A Cross-case Analysis of Four Exemplar Inclusive STEM High Schools: Mission and Supports for Students Under-represented in STEM Education

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Abstract

This paper reports on cross-case analyses of School Mission and Student Supports in four exemplar inclusive STEM-focused high schools (ISHSs). Each ISHS has a strong track record of success for students under-represented in STEM fields, along with a mission to prepare them for college. These ISHSs use rigorous STEM education to accomplish this goal, and with the challenging STEM programs in these schools, they also create multi-level support systems for their students. These Student Supports include a commitment to the success of diverse learners, advisories, data management systems, and tutoring. They also provide high-level college and career counseling that takes account of students’ financial situations. These schools have a positive school climate and a nurturing family atmosphere that supports students in increasingly challenging STEM education, inside of school and out. Together, School Mission and Student Supports create opportunity structures for students to be successful in high school and beyond. These opportunity structures help students develop the skills and knowledge for STEM majors, jobs, and careers, and in doing so, students also gain the confidence and social capital for STEM success.
A Cross-case Analysis of Four Exemplar Inclusive STEM High Schools: Mission and Supports for Students Under-represented in STEM Education

America’s socio-economic playing field, in truth, was never quite level, despite allusions to the land of opportunity and the American dream. Generational wealth and social capital have long played an important role in individual success. The American dream was first described as “a dream of social order in which each man and each woman shall be able to attain to the fullest stature of which they are innately capable, and be recognized by others for what they are, regardless of the fortuitous circumstances of birth or position” (Adams, 1931). But even Adams, who coined the term, was born into fortuitous social and economic circumstances, allowing him to quit his prosperous career in the New York Stock Exchange to become a writer and eventually the winner of a Pulitzer Prize for history (Nevins, 1968).

However, since the economic downturn of 2008 and the slow and unequal economic recovery, the American dream has become increasingly elusive. The U.S. has increasing income gaps and a shrinking middle class (Greenstone, Looney, Patashnak, & Yu, 2013; Rhode, 2012). Economists, policy-makers, and the general public are increasingly aware of economic disparities and their effects on the character and quality of life in the U.S. (Sachs, 2011; Stiglitz, 2013), to say nothing of their effects on U.S. economic health (Stiglitz, 2013). In fact, President Obama has said growing income disparity in the U.S. is the “defining challenge of our time” and Washington must confront it (Runnigan, 2013).

Social mobility, the fundamental premise of the American dream, has been stagnant in the U.S. for over a generation (Corak, 2012; Economist, 2014; Greenstone et al., 2013), and opportunity gaps have widened. The Economist (2014) reports on five factors correlated with differences in social mobility. They are: residential segregation (whether by income or race); the quality of schooling; family structure (e.g., how many children live with only one parent); social capital; and inequality (particularly income gaps among those outside the top 1%). Further, the article reported that “social mobility is higher in integrated places with good schools, strong families, lots of community spirit and smaller income gaps within the broad middle class.”

One prominent solution to improving the economy while shrinking the current stubborn socio-economic, mobility, and opportunity gaps that is frequently offered by economists, the business community, and policymakers is to improve the U.S. STEM education system (Locke, 2011; National Research Council [NRC], 2011, 2012; President’s Council of Advisors on Science and Technology [PCAST], 2010, 2012; Robelen, 2013; “Who says math,” 2013). In addition, proficiency in STEM increases an individual’s capacity to earn more money and have more flexibility in jobs and careers (Rothwell, 2013; U.S. Department of Commerce, 2011).

STEM can be an acronym that is mere shorthand for “science, technology, engineering and mathematics.” Or it can be defined in a much more relevant and complex way, capturing the perceived needs of students in the 21st century as well as the needs of their communities and the economic health of the nation, explicitly connecting education to the outside world. For instance, Tsupros, Kohler, and Hallinen (2009) defined STEM education as:

…an interdisciplinary approach to learning where rigorous academic concepts are coupled with real-world lessons as students apply science, technology, engineering, and mathematics in contexts that make connections between school, community, work, and the global enterprise enabling the development of STEM literacy and with it the ability to compete in the new economy.
STEM education consistent with this definition would seem to have high potential for improving student learning and inspiration and providing a more informed way to seek entry to STEM fields. Furthermore, it may provide students the kinds of knowledge and soft skills (Farrington et al., 2012) to succeed personally in many aspects of life, as these young people contribute to the health of their communities. In other words, it is possible to see a strong STEM education as providing both an improved range of career options and a chance to have a go at the American dream. Moreover, STEM education may also be a means for self-actualization (Maslow, 1968; Rogers, 1961; but also see Bencze, 2010), giving youth a more informed view of their world, and more agency in choosing how to study, what to study, and how to work and live. They need not settle for the nearest low-paying service sector job.

This picture of STEM education is complicated by the fact that the portions of our population that have some of the highest rates of growth and who are entering the work-force in the greatest numbers are the demographic groups of students who are currently under-represented in STEM fields (Carnegie Corporation, 2009; Lynch, 2011; Missing from science class, 2013; NRC, 2011, 2012). This includes women, members of some ethnic/racial groups, and young people who are from low SES families or who would be the first in their families to attend college. If students from these groups were better prepared in STEM, then they would reap the benefits of having more options open to them, including access to STEM jobs and careers. Thus, they would be better positioned to share economic benefits and close the social mobility gaps, as they contribute to their communities.

How might schools provide high quality STEM education that is more inspiring than the current fair and that reaches the very groups of students traditionally underserved in STEM? Schools must deliver a high quality, technology-infused, 21st century STEM education that provides students with the academic prerequisites and confidence for success in STEM jobs, college majors, and careers. Too many willing and interested students have been shut out of the STEM pipeline prematurely due to weak academic preparation that discourages further study in STEM. Under-served students also need opportunity structures that provide them with relevant experiences to make informed choices about STEM pathways that they may not even know exist. They need to develop the soft skills (Farrington et al., 2012), which are also aligned with 21st century skills (Partnership for 21st Century Skills, 2013), for success.

