Denver School of Science and Technology, Stapleton High School: A Case Study of an Inclusive STEM-Focused High School in Denver, Colorado

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1. INTRODUCTION

President Obama and his administration have repeatedly stressed the vital importance of a science, technology, engineering, and mathematics (STEM) literate citizenry (Obama, 2010). Alongside this are concerns that students from groups currently underrepresented in STEM fields and STEM careers (e.g., African Americans, Hispanics) are a resource that cannot be ignored as we seek to expand both STEM literacy and STEM competency (PCAST, 2010). A number of states have already implemented policies to address these concerns.

High schools targeting students who already demonstrate strong interest and competence in STEM content areas have existed for decades as elite and exclusive institutions. While successful in their own right, these *selective* STEM-focused high schools have not typically addressed the dual goals of expanding the demographics of students prepared for and interested in pursuing STEM college majors and careers, and broadening STEM literacy in general. *Inclusive* STEM-focused High Schools (ISHSs), in contrast, are designed to serve students who range broadly in terms of prior academic achievement. ISHSs are a more recent addition to the field of secondary education. Some ISHSs have demonstrated the potential to target and welcome diverse student populations while also helping to ensure their development in STEM competency (Means, Confrey, House, & Bhanot, 2008; National Research Council, 2011). ISHSs that provide strong course offerings in science and mathematics, supported by a solid college preparatory curriculum, have the potential to increase participation in STEM college majors and STEM careers. Some of these schools have already demonstrated significantly higher outcomes than their school district and state on measures of success such as assessment scores, attendance rates, graduation rates, and college acceptance rates. However, there has been no significant characterization of such successful ISHSs to serve as guiding models for states and school districts.

To address this research need, the National Science Foundation (NSF) funded this study, *Multiple Instrumental Case Studies: Opportunity Structures for Preparation and Inspiration* (OSPrI; Lynch, Behrend, Means, & Peters, 2011), to conduct research to characterize the structures and practices of *exemplar* ISHSs, those recognized by education researchers and state policymakers for their successful performance on a variety of measures.

This case study, the fourth in a set of ISHS case studies, characterizes the first high school established by the Denver School of Science and Technology network of schools (DSST) under public charter to Denver Public Schools (DPS), which serves the residents of the City and County of Denver, Colorado. The selection of this school, *DSST: Stapleton*, is described in the next section, *Framing the Study*.

1.1. FRAMING THE STUDY

This case study of DSST Stapleton High School asks:

1. Is there evidence of each of the candidate critical components[1] (defined in Table 2 of the case study that follows) in the design of DSST: Stapleton?

[1] Herein after, we simply refer to these as critical components with the understanding that they are theorized to be critical to a successful ISHS model.

2. How are the critical components implemented at DSST: Stapleton? Do other components emerge from the data collected on-site that are critical to the school's character and success?
3. What are the contextual affordances and constraints that influence DSST: Stapleton's design, implementation and student outcomes?
4. How do DSST: Stapleton student STEM outcomes compare with those of the school district and state (e.g., STEM achievement measures, graduation rates, college acceptance rates)?

1.2. SELECTION OF DSST: STAPLETON

The goal of the OSPrI study is to find and characterize *exemplar inclusive STEM-focused* high schools. By *exemplar* we mean that the school should have a reputation for success; it should also show some successes with its student body in comparison to school district or state averages given demographically appropriate comparison groups. In addition, the school should be a public school or a public charter school, well established within the school district or state, and have been planned thoughtfully with community support. By *inclusive* we mean that the school admits a range of students with respect to their prior academic achievement, i.e., the school's admissions criteria do not limit applicants to students who demonstrate that they are gifted and talented in STEM or are very high achievers. By *STEM-focused* we mean that the school identifies itself as a STEM-focused school, and in addition requires more, or more rigorous, mathematics and science courses to graduate than district and state requirements, or that its science, technology, engineering and mathematics classes are more integrated than traditional comprehensive public high schools the students might attend. We are primarily interested in STEM-focused high schools that require all of their students to complete college preparatory courses including at least four years of mathematics with the fourth year being pre-calculus or calculus, and at least four years of science including core courses in biology, chemistry, and physics. The school might or might not also require engineering or technology courses.

To find such schools, the selection process combined expert nomination with screening and categorization according to promising elements in a school's design and outcomes. Each school was chosen as a critical case (Yin, 2009), with a governing structure and academic organization likely to have broad effects on implementation and outcomes. The nomination process began by contacting individuals knowledgeable about STEM schools and state STEM networks, reviewing the OSPrI definition of inclusive STEM-focused high schools with these experts, and asking for their nominations of schools representing particularly good examples.

