mr. Hatcher on previous committees involving infrastructure solutions to support dynamic change in the school systems and was aware of the nature of the changes proposed as well as the role of the administration in these efforts. Chesapeake County had no plans for an academy structure at the middle school level. Mr. Hatcher's concept of a middle school model changed the focus of the countywide STEM initiative. (Interview with Mr. Hatcher, February 19, 2010, in author's possession.)

Mr. Hatcher proposed the STEM Academy to a group of teachers at Leicester Middle School, including Mr. Novak, Ms. Montgomery, Mr. Jefferson, Ms. Ness, Ms. O'Leary, and myself. We individually opted to attend the meeting in response to a brief email description of the proposal. At the conclusion of the meeting, we formed a STEM Academy planning team and quickly established roles for the formation of the STEM Academy. Ms. Ness, Mr. Jefferson, and Ms. O'Leary focused on the

pedagogical design of the academy. Mr. Novak, Ms. Montgomery, and myself designed the cohort concept and scheduling aspects.

The STEM Academy was planned in a cooperative manner similar to James Comer's School Development Program, however parents were not involved in the planning aspect due to the potential for conflicts of interest during the application process. Comer's model was designed for whole-school reform. The STEM Academy was a smaller learning community that would only be able to serve a portion of the total student body. Comer's method centers on the value of consensus in school reform. Varying degrees of consensus and conflict affecting the implementation of the STEM Academy at Leicester Middle School are analyzed in this study. (Glazer, 2005)

Our attempts to research existing models of social justice oriented STEM programs in the Maryland, District of Columbia, and Virginia metropolitan area yielded minimal results. The overwhelming majority of STEM programs we observed were designed for high achieving students. We observed one charter school in Baltimore that implemented a social justice oriented program, however the academy was a magnet school for boys only and operated under a radically different scheduling arrangement that included an extended day program and a mandatory summer program. Their autonomy from the traditional public school structure conflicted with the provisions with which we had to operate under per the Chesapeake County Board of Education. (Interview with Mr. Novak and Ms. Montgomery, March 19, 2010, in author's possession.)

The STEM Academy planning team made the first formal presentation to the Chesapeake County Board of Education on March 4, 2009. There was concern at the board level that the STEM Academy should strictly follow the Voluntary State Curriculum (VSC) and not introduce new material. The board viewed the STEM Academy as a new style of teaching but with no new content, only enriched versions of the existing curriculum. (STEM Advisory Meeting Minutes, March 4, 2009, in author's possession.)

I found this level of bureaucratic restriction counterproductive to the idea of true education reform. The board's resistance to transformational projects (coinciding with the "organizationalist" position) directly conflicted with my own view as a "non-traditionalist." The insistence that there would be no new curriculum introduced undermined the ability of the STEM Academy to expand beyond the limitations of the VSC and better prepare students to compete globally. Furthermore, the idea of introducing new material is not mutually exclusive to the VSC's guidelines. One of the goals of the looping aspect was to gain instructional time, which could be utilized to cover new material at the end of the year, after MSA testing.

The STEM Academy planning team presented the academy to the Chesapeake County Board of Education's Curriculum Council on March 12, 2009. The shift from a high school academy to a middle school academy was a concern, particularly that an academy model at the middle school level would unnecessarily track students and predetermine career paths at too young of an age. Such decisions were deemed by some at the meeting to be more appropriate at the high school level, coinciding

with the career and technology program already implemented at the high school level. Questions were raised about the potential efficacy of teaching STEM curriculum that differed from the high-achieving models elsewhere in the state. The board ultimately approved the STEM Academy under the presumption that it would be a pedagogical strategy rather than a radical deviation from the normal middle school design. (STEM Advisory Meeting Minutes, March 4, 2009, in author's possession. Interview with Ms. Montgomery, March 19, 2010, in author's possession. Interview with Mr. Novak, March 19, 2010, in author's possession. Interview with Mr. Hatcher, February 19, 2010, in author's possession. Interview with Ms. Anderson, March 30, 2010, in author's possession.)

Navigating the Bureaucracy

The Chesapeake County Board of Education agreed to run a three-year pilot program at Leicester Middle School. Superintendent Dr. Armstrong supported the idea of STEM based curriculum and had experience administering STEM themed magnet schools. Dr. Armstrong's long-term vision for Chesapeake County Public Schools is to implement teacher-driven academies at all schools. This philosophy is an extension of his previous experience with magnet programs, adapted to the school board's desire for a decentralized, school-based approach to smaller learning communities. Dr. Armstrong's relatively neutral positionality regarding the administrative level of the academy's formation period fostered an atmosphere of comprise between stakeholders with opposing viewpoints, particularly between "non-traditionalists" and "organizationalists." (Interview with Dr. Armstrong, March 22, 2010, in author's possession.)

The STEM Academy at Leicester Middle School would be evaluated at the end of a three year trial based on an analysis of qualitative data in the form of annual student and parent surveys, community involvement in STEM initiatives, and the enrollment data; and quantitative data in the form of AYP data including attendance rates and Maryland School Assessment scores, as well as "soft data" including Scholastic Reading Inventory (SRI) benchmarks and Yearly Progress Pro (YPP) benchmarks. SRI and YPP are respective reading and math assessments used to monitor student progress in preparation for the Maryland School Assessment. The school board determined that if the academy produced measurable student gains in reading and math scores as outlined in the proposal, it would be a viable option for increasing overall school performance per NCLB. (STEM Advisory Meeting Minutes, March 4, 2009, in author's possession.)