One possible solution to this problem is the creation of inclusive STEM schools. Our research project, Opportunity Structures for Preparation and Inspiration (OSPri), focuses on inclusive STEM-focused high schools (ISHSs) across the U.S. By inclusive, we mean schools for students who want a strong STEM high school experience, but who may not have been identified as gifted and talented in STEM. Instead, ISHSs serve a wide range of students. Their missions are to provide a rigorous, high quality STEM education for students who have been traditionally under-represented in STEM disciplines. Such students need access to opportunity structures that build STEM social capital. For many students, the STEM pipeline has been difficult to access, no matter their abilities or interests. If no one in the family or immediate neighborhood or community has had experiences in STEM fields, then learning experiences that build knowledge and skills and STEM capital must be built into school programs. ISHSs provide experiences with STEM jobs, college majors, and careers, as well as more generic, but savvy, information on how to enter college and succeed once there. This kind of support and opportunity system needs to begin in ninth grade, if not before. ISHSs are designed to provide the opportunities that may not be found in local communities due to the structural inequalities of our system (Olinsky & Post, 2011).
CROSS-CASE ANALYSIS OF ISHS MISSION AND STUDENT SUPPORT

2013; Tankersley, 2013), and to provide an education that escapes the boundaries of the school building or the temporal strictures of the normal school day, week, or year.

ISHSs have the goal of providing opportunities to students to access the STEM pipeline. The OSPrI project has (at this writing) completed in-depth case studies of eight exemplar ISHSs. These schools were purposely selected because: they had outstanding records of student academic success and other positive school indicators such as graduation and college admissions rates; they were thoughtfully planned with extensive community support; and they were explicitly designed to attract and serve the range of students in communities characterized by high levels of socioeconomic and ethnic/racial diversity. These ISHSs were also schools of choice and admitted students by lottery.

The purpose of this paper is to report on a cross-case analysis of the first four of the eight case studies of exemplar ISHSs. It focuses on the findings for two of the hypothesized ten critical components of ISHSs. The theoretical framework for the ten critical components was described in a paper presented at the 2012 AERA annual meeting (Lynch, Means, Behrend, & Peters Burton, 2012). A briefer version is available in the Methodology section of the OSPrI Project website (ospri.research.gwu.edu). The ten components we hypothesized as critical to the success of an ISHS are: STEM-focused Curriculum; Reform Instructional Strategies and Project-based Learning; Integrated, Innovative Technology; Blended Formal/Informal Learning; Real-world STEM Partnerships; Early College Coursework; Well-prepared STEM Teaching Staff; Inclusive STEM Mission; Administrative Structure; and Supports For Under-represented Students.

The focal critical components discussed here are Inclusive STEM Mission, herein after referred to as School Mission; and Supports for Under-represented Students, referred to simply as Student Supports. We theorize that ISHSs certainly must provide a rigorous STEM education, but they also need to do more. They need to attract students interested in STEM and deliberately make under-represented groups welcome, through a carefully designed and implemented School Mission that sets the vision for the school. Further, students and their families need assurance that students will be supported in the ISHS in a variety of ways. If students sign up for the challenge of an ISHS, then they must know that that the school will provide them with the means to be successful. Student Supports may include building soft or non-cognitive skills (Farrington, et al., 2012), STEM identity (Carlone & Johnson, 2007), and confidence (Lee, 2002). ISHSs intentionally build opportunity structures (Roberts, 1968) for students that create STEM social capital. Opportunity structures provide insider knowledge of STEM jobs and careers and allow students to map out paths to their attainment.

This study is significant because it provides actual examples of Missions and Student Supports operating in four successful ISHSs to close achievement gaps and bridge the STEM opportunity barrier (Carnegie Corporation, 2009; Means, Confrey, House, & Bhanot, 2008; Scott, 2009). These ISHSs have developed the School Missions and Student Supports largely in response to their local contexts, the communities that they serve, and the resources that they may access to build new opportunity systems for students.

These four schools are located in different states and have no formal connections with one another. They do not communicate, nor are they organized through any common governmental or non-governmental organization. Yet, as the paper will show, these exemplar ISHSs, all having outstanding positive outcomes (e.g., graduation and college acceptance rates that approach 100%), have remarkable similarities in how they have structured their Missions and Student Supports.
CROSS-CASE ANALYSIS OF ISHS MISSION AND STUDENT SUPPORT

Conceptual Framework

The conceptual framework for this study draws upon and extends the evaluation framework proposed in the NRC Committee that reviewed K-12 Mathematics Curricular Evaluations (Confrey & Stohl, 2004) and modifies the survey framework used in the STEM High Schools study (Means et al., 2008).

Figure 1 suggests that in order to understand an ISHS as an instructional and educational entity, there are three primary dimensions to consider: the program’s design, the program as implemented, and student outcomes. These dimensions interact (Means et al., 2008), but are moderated by the school’s context. The elements in a school’s design dimension may include the school’s goals, governance, or academic structure, student recruiting and selection, curriculum and pedagogy, and outside partnerships (Means et al., 2008).

Figure 1. OSPrI Conceptual Framework.

Having identified four exemplar ISHSs (i.e., ISHSs that had been recognized and nominated by experts in the field of STEM high schools for their record of successful outcomes), the OSPrI project researchers sought to understand how each school was designed, by starting with ten critical components hypothesized to be important to the successful functioning of an ISHS. The ten critical components were synthesized from a review of the literature (Peters-Burton, Lynch, Behrend, & Means, in press).