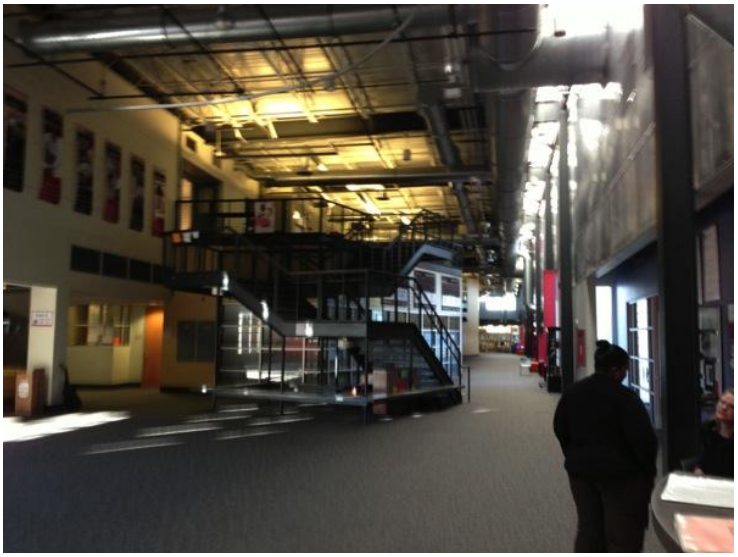
DSST: Stapleton was selected as an exemplar ISHS for our study after being recommended by education experts in the field and having been included in the National Research Council's report, *Successful K-12 STEM Education: Identifying Approaches in Science, Technology, Engineering, and Mathematics* (2011). After verifying through examination of publicly available data that the school met the criteria of strong student outcomes, inclusive admissions, and a STEM-focus, we approached the DSST network Chief Executive Officer (CEO) with a summary of our intended study. He agreed to allow DSST: Stapleton to be a participating school in our study and provided the necessary research approval.

In this case study, the section of the case entitled *Exploring the Design and Implementation of DSST: Stapleton* includes a brief description of data collection methods to first orient the reader, and then findings are presented. The reader is referred to the *Research Framework* document located on the OSPrI website for details about the research design and methods, including the rationale for the 10 critical components, methods for school selection and recruitment, and methods for data collection and analysis (http://ospri.research.gwu.edu/research-framework).

2. THE DSST: STAPLETON CASE

2.1. FIRST IMPRESSIONS

Our first view of DSST: Stapleton was a satellite image downloaded from the Internet (Google Maps, 2012). *DSST: Stapleton sat in the middle of the Stapleton neighborhood of Denver, surrounded by a soccer field and nearby housing developments. The physical structure of the campus consisted of two modern-looking buildings housing the high school and an associated middle school, connected by a short hallway. The day OSPrI's six-person research team arrived in February 2013 for the three-day site visit, the nearby streets were busy with city busses and cars dropping off students. We remarked on how everyone was walking (and not rushing) towards the main entrance of the school on time for their first period classes. Upon entering DSST: Stapleton, we were greeted by a receptionist and were given the opportunity to take in the interior design of the building. We had read that the school had been recognized by the American Architectural Foundation as a well-designed school when it was built, but we were still impressed by the school's unique and open design.*



The school's ceilings and walls left structural elements such as pipes and light fixtures exposed. Its hallways were relatively open, allowing us to see many classroom entrances and several public spaces, called pods. There were jumbo-size screens scrolling lists of students scheduled to attend tutoring or disciplinary sessions after school. We saw huge banners extending from the rafters above the nearby staircase: Respect, Responsibility, Integrity, Courage, Curiosity, and Doing Your Best. *Each banner, also containing an image of a DSST student exemplifying the word or phrase, served as ever-present reminders of the DSST network's core values.*

DSST Core Values:

- *Respect* - Appreciating the value of a person or an object through your words, actions and attitude - treating people appropriately with common courtesy.
- *Responsibility* - Able to be trusted and or depended upon to complete tasks, follow directions and own up to your actions.
- *Integrity* - Being truthful, fair and trustworthy in your words and actions—doing as you say and saying as you do.
- *Courage* - Possessing confidence and resolve to take risks and make right decisions in the face of pressure and adverse or unfamiliar circumstances.
- *Curiosity* - Eager to learn, explore and question things to gain a deeper understanding.
- *Doing Your Best* - Putting your best effort into everything you do. (http://dsstpublicschools.org/about-us/core-values-guiding-philosophy/)

As our research team toured the school hosted by DSST's Special Projects Coordinator, we saw interactions and viewed artifacts that conveyed a sense of community. Student and teacher products, such as posters and art projects, lined the walls. Students stood in the hallway talking with their friends in quiet voices, waiting for classes to start. Students were dressed following the school's required dress code, which did not allow them to wear jeans, t-shirts, hooded sweatshirts, or athletic shoes, but instead required that they wear clothing modeled after professional dress. Most students held laptops as they walked, and one student was playing the piano in the school near the entrance. The serious and professional demeanor was striking. We later found out this professional atmosphere was intentional and that dressing appropriately was part of a larger school culture emphasizing professional behavior, which in turn supported students' presentations on their internship projects to school and community experts. Much like the building's architectural design and core value banners, everything in DSST: Stapleton seemed explicit and intentional, down to the clothes that students wore. As we walked through the school with our tour guide, we were greeted by several students and teachers who welcomed us to their school, and by extension, their community.