Chapter 4: Structural Reform Through "Looping"

The STEM Academy Structure

The STEM Academy model at Leicester Middle School consists of two components: structural design and theme-based curriculum. Kenney (2007) suggests that the traditional schedule structure of a middle school does not provide the optimum environment for relationship building between students and teachers due to the limited classroom exposure per teacher combined with high student-teacher ratios. Ready, Lee, and Welner (2004) indicate that theme-based curriculums engage students directly via their personal interests and frame of reference. However, Ready (et al., 2004) warns that when structurally possible, struggling students self-selected into programs they perceived to have low academic and behavioral expectations whereas higher achieving students self-selected into programs with higher perceived expectations. The STEM Academy was designed to maximize student achievement through interest in the STEM theme and high student-teacher interaction. The academy was presented to parents and students as a theme-based program rather than an academically accelerated one in order to prevent less academically inclined students from self-selecting not to participate.

The centerpiece of the STEM Academy is the structural design process called "looping." "Looping" is the process of organizing students into consistent classes with the same teachers for multiple years. This process contrasts the traditional secondary education structure whereby class composition changes from year to year and students are grouped independently of each other. (George, 2009)

The Looping Handbook (Grant et al., 1996) offers several compelling reasons to consider maintaining consistent student groups from year to year paired with the same set of teachers. This rationale includes an increase in quality instruction time due to the pre-establishment of classroom procedures and climate, the opportunity to design bridge assignments that students work independently on during the summer, and stronger parent-teacher relations due to the extended time frame with which students and teachers interact.

Karen Rasmussen (1998) expands on the benefits of looping for at-risk students. Looping students extends the amount of time students and teachers have to build relationships and strengthen classroom communities. Stronger classroom communities foster academic improvement, personal growth, and identity development that can potentially deter a student's participation in gang activity.

The theory of looping students served as the basis for the development of the academy model at Leicester Middle School. Mr. Novak was curious about the implications looping would have for science curriculum. In the fall of 2008, Mr. Novak, Ms. Montgomery, and I discussed what I termed "de facto looping" that existed in the computer science department. Leicester Middle School's computer

science department was not teamed by grade level, meaning that based on random scheduling, a student could have a combination of computer science teachers from sixth to eighth grade or remain with the same teacher for two or all three grades.

I observed consistent behavior and academic improvements in my classroom when students were placed with me for than one academic year, which was consistent with the research we had reviewed. I attribute this to the fact students who had my class the previous year were already accustomed to my procedures and knew my personal expectations of them.

Mr. Novak and I predicted that looping students would result in stronger relationships between students, teachers, parents, and the community. High-need and gifted children benefit from academic support as well as personal & social skills provided in the looping environment. (Pratt, 2009) The closer relationships students develop with their teachers in a looped environment create a more secure and home-like environment for the students. (Rasmussen, 1998) By building trust with their students, teachers can make a stronger impact in a character education role, while developing a deeper understanding of the student's personal developmental needs. (Kenney, 2007)

Kenney (2007) indicates that as much as a month of time of instructional time is impacted by the traditional organization of secondary schools whereby students have new teachers every year. During the introductory month, teachers must spend time establishing and reinforcing procedures, expectations, and rules of conduct for the new classroom community. This creates apprehension for the students who must adapt to new teachers, and an altered social environment that may or may not prove to

be inviting. This establishment period slows the progression of content learning during the first grading period. Additionally, teachers must use this time to adapt to the learning needs of different students, especially IEP and 504 learners. Qualitative studies indicate that it takes several months to adjust to the individual needs of each student. This time spent and knowledge gained is not directly transferable between teachers as grades are promoted in the traditional system. (Kenney, 2007)

The STEM Academy planning team sought to utilize the looping concept to reduce time spent setting expectations and procedures in seventh and eighth grade during the introductory phase of the school year. Furthermore, teachers and students could bridge the summer break with extended individual learning assignments that would be issued in June and reviewed in August. My vision is that the STEM Academy will serve as a model for school wide restructuring into looped smaller learning communities.

Developing a New Schedule

The proposed sequence would loop students from sixth through eighth grade in cohorts with the same team of teachers: a "STEM team" that consist of Mr. Novak, Ms. O'Leary, Ms. Jackson, Mr. Purnell, an unspecified math teacher, and myself. The STEM team teachers would separate from their respective grade level teams to teach all three grades in the STEM cohort. The creation of a separate STEM team would enable the STEM teachers to have a common planning period, whereas under the current schedule each grade level academic team and elective teachers have separate planning time. Each STEM teacher would teach the same group of students for sixth, seventh, and eighth grade thereby maximizing constancy in the vertical

sequencing of the curriculum in successive grade levels. I conferred with Ms. Montgomery regarding the details of each grade level's schedule then developed a schedule that would enable the STEM team to operate outside the standard schedule at Leicester Middle.

The STEM team would have a single teacher for each of the following subjects: history, math, science, language arts, computer science, and technology education. The standard schedule for core subject teachers provided for four teaching blocks, which were comprised of two back-to-back periods of forty-five minutes each. These are grouped as "one-two," "three-four," "five-six", and "seven-eight." "Five-six" is actually a three-period block alternately referred to as the "lunch block." The timing of periods five, six, and lunch differ between grade levels and noted in Table 1. Core subject teachers teach three blocks and have one planning block. Elective teachers teach six non-blocked periods and have two planning periods during the "lunch block."