We have currently completed four long case studies, which may be found on the OSPrI website (ospri.research.gwu.edu). Having completed these four cases, we are in the position to look across cases for features within critical components that are common or unique to the ISHSs. This paper focuses on a cross-case analysis of two of the ten critical components, Mission and Student Supports, in four exemplar ISHSs.

The Inclusive STEM Mission component was defined in terms of the school’s goals: “The school’s stated goals are to prepare students for STEM, with emphasis on recruiting students from under-represented groups” (Means et al., 2008; PCAST, 2010; Scott, 2009, Obama, 2010). Supports for Students Under-represented in STEM include supports such as bridge programs, tutoring programs, extended school day, extended school year, or looping, which exist to strengthen student transitions to STEM careers. Such supports result in altered, improved opportunity structures (i.e., students are positioned for STEM college majors, careers, and jobs), and student social structures and identities change to accommodate new opportunity structures (Carnegie Corporation, 2009; Lynch, 2000; Means et al., 2008). The study began with reasonable definitions of these critical components based upon our review of the literature. However, we believed that in conducting the actual case studies, an analysis of the data would provide more complete and nuanced definitions. This paper reports on School Missions and Supports in evidence in four exemplar ISHSs.
Our research questions were:
1. What are the Missions of the four ISHSs? Do they fulfill the criteria for exemplar ISHSs as being inclusive? STEM-focused? Rigorous?
2. What Student Supports do these schools provide to ensure their students can be successful?

Methods

The cross-case analyses relied on the four ISHS case studies as the data sources (Stake, 2009). Each school case study is about 75 to 100 pages long, with a similar organizational structure that includes major sections for school context; discussion of evidence for ten critical components; discussion of emergent themes not included among the critical components; presentation of comparative outcome data for the ISHS, district, and state; and summary of findings. The largest portion of each ISHS case study discusses the evidence in each school for each of the ten critical components including definition, design, and implementation. The findings sections are detailed and based on analysis of multiple data sources, allowing for triangulation. The data sources used for the case studies are described in the following section.

Synopsis of Case Study Methods

Before the site visit to the school, we collected: school or district website documents; responses to two questionnaires completed by a school administrator and teachers, respectively; and phone interviews with the principal or designee. Thus, we began to understand the design dimension of each ISHS before we visited the school. The site visit was conducted over a four-day period. A team of six researchers conducted semi-structured interviews with administrative staff at the school and district levels, including the principal; interviews with representatives of school partners such as institutes of higher education and businesses that interacted with the ISHS’s students; separate focus groups with teachers, students, and parents; and classroom observations.

Cross-Case Methods

For Mission and Student Supports, we conducted two separate cross-case analyses of four complete case studies. We extracted the sections for School Mission and Student Supports from each case study and loaded them into new files. We coded these data for the features included in the definition of the critical component (see above for definitions) and then continued to code for other features not included in the original definition. Then we repeated the process from the beginning with the completed list of features to ensure that every case study was systematically examined for each feature and that evidence for a feature was not missed in the initial pass. We followed this procedure for Student Supports, but also decided to include the emergent themes associated with each ISHS case study in the analysis of this component. The rationale was that these themes did not fit easily into any of the ten critical components or they may cut across several components in a new way. An example of such an emergent theme was School Culture that seemed to cut across every critical component, as well as across the dimensions in Figure 1. Emergent themes seemed to be fertile ground for evidence of Student Supports, as well as providing a more dynamic view of this construct.

Findings
Understanding the Context and Mission

Each ISHS in this study was a magnet school intended to attract applicants because of its unique offerings. Each of the four schools formed their student bodies using an application and selection process that varied by school, depending on its context. As the ISHSs built a record of successful outcomes, they attracted more applicants than they had openings. Principals reported that the number of applications had steadily grown due to their reputations for graduating classes with unusually high college acceptance rates (95% or more).

The four ISHSs, all public high schools, differed in context (e.g., geographic location, charter school status, network affiliation, and size of the attendance zone) as shown in Table 1. The two public charter ISHSs, the Gary and Jerri-Ann Jacobs High Tech High (GJJ-HTH) and the Denver Schools of Science and Technology: Stapleton High School (DSST: Stapleton), served students from across major metropolitan areas in California and Colorado, respectively. The third ISHS, the Wayne School of Engineering (WSE), was a magnet high school located in a rural county seat in North Carolina and served students in a county-wide school district. The fourth, Manor New Tech High School (MNTHS) was a magnet high school created by a small school district in Texas, outside of Austin. At the time of our study, the two charter schools were part of charter school networks that included middle schools and drew about half of their student bodies from these feeder middle schools. WSE had just started a middle school adjoining the high school consisting of a sixth grade, with plans to expand it by one grade a year. And MNTHS had plans to add a middle school beginning the year after our research visit.

Table 1
Four ISHSs as of 2011-2012 School Year

<table>
<thead>
<tr>
<th>School</th>
<th>Attendance Zone</th>
<th>Network Affiliations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gary and Jerri-Ann Jacobs High Tech High [GJJ-HTH]</td>
<td>Large Metropolitan Area</td>
<td>Public Charter Network (K-12): High Tech High</td>
</tr>
<tr>
<td>Grades 9-12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>About 600 students</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public charter school</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DSST: Stapleton High School [DSST: Stapleton]</td>
<td>Large Metropolitan Area</td>
<td>Public Charter Network (6-12): Denver Schools of Science and Technology (DSST)</td>
</tr>
<tr>
<td>Grades 9-12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>About 500 students</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public charter school</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wayne School of Engineering [WSE]</td>
<td>Rural County School District</td>
<td>State-level STEM Network: NC STEM</td>
</tr>
<tr>
<td>Grades 9-13 (optional fifth year to earn an associate’s degree in engineering)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>About 320 students</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public magnet school</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grades 9-12</td>
<td></td>
<td>National-level Network: New Tech</td>
</tr>
<tr>
<td>About 330 students</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public magnet school</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The mission and goal statements of the four ISHSs are shown in Table 2. We analyzed these statements to understand the design and implementation dimensions of the school’s mission. All four ISHSs identified a college preparation goal that emphasized readiness to succeed in college. MNTHS’s mission went beyond with the goal for all of students to be accepted to college. These ISHSs supported all of their students in mastering rigorous college preparatory coursework, often with programs that encompassed all students rather than those who were encountering problems. These ISHS mission statements did not specifically target increasing the number of under-represented students who majored in a STEM program, but focused on college preparation. Other mission features were preparation for the 21st century and for effective citizenry.