As we learned about the school's founding and current offerings, we ascended the large central staircase to see the school's motto "Culture is King" emblazoned in a student-designed mural on a nearby wall. In addition to the motto, the wall included an image of the mascot and several artistic images related to the engineering theme. DSST: Stapleton wanted everyone to know its motto and be aware of the beliefs and values of the school.

2.2. CONTEXT AND OVERVIEW

This case study begins with a description of the school including how it was founded, its mission, student demographics, admissions process, and other contextual factors to help situate the reader before the research findings are introduced.

2.2.1. School District and Locale

DSST: Stapleton is a public charter high school located in the Stapleton neighborhood of Denver, Colorado. Denver, the largest city in Colorado with a population of approximately 620,000, is located in the Front Range Urban Corridor, bracketed by the Rocky Mountains on the west and the High Plains on the east. As of October 2012, Denver Public Schools operated 155

schools including traditional, magnet, charter, and pathways schools, with a total enrollment of 84,424 students, with 20,174 students enrolled at the 9-12th grade level. The 2012 graduation rate for Denver Public Schools was 58.8%, compared with 75.4% for the state of Colorado.

DSST: Stapleton, located east of the downtown area, was close enough to the heart of the city to be served by an extensive city bus system, but was situated within a residential neighborhood. Having been built on property formerly occupied by the Denver airport, the school was surrounded by two disparate housing areas. On one side were neighborhoods that had existed for over 50 years, and on another side, new neighborhoods had been built on property that once welcomed air travelers .

2.2.2. The DSST Network

A decade before our visit, the Denver School of Science and Technology (DSST) opened as a single public charter high school within the Denver Public School (DPS) system. In 2008 the charter school grew to include a next-door middle school based on the same model. In 2010 the Denver School of Science and Technology Public Schools (DSST) was established to manage the growing network of charter STEM-focused schools and by the time of our visit, the network had expanded to include two schools—a middle school and a high school—in the Green Valley Ranch area of Denver, and three standalone middle schools in different areas of Denver. The original campus was called DSST: Stapleton, although some people who had been involved in its inception still referred to it as "Science and Tech." The DSST network had plans to grow to 14 schools on seven campuses by 2022.

Establishment of DSST: Stapleton had significant funding from the Bill and Melinda Gates Foundation and Oprah's Angel network, as well as contributions from the Morgridge Family Foundation, First City Stapleton, Barton Family Foundation, and others. In total, ten million dollars, half of which was provided by DPS district construction bond funds, contributed to its growth.

At the time of our study, the DSST network had a Home Office administrative team of about 15 individuals, which included President Bill Kurtz (the original DSST: Stapleton Head of School and now DSST Chief Executive Officer), and several managers and coordinators who were responsible for the larger picture strategic planning and network-wide structures and processes, including information technology. As charter schools in the DPS system, the DSST network schools were not required to use the DPS curricula or to administer DPS assessments, and their teachers had a different pay structure and were not unionized. However, all DSST students were required to take state tests.

The vision and educational plan for the DSST network focused on providing a rigorous college preparatory curriculum to a student body that reflected the diversity of the DPS student population and achieving a 100% graduation rate. The goal was to prepare all of their students for acceptance to, and subsequent success in, four-year colleges and universities.

2.2.3. DSST: Stapleton High School

DSST: Stapleton opened in August 2004 with 130 ninth grade students, subsequently adding a grade each year, and graduating its first class of seniors in May 2008. Each DSST school had a

different STEM focus and DSST: Stapleton's was engineering. As such, its building was intentionally designed to immerse its community in this theme. Structural elements were left exposed in the multilevel open design. Flexible use of facilities was also part of the plan, enhanced through a large open space and pod design on the lower floor that had movable seating and tables. These spaces were used by various elective classes and student groups, and also provided venues for student and community presentations. Classrooms were also designed to allow varied seating configurations. There were a number of engineering or science-enabled classrooms. Integrated technology, such as projectors and smart boards connected to the teacher's computer and the Internet, were evident in all the classrooms. As part of the DSST network, this ISHS had extensive information technology and network access resources to connect students, teachers, parents, and administrators, including access to DSST statistical databases that maintained data at the student-level. Additionally, DSST provided students with laptops capable of accessing Internet and other resources, and maintained a strong wireless network to support high levels of student use. Details on the school's technology are provided in the section *Integrative, Innovative Technology Use*. The facilities of this ISHS were a showcase of careful planning and strong start-up funding, and its building was recognized by the American Architectural Foundation as a well-designed school in 2006.