Planning blocks are grouped by grade level according to the standard schedule. Students in each respective grade go to their electives while their core subject teachers have planning. All three grade levels are teaching during the "lunch block" in order to provide a common planning time for elective teachers.

The thematic cross-curricular organization of units indicated a need for common planning time for the STEM team. This team was proposed as a separate team from the various grade-level teams, therefore common planning for the STEM team was theoretically non-obtrusive to the other teams. In order to maximize the

theme-based curriculum aspect of the academy, I developed a schedule (Table 3 and Table 4) that would allow for a common planning period for the STEM team.

I presented the schedule to the STEM Academy planning team before formally presenting it to Ms. Herschel for approval. Ms. Jackson and Ms. O'Leary noted that the proposed schedule required all STEM students to take their free special class during the seventh grade electives block[2]. Ms. Montgomery advised that this could potentially conflict with Code of Maryland Regulations (COMAR) guidelines (state law) as well as the Maryland Voluntary State Curriculum (VSC) for health and physical education courses. We speculated that individual health and physical education teachers could be approached about altering the sections of their courses to accommodate the STEM schedule, but this issue would wait for resolution until the schedule was approved or denied.

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[2] Students alternate between four elective courses per semester on a two-day (A-B) rotation cycle. For example, a sixth grade student will take "Elective 1" during Period 7, A Day; "Elective 2" during Period 8, A Day; "Elective 3" during Period 7, B Day; and "Elective 4" during Period 8, B Day. STEM students would be enrolled in their computer science and technology education courses during the same period on alternate days.

Table 1: Standard Student Schedule

Period	6th Grade	7th Grade	8th Grade
1	1/2 Core	1/2 Core	Electives
2	1/2 Core	1/2 Core	Electives
3	3/4 Core	Electives	3/4 Core
4	3/4 Core	Electives	3/4 Core
L1	5/6 Core	5/6 Core	Lunch
L2	5/6 Core	Lunch	5/6 Core
L3	Lunch	5/6 Core	5/6 Core
7	Electives	7/8 Core	7/8 Core
8	Electives	7/8 Core	7/8 Core

Table 2: Standard Teacher Schedule

Period	6th Grade	7th Grade	8th Grade	Electives
1	1/2 Core	1/2 Core	Planning	8th Grade
2	1/2 Core	1/2 Core	Planning	8th Grade
3	3/4 Core	Planning	3/4 Core	7th Grade
4	3/4 Core	Planning	3/4 Core	7th Grade
L1	5/6 Core	5/6 Core	Lunch	Planning and lunch times vary individually
L2	5/6 Core	Lunch	5/6 Core	
L3	Lunch	5/6 Core	5/6 Core	
7	Planning	7/8 Core	7/8 Core	6th Grade
8	Planning	7/8 Core	7/8 Core	6th Grade

Table 3: Proposed STEM Student Schedule for 2009-2010

Period	6th Grade	7th Grade	8th Grade
1	Computer/Technology	Language Arts	Math
2	Science/History		
3		Computer/Technology	Foreign Language
4	Electives	Electives	Electives
L1	Lunch	Lunch	Lunch
L2	Math	Science/History	Language Arts
L3			Computer/Technology
7	Language Arts	Math	Science/History
8			

Table 4: Proposed STEM Teacher Schedule for 2009-2010

Period	History & Science	Math	Language Arts	Computer/Technology
1	Planning	8th Grade	7th Grade	6th Grade STEM
2	6th Grade			8th Grade
3		Planning	Planning	7th Grade STEM
4	Planning	Planning	Planning	Planning
L1	Lunch	Lunch	Lunch	Lunch
L2	7th Grade	6th Grade	8th Grade	Planning
L3			Enrichment	8th Grade STEM
7	8th Grade	7th Grade	6th Grade	6th Grade
8				6th Grade

Systemic Restraints and Ideological Compromise

I proposed the STEM schedule to Ms. Herschel in January, 2009, but Ms. Herschel did not support the idea of removing core subject teachers from common planning with their grade level or creating an exclusive STEM team that operated outside of the standard schedule.   Grade level common planning periods are typically used to review MSA data, benchmarks, IEPs, and behavior intervention plans for students. Ms. Herschel envisioned STEM teachers aligning to a grade level team in addition to the STEM Academy by creating a STEM sub-team that was secondary to

their respective grade level teams. The systemic limitations that were placed on the academy schedule combined with the brevity of our discussion on the matter frustrated me. The STEM teachers felt very strongly that the cross-curricular aspect of the academy would be extremely difficult to implement without common planning time for STEM teachers. (Author's field notes, January 29, 2009, in author's possession.)

The rejection of the STEM team schedule proposal coincided with pressure from two sixth grade teachers on the STEM Academy planning team, Ms. Ness and Mr. Jefferson, for a STEM teacher representation in sixth grade. This sparked a debate that the efficacy of the looping process would be reduced if the students had a separate set of teachers for sixth grade. Mr. Novak, Ms. Montgomery and I advocated for a full three-year loop in order to maximize the consistency and relationship building aspects of looping. We further debated against removing the sixth grade students from the loop due to the increased complexity of the schedule.