**STEM focus.** In determining STEM focus, we used the following criteria: “Strong courses in all four STEM areas; or, engineering and technology explicitly, intentionally integrated” into science and mathematics subjects or other core subjects such as the humanities. Our selection criteria ensured that schools in this study had strong, college preparatory curricula in mathematics and science, including four years of mathematics at the Algebra 1 level or above, and three or four years of science, including Biology, Chemistry, and Physics. All four ISHSs had graduation requirements that met these criteria. They differed in the amount of required coursework in technology and engineering, and the degree to which technology and engineering were integrated into the curriculum.

**College readiness focus.** One of the key findings from our analysis of School Mission was that these four schools, although they had met our selection criterion of STEM focus, did not necessarily self-identify primarily as a STEM school. Rather they saw their missions as college preparation, with the understanding that students would need a college preparatory curriculum strong in mathematics and science. This can be seen in Table 2.

**21st century preparation.** Another mission feature that emerged from our analysis was preparation for the 21st century, with all but one of the four ISHSs explicitly identifying this goal. While this may be a common feature of any school mission statement currently, school site visits demonstrated how it was implemented at these four schools. All had norms and supports aimed at the development of at least some of the 21st century skills identified by the Partnership on 21st Century Skills (2013). In particular, collaboration, communication, and critical thinking skills were openly valued and taught. For example, MNTHS, WSE, and GJJ-HTH used projects in their instructional approaches, affording students the means to develop collaboration, critical thinking, and communication skills. DSST: Stapleton had a more traditional instructional approach, but particularly emphasized the gradual building of student soft skills (Farrington, et al., 2012), especially **grit**. The Farrington et al. (2012) report on the effects of non-cognitive factors on student performance described two aspects of grit: “the degree to which students stay focused on a long-term goal despite obstacles; and self-control—whether students forego short-term temptations to prioritize higher pursuits (related to delayed gratification and self-discipline)” (p. 20). All members of the DSST: Stapleton community (e.g., students, teachers, administrators) were expected to push through obstacles. For example, a mathematics teacher described grit as “to push through difficulties,” and said she told her students that “when you get stuck, go look in your notes and figure out a way to proceed.”
Table 2  
*Mission and Goals of the Four ISHSs*

<table>
<thead>
<tr>
<th>School</th>
<th>Mission and Goal Statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gary and Jerri-Ann Jacobs High Tech High</td>
<td>Charter Network mission statement: “The mission of High Tech High is to develop and support innovative public schools where all students develop the academic, workplace, and citizenship skills for postsecondary success. This is attained through four goals. Goal Statements: The first goal is to serve a student body that mirrors ethnic and socioeconomic diversity of the local community. The second goal is to integrate technical and academic education to prepare students for post-secondary education in both high tech and liberal arts fields. The third goal is to increase the number of educationally disadvantaged students in math and engineering who succeed in high school and post-secondary education. The fourth goal is to graduate students who will be thoughtful, engaged citizens.”</td>
</tr>
<tr>
<td>DSST: Stapleton High School</td>
<td>School District mission statement: “…transforms urban public education by eliminating educational inequity and preparing all students for success in college and the 21st century.” Network Charter goals: (1) “increase the number of under-represented students who succeed in math, science and technology at the high school level, including girls and students from low-income families”; (2) “prepare all students to earn four-year college degrees.”</td>
</tr>
<tr>
<td>Wayne School of Engineering</td>
<td>Own Mission Statement: “…will provide a caring, supportive environment with rigorous inquiry based academics, focusing on real-world applications to produce citizens ready to achieve success in the 21st century. Own Vision Statement: “…students will possess the necessary character traits and academic skills to achieve responsible citizenship, college readiness, and success in the 21st century.”</td>
</tr>
<tr>
<td>Manor New Tech High</td>
<td>School District Mission Statement: development of 21st Century Learning Skills Admissions Letter Goal Statement: “…college admission [is] the goal for all students.” Principal’s Statement on School Founding: “it was just to get our kids to go to college. I mean we [the school district] had a 40% high school completion rate, and maybe 15% of students go to college.”</td>
</tr>
</tbody>
</table>

One of the first courses students took was Creative Engineering where they learned that they would have to revise and rework prototypes. The teacher noted the connection to grit, learning to
“handle frustration and be comfortable with failure.” This certainly supported development of critical thinking and problem solving. Since 21st century skill development was not in our original framework of critical components, it was not a specific focus of our data collection; rather it emerged as a theme. The section on Student Supports further explores this theme.

**Inclusiveness.** The two public charter ISHSs, GJJ-HTH and DSST: Stapleton, each had charter network goals that included college preparation for students under-represented in STEM fields; these goals were actually part of the charter between the State and DSST. DSST: Stapleton expressed this explicitly in its goal to “increase the number of under-represented students who succeed in math, science and technology at the high school level, including girls and students from low-income families.” GJJ-HTH specified a goal to “increase the number of educationally disadvantaged students in math and engineering who succeed in high school and post-secondary education.” The two non-charter public schools did not include language about student body diversity in their published mission, vision, or goal statements that were included in the schools’ case studies. Before presenting the demographics of each ISHS, a description of how the schools formed their student bodies is provided.