According to the DPS School Performance Framework, between 2008 and 2011 DSST: Stapleton was the highest performing secondary school in the district in both absolute performance and overall improvement. It was also one of three top finalists in the 2010 national Race to the Top Commencement Challenge sponsored by the Department of Education, out of more than 1,000 schools competing. The section *Examining Student STEM Outcomes* synthesizes and discusses outcome measures including attendance, graduation, and college acceptance rates and achievement data for 2011 and 2012.

At the time of our study, the job of school principal—titled *School Director* in the DSST schools—was performed by Mark Heffron. Heffron was supported by the Home Office Administration Team at the DSST Network level, a DSST Public Schools Board with a governing board type of role, and a DSST Public Schools Advisory Committee, consisting of local political, educational, and philanthropic representatives. Within the school building, in addition to the School Director, were two Deans of Students, one working with the Prep Academy, 9th and 10th grade, the second with the Senior Academy, 11th and 12th grade; a Director of Curriculum and Instruction; a Director of College Placement; and a Director of Athletics and Internships. This team was responsible for administrative duties within the school. More details about the school administration are included in the Administrative Structure section of this case study.

2.2.4. Admissions

All students within the boundaries of DPS interested in attending one of its public or public charter high schools did so through the DPS SchoolChoice enrollment process. SchoolChoice Forms were available in English and Spanish. Students could apply to up to five schools from throughout the Denver public school system and enrollment requirements might vary for each. The DSST schools, however, had no additional admissions requirements. The form required minimal information: name, address, age, current school, siblings' schools, race/ethnicity, and whether the student qualified for the Free and Reduced Lunch Program. According to DSST:

Stapleton's charter, the lottery selections prioritized the acceptance of a minimum of 40% of the student body being students eligible for Free and Reduced Lunch. Preference was given to siblings of current students, and 45% of the remaining seats went to students living in Stapleton. Remaining seats were filled from any students living within the boundaries of DPS.

According to the SchoolChoice website, selecting a non-neighborhood boundary school as a school of choice removed that child from enrollment in their neighborhood boundary school. Transferring back to their neighborhood boundary school required resubmission of a SchoolChoice form. Moreover, transportation was not guaranteed to the school of choice. As not all of DSST: Stapleton's students lived in the Stapleton neighborhood or a neighborhood conveniently served by the city bus system, many students' families had to consider alternative means of transportation such as carpooling or providing a car for their student's use. Comparison demographics among 9-12th grade DSST: Stapleton students, all DPS high school students, and the city of Denver (all ages) from the year of our study (2012-2013), are shown in Table 1.

Table 1

Student Demographics

	DSST: Stapleton (9-12) % of High School Student Population (N=508)	DPS (9-12) % of High School Student Population (N=20,174)	Denver % of General Population (N= 600,158)
White	27.6	18.1[a]	68.9
Hispanic or Latino	34.8	57.5	31.8
Black or African American	26.2	16.6	10.2
Asian/Pacific Islander	3.0	3.7	3.4
Native American	0.8	0.9	1.4
Some Other Race or Multiple Races	7.7	2.9	13.3
Male (%)	46.3	51.0	51.3 [d]
Female (%)	53.7	49.0	48.7 [d]
Free and Reduced Lunch (FRL)	44.8	68.6	
English Language Learners (ELL)	7.9	17.9	
Special Education (SPED)	3.0	11.3	

[a] School data for the 2012-2013 school year, collected in October 2012, unless otherwise noted
All DPS and DSST data from http://communications.dpsk12.org/facts.html

As shown in Table 1, DSST: Stapleton served a student body that was diverse in terms of race/ethnicity and socioeconomic status. Over 50% of its students were from subgroups underrepresented in STEM majors in colleges and in STEM careers, including 35% of students self-identifying as Hispanic and 26% as African American. Students from low-income families, as defined by the Federal Free and Reduced Lunch programs, represented 45% of its student body in the year of our study.

2.3. EXPLORING THE DESIGN AND IMPLEMENTATION OF DSST: STAPLETON

This section describes the 10 critical components that we explored at each ISHS, and a brief synopsis of data collection.

Critical components

Through our review of the research literature on effective practices in high schools and in STEM education (Lynch et al., 2011), we identified 10 critical components that are summarized in Table 2. Our study of DSST: Stapleton systematically examined the design and implementation of each of the critical components at the school. Additional themes that emerged from the data as significant to DSST: Stapleton were further explored as *emergent themes*.