Ms. Ness ("non-traditionalist-organizationalist") and Mr. Jefferson ("modificationist") debated that a transition year to middle school would be better for the students, citing the success of the Freshman Academy. The sixth grade team teachers at Leicester Middle School are mostly elementary education certified and organize many team-wide transition and support activities throughout the year.

Ms. Herschel expressed that the high teacher enthusiasm for this program was a key ingredient to its potential for success. Ms. Herschel did not wish to discourage teachers who were passionate about being involved with the STEM program. A compromise measure was drafted that included a sixth grade STEM sub-team that

could also teach other sixth grade sections, and an eighth grade STEM sub-team that would teach seventh grade STEM, eighth grade STEM, and a additional section of eighth grade students. (Interview with Ms. Herschel, March 19, 2010, in author's possession.)

Students would loop for all three years in Technology Education and Computer Science. Ms. Ness, Mr. Jefferson, and a new hire (to fill an expected vacancy for sixth grade social studies) would be grouped on the same team and teach one STEM section of their subject. Seventh and eighth grade students would loop with Mr. Novak, Ms. Jackson, and Ms. O'Leary. This solution maximized teacher involvement while retaining some benefits of looping.

Table 5: Approved STEM Student Schedule for 2009-2010

Period	6th grade	7th grade	8th grade
1	Language Arts	Math	Computer*/Technology*
2	Language Arts	Math	Electives
3	Science/History	Computer*/Technology	Science/History
4	Science/History	Electives	Science/History
L1	Math	Language Arts	Lunch
L2	Math	Lunch	Math
L3	Lunch	Language Arts	Math
7	Computer/Technology*	Science/History	Lang. Arts/For. Lang.
8	Electives	Science/History	Lang. Arts/For. Lang.

* One semester course

Table 6: Approved STEM Teacher Schedule for 2009-2010

Period	History/Science 6	Language Arts 6	Science/History 7/8	Language Arts 7/8	Technology/ Computer
1	6th Grade	STEM 6	Planning	Planning	STEM 8*
2	6th Grade	STEM 6	Planning	Planning	8th Grade
3	STEM 6	6th Grade	STEM 8	8th Grade	7th Grade
4	STEM 6	6th Grade	STEM 8	8th Grade	STEM 7*
L1	6th Grade	6th Grade	Lunch	STEM 7	Planning
L2	6th Grade	6th Grade	8th Grade	Lunch	Lunch
L3	Lunch	Lunch	8th Grade	STEM 7	Planning
7	Planning	Planning	STEM 7	STEM 8	STEM 6*
8	Planning	Planning	STEM 7	STEM 8	6th Grade

* Technology Education only approved for one semester in sixth and eighth grades.
  Computer Science only approved for one semester in seventh and eighth grades.

The wide range of math levels from students in the applicant pool meant that it would be impossible to implement a specific STEM math course without excluding a large pool of students due to the pre-requisite knowledge required for student success in different courses in the tracked system at Leicester Middle School. A STEM math sequence situated on the advanced end of the spectrum would exclude students who did not have the necessary pre-requisite courses at the time of their application, barring a disproportionate amount of African American students from

being able to participate. Conversely, a STEM math sequence situated in a differentiated on-level track could draw resistance from parents of students that already took higher math courses. We decided not to pursue a STEM-specific math course during the initial launch of the program in order to enable students on multiple math levels to participate, thereby increasing African American enrollment.

Class size was an important factor in order to meet the objective of building stronger student relations. Limiting class sizes to fifteen students in technology education, computer science, and science would ensure high student-teacher interaction, especially during labs. Scheduling limitations required language arts classes to remain at thirty students, however history class sizes mirrored science since they are blocked together on the standard schedule. The standard technology education and computer science curricula are one semester long at each grade level. The STEM Academy planning team sought to maximize the efficacy of the program by extending technology education and computer science into full year courses. (STEM Advisory Meeting Minutes, September 24, 2008, in author's possession.)

Chapter 5: The STEM Curriculum

Thematic Sequencing

The curricular ideology of the STEM Academy was to design themed units whereby students would focus on a broad STEM topic with each class supporting the theme in its curriculum.   In addition to the STEM themed curriculum, students would take specialized technology education and computer science classes. The specialized computer science sequence was presented to all rising sixth, seventh, and eighth grade students at informative assemblies that were conducted at Leicester Middle School and the elementary schools that feed it in the spring of 2009.

I use project-based assessments exclusively in my courses. I observed that students performed differently on project-based assessments compared to traditional standardized assessment mechanisms. For African American students, this difference often equated to higher grades in my class compared to other classes. Project-based assessment is a vital step towards redefining measures of intelligence. (Greene, DeStefano, Burgon & Hall, 2006)

Students were informed of the STEM exclusive, project-based computer programming course that would specialize in video game development as a hook to generate interest in the program. Communication with students was eased due to the captive nature of the audience at a school assembly. Parent outreach efforts included

presentations at Parent/Teacher Association meetings and information sent home with students after the assemblies.