**Admissions.** The two ISHSs in charter networks drew part of their student body from associated middle schools in the network before filling remaining seats using a lottery system. GJJ-HTH’s lottery gave preference to siblings. Open seats were assigned based on zip-code weightings for the entire metropolitan area.

At the time of our case studies, MNTHS and WSE held lotteries to assign all ninth grade seats. MNTHS and WSE were district magnet schools and had lotteries open to school district students.

**Demographics.** The four ISHSs varied from the school district demographics, serving somewhat lower percentages of students who were classified as economically disadvantaged, as shown in Table 3.

<table>
<thead>
<tr>
<th>School</th>
<th>%</th>
<th>School District</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>GJJ-HTH</td>
<td>44</td>
<td>San Diego USD</td>
<td>66</td>
</tr>
<tr>
<td>DSST: Stapleton</td>
<td>46</td>
<td>Denver Public Schools</td>
<td>69</td>
</tr>
<tr>
<td>WSE</td>
<td>44</td>
<td>Wayne County SD</td>
<td>66</td>
</tr>
<tr>
<td>MNTHS</td>
<td>52</td>
<td>Manor ISD</td>
<td>81</td>
</tr>
</tbody>
</table>

The student bodies of the ISHSs were quite diverse in terms of ethnicity/race as shown in Figure 2, and did not exactly reflect the local school district demographics, included in Figure 2 for comparison. Rather, ISHSs tended to be more heterogeneous than their respective school districts. The four ISHSs are schools of choice, and their student bodies reflected that of their applicant pools.
Figure 2. Demographics of ISHS Compared to School District (2012-2013)

**Student and parent perspectives of the school’s inclusivity.** Students and their parents were asked in focus groups about whether they thought their school was inclusive. They did not
interpret this question in terms of demographics alone. They spoke in positive terms about the diversity of the student body and how all students got along together. When asked about why they chose the school, parents responded in ways that suggested they most cared about a safe school with a strong record of academic accomplishments. They noted how the school responded to students and supported and encouraged them. Students in all four schools talked about the lack of cliques and bullying, and how student got along and worked together.

**Summary.** The four exemplar ISHSs in this study were STEM-focused schools with School Missions that centered on college preparation, especially through strong STEM preparation, reflected by their coursework and instruction. These ISHSs were schools of choice, with varying procedures for lotteries for the open slots. The demographics of the schools indicate that they are inclusive and diverse ethnically and socio-economically, but may not exactly reflect the demographics of the their school districts. Rather they reflect the demographics of the parents and students who choose these schools. These ISHSs generally fill all available slots for admission because of the schools’ reputations for getting virtually all of their students into college, with an emphasis on preparing students to also be successful once they get there, through an emphasis on 21st century skills and soft skills such as grit and collaboration. The section below, Student Supports, describes how some of these skills are built in these four ISHSs.

**Student Supports**

The ISHSs in this cross-case analysis were located in different states and had no formal affiliations or communications with one another. Nonetheless, all had well-developed Student Supports in common, as well as supports that were unique to their schools and contexts. It is important to note that all of the schools were small (300 to 600 students). All were schools of choice with students and families committing to a rigorous and challenging STEM program. The section to follow focuses mainly on Student Supports that were found to be common to most schools. Student Supports that were unique and interesting will be briefly mentioned.

**Commitment to the success of diverse student learners.** Inclusive STEM-focused high schools do not happen by accident. They seem to be the product of a fierce commitment to a challenging new type of school with the goal of creating a diverse student body where every student can be successful, especially in STEM. While this commitment may be expressed in mission statements, it is also frequently voiced by school leaders. For instance, the CEO of the DSST Charter School Network in Denver who was the former principal of DSST: Stapleton High School spoke eloquently about the school’s diversity commitment:

DSST has demonstrated from a STEM perspective that we can run as successful and rigorous a STEM program as any STEM program in the country, selective or open enrollment.… In this country, we say that we are the land of opportunity, where kids can grow up to be what they want to be, but [the U.S.] has frankly run a selective science program… for the last 100 years. Essentially, what we have been saying to kids is that you can only study science if you are really smart. And if you are smart and generally look like you’re white upper class, you can study science because you can test into a [selective] STEM school. For the rest of you, maybe you can get good science at your own schools… So we [at DSST] basically said, hey, we can create a great STEM school
for all kids… I think we can compare our outcomes against anybody. We have broken the barrier that only the gifted and talented can study STEM.

Hundreds of miles away, the principal of WSE voiced a similar conviction:

I remember honor rolls in other schools…the same kids earning honors all the time. It didn’t encourage anyone (new) to go up there…the same kids were always rewarded in schools, the ones that followed the rules and conformed. Here, it’s not about being valedictorian or salutatorian. We ask kids, “Who wants to speak at graduation?” I thought our girl last year [who made a video about the school mission] gave the best speech. She went up there, no notes, and nailed it.

Such expressions of commitment did not only come from the school leaders. Teachers, parents, and community members were similarly eloquent, while the students often expressed their belief in the value of belonging to a diverse community of STEM learners in a challenging ISHS. This commitment sets the stage for other Student Supports.