Table 2

Critical Component (CC) Definitions

1. ***STEM-Focused Curriculum (CC1).*** Strong courses in all 4 STEM areas, or, engineering and technology are explicitly, intentionally integrated into STEM subjects and non-STEM subjects.
2. ***Reform Instructional Strategies and Project-Based Learning (CC2).*** STEM classes emphasize active, immersive, and authentic instructional practices/strategies informed by research. Opportunities for project-based learning and student production. Performance-based assessment practices that have an authentic fit with STEM disciplines.
3. ***Integrated, Innovative Technology Use (CC3)***. Technology connects students with information systems, models, databases, STEM research; teachers; mentors; social networking resources for STEM ideas, during and outside the school day.
4. ***Blended Formal/Informal Learning beyond the Typical School Day, Week, or Year (CC4)***. Learning opportunities are not bounded but ubiquitous. Learning spills into areas regarded as "informal STEM education." Include apprenticeships, mentoring, social networking and doing STEM in locations off of the school site, in the community, museums and STEM centers, and business and industry.
5. ***Real-World STEM Partnerships (CC5)***. Students connect to business/ industry/world of work via mentorships, internships, or projects that occur within or outside the normal school day/year.
6. ***Early College-Level Coursework (CC6)***. School schedule is flexible, and designed to provide opportunities for students to take classes at institutions of higher education or online.
7. ***Well-Prepared STEM Teaching Staff (CC7)***. Teachers are qualified and have advanced STEM content knowledge and/or practical experience in STEM careers.
8. ***Inclusive STEM Mission (CC8)***. The school's stated goals are to prepare students for STEM, with emphasis on recruiting students from underrepresented groups.
9. ***Administrative Structure (CC9)***. The administrative structure varies (school-within-a-school, charter school, magnet school, etc.). Affected by the school's age and provenance, i.e., whether the school was converted from another model or was created "from scratch" as a STEM school. Funding structure varies.
10. ***Supports for Underrepresented Students (CC10)***. Supports such as bridge programs, tutoring programs, extended school day, extended school year, or looping exist to strengthen student transitions to STEM careers. Altered, improved opportunity structures, i.e., students are positioned for STEM college majors, careers, and jobs.

Data collection synopsis

Data collection began before the site visit to the school. We used publicly available data to begin to understand the school's design and context. Also, two online questionnaires were completed prior to the visit: a school description questionnaire completed by a school administrator and a questionnaire completed by the school's teachers. Phone interviews were conducted with the administrator to follow up on questionnaire responses. To understand the implementation of the DSST: Stapleton program, the OSPrI study team visited the school for three days and collected design and implementation data using observation instruments and focus group and interview

protocols. Data were then analyzed in the context of the school to answer our research questions. Table 3 lists the data collection activities carried out during our DSST: Stapleton site visit.

Table 3

Data Collection Activities at Site Visit to DSST

Classroom Observations	
STEM Classes	Non-STEM Classes
Biology Biotechnology Chemistry Creative Engineering Integrated Algebra/Geometry 1 Physics Upper Level Math	Senior English
Focus Groups	
Teachers	Students/Parents
Teachers of Engineering Teachers of Science Teachers of Mathematics Teachers of Informal learning Teachers of Technology	9th Grade 11th Grade Engineering & Use of Technology Parents
Interviews	
School Personnel	Non-School Personnel
Director of Athletics and Internships, DSST: Stapleton CEO, Home Office Team Chief of Staff, Home Office Team College Support Coordinator, DSST: Stapleton Dean of Students, Prep Academy Dean of Students, Senior Academy Director, DSST: Stapleton SPED Coordinator, DSST: Stapleton	Alumni Interview Denver Public Schools Representative University of Colorado at Boulder Representative
Other Activities	
School Day	After School
Advisory Morning Meeting School Tour	Engineering Tutoring
Researcher Activities	
Team Debrief – Day 1 Team Debrief – Day 2	

The research team consisted of six researchers from the George Washington University and SRI International. Three of the researchers were either professors or research professionals while the

other three were doctoral students. Most of the research team had experiences teaching in high schools and all of them were experts in science, technology, engineering, or mathematics. The group was evenly split between men and women, with five members identifying as White and one member identifying as Asian.

For a detailed treatment of the research design of this study, the reader is referred to a paper available on the OSPrI website that was published online in the AERA repository, and *Research Framework for ISHS Case Studies* that details the literature underlying the critical components plus school selection, data collection, and data analysis methods. The website address is http://ospri.research.gwu.edu/research-framework.