Curriculum Considerations from a Social Justice Perspective

Chesapeake County tracks students into three groups: "gifted and talented," "on-level," and "working towards[3]." (Chesapeake County Public Schools Division of Instruction document, in author's possession. Chesapeake County Public Schools Board of Education GATE document, in author's possession.) The goal of the STEM academy was to operate outside of the tracking parameters. African American, Latino, and low-income students are disproportionately assigned to lower tracks in the public school system. (Rogers & Oakes, 2005) Oakes and Wells (1996) indicate that de-tracking efforts are often subject to criticism from parents of high-achieving (usually white) students out of fear that a de-tracked environment will reduce the rigor of courses and expose their children to disruptive behavior from lower-achieving students.

The criterion for admission to the STEM Academy was a score of "proficient" or higher on the math and reading MSA. This prerequisite was mandated by the Board of Education to prevent a limitation of resources for "working towards" students who would be removed from their track, and to alleviate scheduling conflicts with remedial reading and math intervention classes typically occupied by "working towards" students during their electives block.

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[3] The "working towards" track is comprised of students who did not score "proficient" in at least one category on the previous year's MSA. These courses receive additional classroom support from special education resource teachers, but are not a special education track. Special education students are represented in all three tracks to varying degrees.
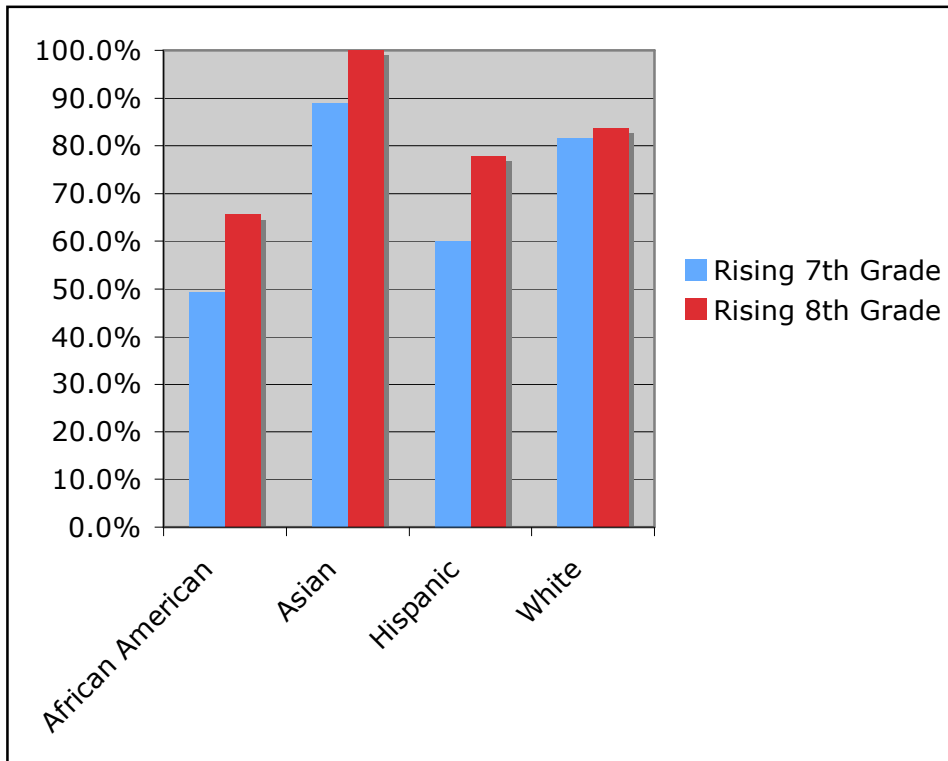
Figure 2: Student Eligibility for STEM by Race[4]

Figure 2 indicates the percentage of eligible students by race for the rising seventh and eighth grade classes.[5] An equity issue arose during the application process as a result of the timeline of MSA scoring. Scores for the current school year were unavailable during the application time frame. Due to the unavailability of the scores from the current year, the previous year's scores were used as eligibility criterion. This meant that a rising sixth-grader's score on the fourth grade MSA determined his or her eligibility for the STEM Academy. I strongly opposed this

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[4] Sample data from 2009 MSA results. (www.mdreportcard.org)
[5] Data for the rising sixth graders was not directly available due to the districting arrangement in Chesapeake County, whereby individual elementary schools send students to multiple middle schools. I did not have to access to the individual student data necessary to compile eligibility for rising fifth grade students.

measure and advocated that the admissions decision be pushed further into the summer. African American students at Leicester Middle School had disproportionately lower scores on the MSA and as such comprised the majority of "working towards" classrooms while experiencing under-representation in "gifted and talented" classes. The STEM Academy was designed to operate outside the tracking system, yet our admissions policy inadvertently disqualified a disproportionate number of African American students who may have made significant academic progress in the most recent year.

Leicester Middle School offers a variety of math course levels for middle school students. Sixth grade students have the option of grade level math at the "on level" and "working towards" levels as well as a pre-algebra course. Seventh grade students can take pre-algebra, algebra I part I, or algebra I CM (certificate of merit). Eighth grade students can take algebra I part I, algebra I CM, or algebra II.

The prerequisite skills required for success in higher track math classes precluded the ability to plan for a single STEM math class. The dilemma was further compounded by the fact that no math teachers at Leicester Middle School expressed interest in participating in the STEM Academy. The STEM Academy planning team decided to omit a STEM specific math course from the sequence. By allowing a wide variety of math levels the program would be accessible to a broader range of students. No concrete model has been devised for a long-term solution to math course sequencing.