**Advisories, data support systems, and tutoring.** While nearly every school in the U.S. likely provides some sort of advisory, homeroom, or looping system, the advisories of ISHSs functioned like no other that we had seen. They seemed central to a student’s success at a challenging ISHS. Teachers took their roles in advisories extremely seriously. The advisories in various ISHSs may have met daily for thirty minutes or biweekly for longer periods of time. Often they were used to conduct planned programs related to college advising, to discuss challenges faced by students as exams loomed, or to plan inter-disciplinary STEM activities for a year-long STEM themed project for an entire class of students (such as all the ninth graders in a school). For instance at GJJ-HTH, a teacher reported that advisories were an important structure for encouraging and supporting students. Students stayed with the same advisory group and advisor throughout their four years, and each group contained students with a range of grade levels. This commitment was published on the school website:

Each… student has a faculty advisor who meets regularly with a small group of students to build community, support their academic progress, and plan for their future. The advisor also visits each of their advisee’s homes and serves as a point of contact for the family.

All of the schools had student data support systems, sometimes attached to an on-line site for an instructional platform and electronic communication among students, families, and the school. In the 21st century, most schools have such systems; the ISHSs tended to use them in intense and innovative ways to support students. The MNTHS ECHO communication technology was not only a tool for helping students to learn and be successful through a project-based learning (PBL) instructional approach, it served as a sort of “nervous system” to connect students with one another and with teachers in order to work on the projects. The ECHO system linked student PBL activities with complex project entry documents, schedules and rubrics. An 11th grader pointed out:
Teachers are always willing to help with homework through the technology, as long as it is during reasonable hours. There are agendas that teachers post [on ECHO] and we are responsible enough to go back and check. The substitute does not even need lesson plans. There is a lot of communication going on. The technology has made us open. Teacher-student relationships are much closer [than at the comprehensive school]. My parents talk to my teachers a lot through [ECHO] email.

In addition, learning communities were formed by students using these resources. This is a key “soft skill” for diverse learners.

At DSST: Stapleton, if a student came to class without a successfully completed homework assignment, the student’s parents/guardians might be contacted by noon to notify them of tutoring services to be provided after school, the same day. The data support system also was used to monitor student progress in their courses. Teachers worked together to break down the learning goals for a course such as biology into discreet conceptual units to be mastered, using formative and summative assessments to track student progress toward mastery. Teachers and advisors could access these data and get help for individual students if the data showed a student in difficulty. Students kept track of their grades through the system. DSST: Stapleton’s values overtly encouraged gritty determination to access a range of resources if help was needed to get out of a difficult spot or simply as a normal way of keeping up with the school’s demands. Some students used the systems for advanced learning opportunities. Students might be directed to tutoring, on-line supports, or specific learning activities to create deeper understanding in order to achieve mastery. This mastery learning program probably could not succeed without the data system. Technology also led to personalization of learning; there was always a caring teacher or advisor attached to the data system so that mastery was attainable.

At WSE, tutoring was used to help students who needed extra support. The staff saw this as an important part of their jobs. They were willing to work with students who needed extra help by meeting after school or before school. What was remarkable at WSE was that there seemed to be little stigma attached to needing a tutor—rather it was regarded as a natural part of students developing soft skills (Farrington, et al., 2012). This was especially true for the mathematics program where there was a high frequency of students requiring extra help to succeed. One WSE parent commented:

I don't know where it is coming from, but the kids are able to learn… My daughter has been tutored massively with her math teacher. It is an easy thing to get, in the math program. The one-on-one tutoring has been fantastic. Teachers get here early and stay late and they help the students a lot. Many of these teachers are really good. It is a shorter school day than a traditional school [so they are able to help more].

**College advising and planning.** Although all four ISHSs in this study are STEM-focused schools, the primary mission was to get students into colleges. The goal was to prepare students to be successful in the four-year college environment. All of the ISHSs emphasized gaining college admissions to the best four-year college possible, a philosophy similar to what is often encountered in striving middle class families. But at an ISHS, the main locus of college advising and planning was likely to be at the ISHS rather than the home. Nonetheless, families were integrally involved with college planning supports from the time students entered the ISHS in ninth grade and the school orientation sessions that came before admission.
At DSST: Stapleton, the most dominant theme was getting students into college. This goal was explained in response to the “Colorado Paradox.” Colorado ranks in the top five states nationwide for the greatest number of degree holder per capita, yet only one in five ninth grade students will earn a college degree, ranking the state in the lowest quartile nationally (College-in-Colorado, 2013). In other words, Denver’s highly skilled information workers are imported from other states. DSST-Stapleton’s students, parents and teachers understood that the goal of the school was to graduate students who could get into college and who were prepared to be successful once they were there. Parents reported that the school’s reputation was more about accountability and holding students responsible for their work, than about its STEM focus. Many students came from families where they would be the first generation to graduate from college, or even from high school, in some cases. At DSST: Stapleton, many students had to learn the terminology and mindset about college admissions. This was taught to both parents and guardians, as well. One educator at DSST: Stapleton was assigned to work on scholarships and financial aid. A “Ninth Grade Counts” program was designed to help students see the big picture of college planning. It used software called Naviance as a college planning tool based upon personality assessments. During their ninth grade seminar, students engaged in a College Success class to help them start thinking about what careers they might choose. In addition, parent meetings about college admissions began when their students were in ninth grade and occurred regularly throughout the four high school years. In the upper grades, students were assisted with college admissions and financial aid. For instance, one alumna said that she really wanted to go to an expensive private university, but that the finances were not feasible for her family. So DSST: Stapleton advisors helped her to see that a public university might be a better option. “They gave me a lot of choices. Junior year, they gave me a list of twenty colleges that might be good matches [for my goals].” Another alumna pointed out that there was a drop-off of academic support when she entered college, but that DSST: Stapleton prepared her. “DSST teaches you to ask for support, and going here is why I know how to do that. In college, you have to ask for support.” She also reported that former DSST: Stapleton students who were currently in college were all breezing through. The DSST CEO pointed out that the process resulted in many successful applications for college admissions and for financial aid, which was crucial for many students. The only students who presented real problems for financial aid were those from non-documented families, but administrators claim to have had some successes there, as well.