In the following sections, findings on the design and implementation dimensions of the 10 critical components are discussed with attention to alignment, which are then summarized.

2.3.1. STEM-Focused Curriculum (CC1)

2.3.1.1. Definition.

Strong courses in all four STEM areas, or, engineering and technology are explicitly, intentionally integrated into STEM subjects and non-STEM subjects.

2.3.1.2. Design.

As an ISHS with an engineering theme, DSST: Stapleton required all of its students to complete a college preparatory STEM curriculum. There was no remedial academic track, and all students completed a rigorous college preparatory program of study—described on DSST's website as a "core curriculum or a challenge course in each subject." According to the school director, deans, and teachers, the academic STEM curriculum was fundamentally designed around the *ACT College Readiness Standards* (ACT, 2011). Every student was required to complete a minimum of four years of mathematics through at least pre-calculus, five years of science, and an engineering course—well beyond the high school graduation requirements of DPS and Colorado. Engineering coursework, initially offered only through elective courses when DSST: Stapleton first opened, had since become a ninth grade Creative Design course taken by a majority of DSST: Stapleton students, with the option to take a senior year advanced Engineering elective. Technology was an active tool for education at DSST: Stapleton in 2012. Student use of technology was integrated into every class; every student was provided with a customized DSST laptop with wireless access.

DSST: Stapleton had its eyes firmly on the goal of getting all students not just into college, but also successfully *through* college. With the particular focus of enabling students to enter STEM majors in college, one of the predominantly articulated outcomes of a DSST: Stapleton education was that every student would pass mathematics courses through pre-calculus, often considered a gate-keeping course for college STEM majors, particularly the calculus-based science and engineering majors.

According to discussions with several teachers and administrators, DSST: Stapleton's curriculum design began with the *ACT Standards for College Readiness* (ACT, 2011) as a foundation for the junior year curriculum. To ensure that students were prepared for the rigors of the junior year

program of study, the curriculum was then backward designed for the 10th and 9th grades focusing on the *Colorado Academic Standards* (CAS) (and later the *Common Core State Standards*) as guidelines. Supports were put in place to ensure students were well guided, had access to personalized help if need be, and were held accountable for meeting the academic challenges of each year. (See section entitled *Supports for Underrepresented Students* for additional information.) For the senior year, curriculum was built to include additional experiences to prepare students to not just get accepted into college, but to also be prepared to be successful in college. Some course content was grounded in *Advanced Placement* course guidelines even in non-AP courses, with additional focus on opportunities for the application of disciplinary content knowledge, the acquisition of 21st century skills, and increased student autonomy and responsibility.

2.3.1.3. Implementation.

Four aspects of DSST: Stapleton's implementation of its STEM-focused curriculum design emerged in our data analysis: the evolving nature of its curriculum, the emphasis on the *E* in STEM, the overall rigor of the STEM coursework, and individualized opportunities to accelerate or increase the rigor of their STEM learning. The STEM curriculum in place at the time of our visit is shown in Table 4 and discussed in the sections that follow.

Table 4

Typical and [Advanced] [a] Course Sequence in STEM Courses

Grade	Science	Math	Engineering	Technology
9th	Physics [Honors Option [b]]	Integrated Algebra/ Geometry 1 [Algebra II, Honors Option]	Creative Engineering	Computer Science Elective [c]
10th	Chemistry	Integrated Algebra/Geometry 2 [Pre-Calculus, Honors Option]		
11th	Biology [Honors Option, may take AP Exam] Earth Science	Algebra 2 [AP Calculus AB]		
12th	Biochemistry/Biotechnology Environmental Biology [Advanced Physics in conjunction with Advanced Creative Engineering/ may take AP exam]	Pre-Calculus [AP Calculus BC]	[Advanced Creative Engineering (in conjunction with Advanced Physics]	

[a] Courses listed in brackets indicate one advanced pathway

[b] An honors designation is added to the student's record for additional work completed within the heterogeneous class. Some of these classes are designated with an "X," Biology-X, for example, and allow students to take the AP exam for that course.

[c] This is not a required course, but is a course option that may be taken any of the four years.

In addition to this coursework, students were required to complete an internship in junior year and an applied research project in their senior year. More details about these graduation requirements are detailed in the section *Blended Formal / Informal Learning Beyond the Typical School Day / Week / Year.*

2.3.1.3.1. Honors or accelerated learning. Table 4 identifies two possible course progressions for typical and advanced students. The overall goal at this ISHS was to maintain a diversity of student ability in each class. The one exception to heterogeneous grouping came in mathematics. Mathematics classes offered different course levels to accommodate broader student mathematics preparation. Using standardized assessments, 9th, 10th and 11th grade students were evaluated each fall and the spring. Based on their performances on these tests, students were put into performance bands so their needs could be more directly addressed. Otherwise, most of the courses at DSST: Stapleton were heterogeneously grouped with accommodations made within each class for differentiated learning. The school schedule allowed within-class differentiation of instruction, particularly in the few weeks following each trimester exam. Teachers were given two days after each trimester final exam to analyze student performance data, and the subsequent few weeks allowed instruction to focus directly on particular student needs. Standards data on each student's performance could be followed over time to appropriately target instruction.