In addition to the MSA requirement, students were required to complete an essay addressing the following question: *"How would you define science and*

technology and what role do you think they play in society?" (LMS STEM Academy Application Essay document, in author's possession.) One-hundred-eighty students applied for the STEM academy. One-hundred-twenty-five applicants were eligible for admission based on their MSA scores and an acceptable essay. Ninety-one eligible students were drawn at random to participate in the program due to space limitations. The random selection method was used in lieu of further narrowing MSA or essay criteria to ensure diversity in the program without resorting to controversial race quotas. The STEM Academy accepted twenty-five African American students (twenty-eight percent), twelve Asian students (thirteen percent), three Hispanic students (three percent), and fifty-one white students (fifty-six percent). The gender ratio for African American students was thirteen females to twelve males; Asian students was four females to eight males; Hispanic students was one female to two males; and white students was twenty-seven females to twenty-four males. White and Asian students were over-represented, Hispanic students were accurately represented, and African American students were under-represented compared to the school's demographic makeup. (Leicester Middle School STEM Student Profile document, in author's possession.)

Figure 3: STEM Student Race and Gender Comparison
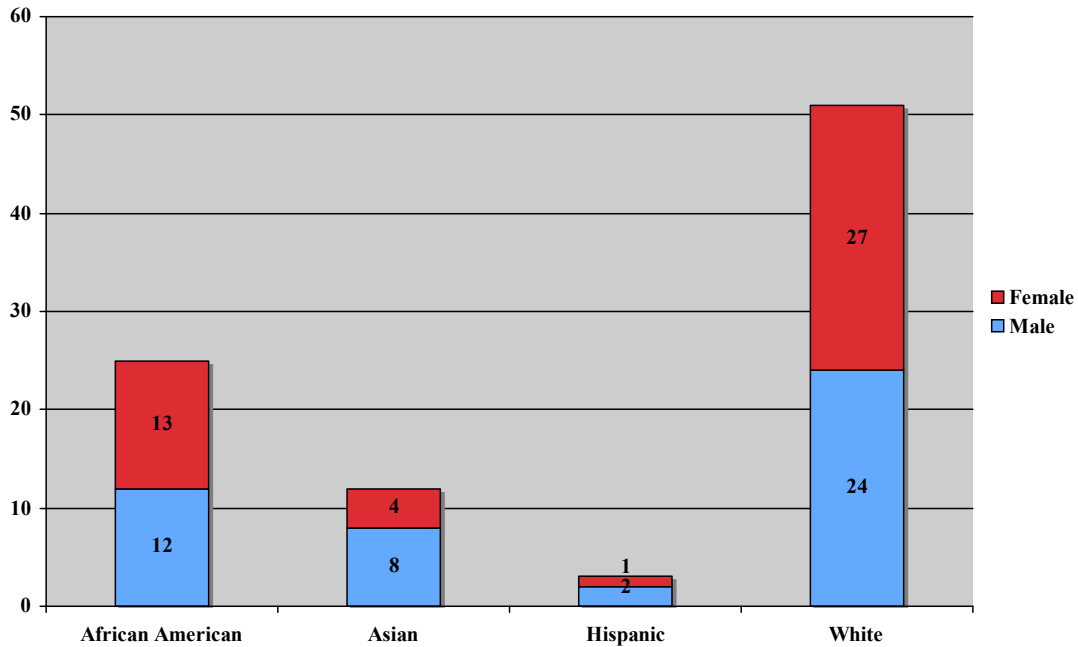
Engineering and Computer Science as a Cornerstone

Technology education and computer science enrichment at the middle school level were not new proposals. I proposed the idea of a computer programming course for eighth grade students in the spring of 2008 while Mr. Purnell had concurrently advocated to offer the high school Foundations of Technology course to eighth grade students. Mr. Purnell's proposal offered an opportunity for students to earn a technology credit required for graduation. My proposal was designed to increase the inconsistent enrollment in Computer Science I at the high school level. Both of us had the support of our respective district level supervisors for our course proposals.

Mr. Purnell and I decided to merge our efforts at the first STEM Academy planning team meeting. Mr. Hatcher agreed that offering a computer science and

technology cornerstone sequence would be an effective hook to recruit students into the program. Mr. Purnell and I discussed the new objective for with our content supervisors, who agreed that the new initiative would enhance the computer science and technology education agenda at the high school level. (STEM Advisory Meeting Minutes, September 24, 2008, in author's possession.)

Extending technology education and computer science would impact enrollment and class size for students not enrolled in STEM. Students are required to annually take one semester of computer science, one semester of health, and two semesters of physical education. These classes meet every other day for one period. Students are encouraged to, but not required to, take technology education.

Leicester Middle School has three computer science teachers and an average class size of sixteen students per class. The projected displacement of students as a result of the yearlong STEM sections would increase average class size for non-STEM sections by two students. Technology education enrollment would be more adversely affected since Mr. Purnell was the school's only technology education teacher. The effect of the STEM Academy as proposed would reduce the number of sections of technology education offered from twenty-four to eighteen.