At GJJ-HTH, located in San Diego, the college counselors focused on how to get first generation students into college. One offered these thoughts:

For first generation, it’s tricky… As long as the student is in my office we keep moving forward. Obviously we engage parents when I can. When you counsel a student, it’s a holistic program and you are counseling the family system they come from. Every year I get the Hispanic female that says, “I can’t go to this program in Ohio even though I got admitted and I have a free airplane ride to see the university, because [my] parent doesn’t want their kid to go any further than LA [Los Angeles],” and it hurts. So you have to get the parents on board obviously and educate them about the process and sometimes you will have families that won’t let their kid go beyond LA. And it’s not all negative; it’s just the reality of the culture and I know there are many students I have worked with that had more options. But you work with what you have and move forward.
Small school, personalization, school as family, safety. In effective schools, individuals report strong connections between the students and the school, as well as widely distributed meaningful relationships among students and adults at the school (Rutledge et al., 2011). Connections between students and adults are authentic, relevant, and responsive to students’ needs and interests. Opportunities for connections among students and the school interact and build upon one another. There is an emphasis on personalization. By personalization, we mean something more than individualized or differentiated instruction or culturally responsive curriculum. Rather, personalization encompasses the entire student as she presents herself to the school community, and includes who she is, her family and background, her goals and aspirations, as well as the set of abilities and achievements for academic learning. It includes not only the academic, but the social and emotional. The academic self and positive relationships are contingent upon the organization of these factors.

There was a cluster of related themes revealed through an examination of the case reports for Student Supports, as well as emergent themes associated with each school. They included comments about how the relatively small size of the school made caring communication about students and how to support them possible. This feature focused on sense of place, family, home, house, and community. The schools strived for personalization, where each student was seen as an individual and the coursework and advising were tailored to the academic and socio-emotional progress of the student in the context of family and personal goals and the school program.

Teachers seemed to be viewed by students differently than they often are at other high schools. A MNTHS parent pointed out that while her daughter was initially reluctant to attend the school, after two weeks she had a brand new attitude toward brand new things. A 10th grader said that before she came to MNTHS, she made no efforts to talk to her teachers, but at MNTHS she does because she knows that the teachers care about the students.

At GJJ-HTH, teachers were seen as friends or as persons trusted as family members. Students in focus groups said that their teachers and administration cared about them academically and personally, and that they could talk to anyone when they needed academic or personal support. One former student said, “It was nice to feel you were on the same plateau with them, talking about current events, life, arts, movies--you felt like equals.” Another alumnus noted the impact of calling their high school teachers by their first names and developing close relationships with teachers: “It seems petty, but it makes a difference. It’s different from professors I had in college, like the one I went to in Europe, needing the title professor, which felt like he was automatically distancing himself from the students.”

These four ISHSs were viewed as places where students could be safe, and where they could grow, in an individual way, as in a nurturing family. This far surpassed the aims of individualized instruction, accommodations, or differentiated instruction. The goal was something more profound, leading to a goal of students’ self-actualization.

For instance at MNTHS, the family theme was strong and often literal, as students and parents directly spoke of members of immediate or extended family and kinship relationships and direct involvement of families in the school. At other times, family was used metaphorically to refer to the school community, and the larger sense of Texas culture, identity, and place. The MNTHS buildings were referred to as “our house” and connoted not only the structure, but the relationship of the house as a safe place for the family to live and work together, and where youth can grow.
A MNTHS administrator pointed out that, “There is a wide range of student ability here. Students do weird things—jumping rope, playing Pokemon. In this culture you are not afraid to look like a fool, be a kid… We teach them what it means that this is our house.” MNTHS had a summer orientation for rising ninth graders that was largely run by rising seniors who took on a filial role with the newcomers. The focus of the orientation is on PBL, technology, school culture, and expectations for graduation requirements. During the second week of school, there was a ninth grade class bonding activity led by seniors and teachers. This is a somewhat “secret” event; parents are informed of it, and the rest of the students in the school are released from school early. The activities are designed for team-building and trust among ninth graders and teachers.

At WSE, a community activist who worked with WSE students to link them as tutors in projects outside of school and across the entire rural community, talked about the sense of family that WSE had developed:

I do know that teachers here privately help some kids who have struggling families. These students are connected to their teachers, and vice versa. They care about each other’s lives. It’s a completely different school than I’m used to. They [teachers] know their names, they know their families, who they are, where they’re from, what they want to do. I work with a lot of different schools all over NC, and I’ve never been in a school where teachers and students were as invested in each other and the learning process.

School culture of learning. “Positive School Culture” was either named as an emergent theme in each case study or was seen as a vital aspect of school context, so infused in the workings of the school as to be inseparable from any other critical component or contextual variable. In a review of the literature on school culture, Hinde (n.d.) noted that school culture has been described as being similar to the air we breathe; it can positively or negatively influence all aspects of a school. A positive school culture provides an encouraging and supportive place where students and staff like to be. Peterson and Deal (1998) note that positive school culture includes norms of collegiality, improvement and hard work, where there is a shared sense of purpose. There are rituals and traditions that celebrate student accomplishment, teacher innovation, and parental commitment. An informal network of storytellers and heroes provide a social web of information, support, and history. There is a shared ethos of caring, concern, and commitment to helping students learn. In a recent study that contrasts characteristics of effective high schools, Rutledge, Cohen-Vogel, and Osborne-Lampkin (2012) found that effective high schools take part in a strong culture of learning and professional behavior. There is a shared focus on high expectations for students and emphasis on students’ academic needs among the all of staff. Students internalize these cultural values and take responsibility for their learning, working together toward clear learning goals. Further, effective cultures of learning are collaborative, with individuals across organizational levels working together to meet the School Mission.