Few classes were specifically labeled *honors*; however, students could negotiate taking an honors level with a specific teacher involving, for example, additional work such as preparation for an AP exam. The course was then designated with an X on the student's transcript (e.g., Biology-X). These students took the same class as other students, but additional assignments were completed, and there was sometimes an expectation that a student would take the respective AP exam.

2.3.1.3.2. Engineering. One of DSST's founding board members indicated that from the very beginning it was important "that the E was in STEM." There was a general sentiment at DSST that in order to create engineers, the best place to do that was in academic facilities designed explicitly for the purpose of developing engineers—four-year institutions of higher education. What DSST: Stapleton aimed to do, however, was ensure that students were academically prepared to apply to, be accepted into, and to flourish once enrolling in these programs. To that end, to indicate confidence in DSST's program of study, arrangements were made for guaranteed admissions into the College of Engineering at The University of Colorado (CU) Boulder for students who achieved targeted GPA and test scores in DSST: Stapleton's program. As reinforced by the CEO of the DSST Home Office:

If we want our kids to be the best, we need to get them to the places where they can have that opportunity. That's where we got to a pre-calc. finish. If we want our kids to have the choice of an engineering school, at least a minimum admit for some of the most selective engineering schools, then we'd better set the math bar because we know it is the highest correlated factor for college success, and we know that it's so important in STEM that they have that fluency.

DSST: Stapleton provided a solid foundation to prepare students for entry into STEM fields. This included success in appropriate coursework, introduction to the STEM careers and majors through internships, field trips, connections with the university, etc. This gave students the knowledge they needed to both be aware of possible fields they might enter and the academic knowledge to be able to pursue their chosen pathways. (These experiences are discussed further in two sections entitled *Blended Formal / Informal Learning Beyond the Typical School Day / Week / Year*, and *Supports for Underrepresented Students*.)

Early in DSST: Stapleton's evolution, according to a university administrator, CU Boulder sent professors and graduate students to the school to teach engineering elective classes to interested students "until the school had grown up enough that they had seniors and then they hired a teacher to teach AP Physics and Engineering." Because of student deficiencies in math in the earlier years of DSST: Stapleton, there wasn't time in the schedule to include a required engineering course. As a Board Member describes:

Kids were doubled, up, tripled up some, two and three periods of math a day because they were so far behind, some of them. And those kids who were doubled and tripled in math, or in reading, had to be full court presses as well. They didn't have time for electives.

However, within the past two years, as more students from the middle school entered the high school with grade appropriate skills and fewer students needed to spend additional time catching up in reading and math, DSST: Stapleton found time in the school schedule to introduce the Creative Engineering course for ninth graders.

2.3.1.3.3. Evolving curriculum. According to school administrators, the curriculum at DSST: Stapleton was not static, but rather in a constant state of refinement to meet the evolving needs of their student body and a changing world. The school moved forward with the idea that the curriculum is *the best for now,* a reflection of their continual process of maintaining the curriculum where the school staff noted it was working well and improving it where changes could be made for the better.

When DSST: Stapleton opened in 2004, it was designed to serve grade 9-12 students. Some students struggled mightily with the science and mathematics academic content during the first few years of the school's operation, not necessarily solely because of inadequate preparation in science and mathematics, but also because of deficiencies in their reading skills. Instead of reducing the requirements or watering down the school's expectations, DSST: Stapleton sought to find a solution that would help students reach the bar necessary for the school's mission. Throughout those early years, school administrators explain that the solution came through students doubling up on mathematics courses and having targeted instruction in reading. However, even though DSST: Stapleton had a very strong English department; according to the school director, there was still a challenge in "moving the needle with non-readers coming in in the ninth grade."

The CEO explained that a subsequent solution came in the form of opening a DSST middle school to provide students with support to start ramping up their math and reading skills in the sixth grade rather than waiting for them to be much further behind by ninth grade. This middle school, which opened in 2008, followed an integrated algebra/geometry math curriculum as well as an integrated science curriculum incorporating earth science, physics, chemistry and biology, to prepare the students for more rigorous disciplinary focus beginning in the ninth grade. In the 2011-2012 school year, the ninth grade engineering design class was duplicated in the eighth grade providing a foundation for the creation of a two-year design sequence bridging the two academic years and connecting the middle and high schools.