Perceptions of Equity and Miscommunication

The Chesapeake County Board of Education did not support the idea of offering high school credit to eighth grade students for the Foundations of Technology course, citing an equity concern for students at other county schools. The position of the Board of Education was that the Foundations of Technology

implementation should be a countywide initiative, not exclusive to one set of students at a single school. (Interview with Ms. Anderson, March 30, 2010, in author's possession.) Despite the fact that the other middle schools were not seeking the addition of this course, Leicester Middle School would not be allowed to provide an opportunity for high school credit that was not available to all Chesapeake County middle school students. This "organizationalist" position of maintaining systems in place conflicted with the "modificationist" stance to offer an approved curriculum to STEM students. A similar "organizationalist" versus "non-traditionalist" conflict surfaced over the proposal to offer full-year technology education and computer science courses even though they were not for high school credit.

Requirements for health and physical education further complicated the scheduling for computer science and technology education courses. Due to the number of elective sections available in the student schedule, participation in STEM would bar students from participating in art enrichment, band, or chorus. The STEM Academy planning team was aware of this limitation and chose to pursue their full year schedule for technology education and computer science for eighth grade only. This compromise would reduce the sixth grade technology education requirement and the seventh grade computer science requirement to one semester, as indicated in Table 6. A miscommunication between the board of education, Ms. Herschel, and the STEM Academy planning team over the cornerstone course scheduling resulted in a confusing program launch.

As of May 2009, the STEM Academy planning team received approval to launch the program in the fall of 2009 with the understanding that the cornerstone

sequence we had presented was approved. The committee proposed the cornerstone classes to run in a modified sequence to enable students to participate in art, band, or chorus for sixth and seventh grade by alternating between a full year of computer science and half year of technology education in sixth grade then a full year of technology education and half year of computer science in seventh grade. During the course of this modified sequence, students would satisfy the curriculum requirements for sixth through eighth grade in the respective courses. Students would take both courses for the full year in eighth grade. This plan enabled students to take one of the two STEM cornerstone courses for the full year in sixth and seventh grade in order to strengthen the cross-curricular aspect of the academy and include full year exposure to the "T" and "E" in STEM.

The STEM teachers informed students and parents of the STEM course sequence in an acceptance letter that was sent home during the summer of 2009. Unbeknownst to the teachers, the full year cornerstone courses were not approved for eighth grade and the curriculum council did not approve of altering the grade level sequencing. This decision undercut the ability for full year thematic units across the entire STEM program that incorporated technology and engineering. A letter was sent home to parents at the end of the first semester explaining changes in the technology education and computer science sequence from what they were originally informed. (Letter to Parents, January 4, 2010, in author's possession.)

Parents and students were upset that they would not be learning the C++ programming unit in eighth grade as a result of this policy. The computer programming aspect of the STEM Academy generated a lot of student interest during

the application period.   Students viewed the opportunity to learn video game programming as an incentive to self-select into a rigorous program. It was the STEM teacher's perception that the students and parents felt misled, and that the academy's credibility was damaged by not offering the computer science and technology education courses promised to students at the time of their enrollment.

Chapter 6: Implications and Future Plans

Systemic Resistance to Change

The STEM Academy at Leicester Middle School was designed to be flexible in the face of political, personnel, and budget shifts. As indicated, there were many instances where the teachers' visions did not align with the restraints of the bureaucracy. Two issues were considered most important to resolve during the first year of the program: common planning, and revised admission criteria to increase the equity and relevance of the application process.

The absence of a common planning time in our schedule made implementing the thematic curriculum very difficult. (Haney, Wang, Keil & Zoffel, 2007) The schedule I proposed in May 2009 provided common planning time for STEM teachers but was rejected due to its incompatibility with the systems in place. We were advised that alternative means for STEM team planning would be available to us, but our first common planning time came in the form of a STEM planning day on January 29, 2010[6]. This common time occurred after the end of the first semester, meaning Mr. Purnell and I had already completed instruction for two of the three STEM cohorts for the year.

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[6] The common planning day was originally scheduled for January 8, 2010 but rescheduled due to a snow storm.

Mr. Hatcher, Ms. Montgomery, and I proposed a new schedule on April 12, 2010. This schedule will enable the seventh and eighth grade STEM teachers to have common planning time with the cornerstone course teachers. The schedule also builds on the "enrichment" theme of the extended sixth grade computer science course and seventh grade technology education course to create a co-taught STEM enrichment class for eighth grade. The enrichment course would be a compromise measure to enable STEM students to participate in art, band, or chorus in eighth grade as well by following the three-section arrangement that sixth and seventh grade STEM electives operate under. In order to implement this for eighth grade students, they would take the combined STEM cornerstone course for the first semester, then split into two sections of computer science and technology education for the second semester.

The new schedule does not provide for common planning time for the sixth grade STEM teachers because previous attempts to radically change the schedule were rejected. Ms. Montgomery expressed that a small steps approach with minimal teacher displacement would be easier to incorporate into the current system. Ms. Herschel did not approve of the schedule at our meeting, citing the same concerns as last year's proposal and reinforcing her desire to maintain the integrity of grade-level teams. At the time of this writing she is reviewing the proposal and we anticipate some form of a compromise measure to be determined at a future date.

Table 7: Proposed STEM Student Schedule for 2010-2011

Period	6th grade	7th grade	8th grade
1	Language Arts	Science/History	Computer/Technology*
2	Language Arts	Science/History	Electives
3	Science/History	Computer/Technology*	Language Arts
4	Science/History	Electives	Foreign Language
L1	Math	Math	Lunch
L2	Math	Lunch	Math
L3	Lunch	Math	Math
7	Computer/Technology*	Language Arts	Science/History
8	Electives	Language Arts	Science/History

* Computer and Technology follow the same sequence as before but include a combined enrichment class in eighth grade.