This paper includes “School culture of learning” as a Student Support, recognizing that it is both prerequisite to all of the critical components and emergent themes and is, at the same time, the product of these components, enacted. All of the exemplar ISHSs that the OSPri team visited appeared to have positive school cultures organized around STEM learning.

For instance at MNTHS, the core values or “pillars” include respect, integrity, responsibility, perseverance, and trust. If one sign of a positive school culture is that the school is...
a place that students like to be, then MNTHS is such a place. Choice is inherent to the admissions process. Students, with support from parents, must apply to attend. Their first experiences with the school require understanding how its expectations are different from those of the nearby comprehensive high school, or other schools that they have attended. Students must decide that they want to attend a STEM-focused, New Tech (network) high school along with other students who made the same decision. They know that they will be required to do more work, learn in a different way, and commit to more STEM coursework. Different kinds of learning activities will be expected of them, due to MNTHS’s focus on project-based learning (PBL) in all classes for four years. The constant collaboration required by PBL is a feature that helps to create MNTHS’ positive school learning culture. Teachers are respected for their varied areas of expertise. Students are respectful to teachers, and they also like them. Teachers acknowledge that students know more than they do about some things, especially apparent when using new technologies. Teachers and students engage in reciprocal teaching and learning. Students are allowed access to the Internet without the usual firewalls so prevalent in many schools, so the information available on the web is accessible to all; the teachers are not the only ones with power due to the universal access to information.

At DSST: Stapleton, administrators described a deliberate intention to create a strong culture to guide students and staff. With its formal guiding statements for goals and conduct, DSST: Stapleton created several structures to support its learning culture. For example, all students were placed in multi-grade advisory groups so they could work together and discuss any issues that arose, to ensure that students stayed on track to graduate high school and attend a four year college. A dean at the school claimed that advisory required “a lot of culture building.” This expectation of community support guided all interactions at the school. While there were rules and guiding principles, there was a culture of respect and caring that permeated the school. A board member explained, “Student’s don’t admire each other for harming each other, they don’t admire students for bullying and ridiculing another student; they just don’t admire that. It’s not respectful. And respect is one of the core values. They live it.” The DSST CEO elaborated:

We would say we are a values-based institution that’s building the character of our kids from the very beginning of when they start with us. [It is a ] culture of: “You guys are a part of something much larger than yourself; you are part of a community that you have expectations for, and expectations from, that you have to meet. You are a part of something that you have a responsibility to.” I think those notions of culture are very powerful, [and] that collectively challenge kids to be their best, to help each other succeed. I think that’s a foundation of everything.

Both at MNTHS and DSST: Stapleton, there were regular school meetings with large portions of the school present. The meetings had a ritualized aspect and were collaborative, led by administrators, teachers, and students. They were democratic. For instance, if there was a serious infraction of the school rules or values (the few examples that we saw seemed quite mild compared to other high schools), then the entire school voted on the outcome for the student. Similarly, student achievements were celebrated as well as student talents. We watched step dancing and rap performances, as well as the coordination of plans for outside-of-school academic events. All of the ISHSs in this study required quite a bit more of students than typical schools in terms of academic demands. STEM accomplishments and taking responsibility for one’s own actions as one collaborated and supported others resulted in a positive school climate.
This could be seen either as a Student Support actively built by school personnel, or as the product of the School Mission and the other activities.

**Summary.** One of the prominent critical components of the initial ten offered in the framework for this study is Supports for Students Under-represented in STEM. As can be seen in the section above, there was a high level of supports provided and they were ubiquitous. While many of the Student Supports discussed here can be found in most high schools, it seems rare to find this level of support woven into the fabric of the school program. Indeed, supports in ISHSs may be less about “add-ons” for students who need extra help, than the enactment of a personalized education.

**Discussion**

In this paper, we opened with a discussion of a fading picture of the American dream for too many Americans. The economic needs of the nation are certainly important, but we are more concerned about the economic prospects of individual students in definable communities across the U.S., places where the American dream can prove elusive for too many young people. Out of the landscape of U.S. education has emerged a new kind of school—inclusive, STEM-focused high schools. This paper focuses on four exemplar ISHSs, schools with strong track records of success for their diverse student bodies. These schools have missions that provide goals for the students who attend them that suggest that graduates can gain the social capital for success in STEM college majors, jobs and careers. The schools are inclusive and challenging. They use rigorous STEM education as the vehicle to prepare students for college, and for life, through their emphasis on 21st century skills.

It would be a mistake to under-emphasize the fact that in this set of four ISHSs, most of the students came from groups under-represented in STEM, and that a substantial proportion of the students, around 50%, were from families that are poor or working class. Often, such families and communities cannot create the social capital that prepares young people for a college or for college majors, jobs, or careers in STEM. They are cut off from the opportunity culture and the school system does not build the bridges to close these gaps.

ISHSs take on this issue squarely and design new school models in the context of their local communities, with the help of parents who want more for their children. These schools deliberately build opportunity structures, experiences inside of school and out, that provide students with a strong STEM education. As a result, students see their options for the future more clearly and better understand what it takes to obtain them. They have built, or perhaps earned, the social capital to understand how to succeed in their life goals, which may have expanded because of the experiences offered by the exemplar ISHSs in this study.

ISHSs promise challenges, but they build Student Supports into every fiber of the school program. These supports are not ways to merely prop up weak students. Rather, they are intentionally designed to strengthen students’ soft skills and habits of mind, and build the 21st century skills so valued in the world of work, as students develop their knowledge of STEM. Mission goals and Student Supports combine in a challenging STEM environment to provide opportunity structures for students. While achieving the American dream is not a claim that this study can make for students in these ISHSs, the opportunity structures build by ISHSs can certainly set students a bit further along on that road.
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