Table 8: Proposed STEM Teacher Schedule for 2010-2011

Period	Language Arts	Science/History	Computer/Technology
1	7th Grade	STEM 7	STEM 8
2		STEM 7	8th Grade
3	STEM 8	8th Grade	STEM 7
4	STEM 8	8th Grade	7th Grade
L1	Planning	Planning	Planning
L2	Lunch	Lunch	Lunch
L3	Planning	Planning	Planning
7	STEM 7	STEM 8	STEM 6
8		STEM 8	6th Grade

The Equity Agenda

Equity is the centerpiece of the STEM Academy philosophy at Leicester Middle School. Out of ninety-one students enrolled in the program during its first year, only twenty-five African American students were represented. This accounts for twenty-eight percent of the program, yet African American students make up fifty-five percent of the school's population. Fifty percent of accepted students entering seventh and eighth grade were in the "on level" track at the time of their

application. (Leicester Middle School STEM Student Profile, 2009-2010 School Year, in author's possession.)

Despite our efforts to create a racially diverse program, we fell short of our fifty percent goal for African American enrollment. Using seventh grade as an example, every eligible rising seventh-grade student who applied for the STEM Academy was accepted. Out of these thirty-one students, nine were African American, representing twenty-nine percent of the seventh grade STEM class, which is consistent with the overall African American representation in the academy. (STEM Program Students Entering Seventh Grade document, 2009-2010 School Year, in author's possession.)

The absence of African American teachers in the STEM Academy is a potential cultural barrier for prospective African American students. Our future plans to recruit more African American students to the academy include incorporating African American resources at the school including coaches, the home-school liaison, and a nationally recognized professional athlete who is both an alumnus of the school and a regular volunteer. These initiatives, combined with the opportunity to build stronger relationships between parents and teachers through the looping structure could increase African American parent participation in the (white over-representative) Parent/Teacher Association. (Hitz, Somers & Jenlink, 2007)

In my observation, the most vital factor to increase African American enrollment is to increase the applicant pool. As the program grows, more special education resources could be incorporated into STEM classes thereby making the academy accessible to "working towards" students. A wider pool of eligible students

would reach more African American students in need of academic support, furthering the STEM Academy's equity agenda.

The STEM Academy's prominence at Leicester Middle School furthered the equity agenda at the school at large through the school wide community and parent outreach efforts outlined in the grant proposal. An example of one outreach success was a competition where students self-selected into design teams to build a trebuchet, sling shot, or catapult to launch a pumpkin the farthest in a field. Students from all socioeconomic and tracked levels participated in the event, many with mixed-track groups, who were coached by parent volunteers.

As a result of school wide STEM initiatives, parents have expressed their desire for an expansion of the program at Leicester Middle School to include more students. As of the spring of 2010, another middle school[7] in the county was authorized to implement a STEM academy for the 2010/2011 school year that will serve one-hundred-eighty students. Leicester Middle School has not received authorization to expand the program at the time of this writing. This is an equity issue that is currently being addressed by Leicester Middle School's STEM Academy teachers and parents.

Student reaction to the academy thus far is uniformly positive. Many students expressed concerns during the beginning of the school year that the academy was too demanding academically. As the school year progressed, these students developed stronger work habits and eventually recognized how the high expectations of the academy have made them stronger students. The strongest evidence thus far of the

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[7] School's student demographics are thirty-eight percent African American, five percent Asian, six percent Hispanic, and fifty-one percent white. (msp.msde.state.md.us, 2009)

success of the STEM Academy's differentiated structure is the manner in which students self-selected into diverse learning groups, effectively dissolving their pre-established academic stratification and social cliques. Project-based learning challenges the conventional cultural context of intelligence. In a differentiated classroom, project-based learning utilizes the strengths of each group member and fosters higher-order thinking and comprehension for all students. (McDermott, Goldman & Varenne, 2006)

Rogers' and Oakes' (2005) analysis of "detracking" efforts in public school systems expose the inadequacies of tracking students. I hope that future enhancements to the STEM Academy will include adequate resources to include "working towards" students as well. Systemic limitations on the academy will ultimately depend on the balance of power between "non-traditionalists" and "organizationalists." "Organizationalists" held the most administrative positions and therefore had the final decision making authority over many vital aspects of the academy, including those with equity implications. The more autonomous the academy is allowed to be, the more flexible it will be at serving diverse learners.

Overall, I feel that the STEM Academy has been a successful endeavor thus far. I define the academy's success in terms of its creation of a distinct community within the school comprised of a diverse range of learners who were afforded the opportunity to demonstrate their intelligence through project-based learning. (Freire, 1970) Research indicates the outcomes of themed-curriculum, inquiry based project assessment, and cross-curricular initiatives are transformative for teachers and

students alike, resulting in deepened conceptual understanding and redefinition of measures of intelligence. (Haney, et al., 2007)

The STEM Academy succeeded in its objective to circumvent tracked classes to create a separate distinction that does not carry a positive versus negative connotation. (Sternberg, 2007) STEM students and parents perceive the STEM Academy as a unique learning community, not an elite learning community. This distinction between what is considered "different" and what is considered "better" supports classroom diversity and embodies the social justice initiative we set forth to achieve.

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