As already alluded to, the curriculum at DSST: Stapleton was constantly evolving. Each summer teachers met to review and revise the curriculum to ensure that the targets, as well as students' needs, were being met, considering both course level and school-wide curriculum changes. Teachers within each subject area coordinated with each other, especially with teachers of courses that come in sequence just before or just after one's own to ensure vertical content alignment. Mathematics teachers tended to talk with other mathematics teachers to ensure continuity across the course progression. Science teachers did the same. Teachers of the same high school course also coordinated with teachers at the other DSST schools serving grades 6-12 since they were responsible for preparing students for the same end-of-course exams, at essentially the same pacing, while still being able to approach teaching the content in ways that were unique.

During the 11th and 12th grade years, additional coordination between the teachers of different subjects helped to eliminate redundancy and ensure a common message when students were taking, for example, two science courses at a time. In the 11th grade year, students took three trimesters of biology, two trimesters of earth science, and a one-trimester internship. According to the teachers, coordination between biology and earth science allowed one course to focus "on content and wet labs" and the second to focus "on interpretation and reading science" with the goal of producing good science readers prepared not only for the ACT, but also able to read and understand science related media.

Another evolution of the curriculum related to a move towards integration and application of subject matter. According to Bill Kurtz, the CEO of the DSST Home Office, the academic program at DSST: Stapleton moved from "a little more traditional to a lot more application," based on the view that a strong academic foundation in the subject areas was vital before moving into greater content application through opportunities such as the Junior Internship, the senior year applied STEM classes of Biochemistry/Biotechnology or Engineering/Physics, and the Senior Projects. He stated,

We developed a philosophy of we are going to be very rigorous, and a little more traditional in the early years of our program to build that foundation in, so when we go to application at the end, in our senior academy program, they are going to have the rigor and the skills to do college level work there and not fluff.

Much of the school's STEM focus was through the individual course offerings rather than in their integration. The academic coursework we observed, especially in the ninth and 10th grades, had a fairly traditional feel, focusing more heavily on content knowledge acquisition and mastery in the individual subject areas. Physics, however, was intentionally introduced in ninth grade as a way to provide useful and appropriate application of mathematics skills. The physics teacher described this approach to physics and mathematics learning as "a lot of math to push content skills to a higher level." Along the same lines, the recently introduced ninth grade Creative Engineering class intentionally taught mathematical ideas of scale and measurement that were necessary for students' science and mathematics courses. While these courses were separately taught, they were mindfully related to each other with the idea that the learning in each class would both reinforce and support that in the others.

Teachers of ninth and 10th graders in physics and chemistry indicated that only 5-10% of class time was spent on labs, but that this percentage increased in the upper grades, when such lab-heavy classes as Biotechnology and Advanced Engineering were offered. The Biochemistry/technology teacher noted, "the lab drives the curriculum" and that the "application is seamless."

In the 11th and 12th grades, the disciplinary focus continued, but also broadened to include increased interdisciplinary connections and the applications of knowledge. Teachers described the senior year science option as having a "content course and an application course" with a "double period every day" for Physics with Engineering, or Biochemistry with Biotechnology. An integrated STEM focus continued through Junior Internships and Senior Projects, which were often heavily skewed toward STEM fields and provided opportunities for students to delve deeply into real world applications of previously acquired STEM content knowledge and skills.

2.3.1.3.4. STEM rigor. Each assessment that students took to demonstrate mastery of the subject matter had all of its items linked to particular academic disciplinary content standards adapted from *ACT College Readiness Standards*, *Colorado Academic Standards*, and the *Common Core State Standards*. Teachers disaggregated student performance on exams to understand what content areas needed reinforcement and where students could move forward. *ActiveProgress*, a database accessible to all teachers, had question banks where teachers had coded each question to the course standards. After taking an exam, the student and teacher would both know which standards a student had mastered and which needed further instruction.

There was no question that DSST: Stapleton was recognized for its academic rigor, particularly in science and mathematics. Comments made in interviews and focus groups with stakeholders—including business and college partners, parents, and students—pointed to a challenging curriculum for all students. Parents in a focus group agreed with a statement made by one parent: "There [are] no rinky-dink courses here." And an alumnus of DSST commented, "a lot of students have mixed feelings about DSST because it's really rigorous" but went on to say that he chose to apply to DSST: Stapleton because of its reputation of being a "really hard school." Additionally, he said that while at DSST: Stapleton he "wasn't very good at math," but the school taught him "how to go for help" and now in college, he is "taking a lot of hard [math and science] classes and doing really well."

Another important indicator of the rigor of the STEM program at DSST: Stapleton was its students' low college remediation rate—the rate of students entering college who are required to take more high school level coursework to be fully prepared for the college curriculum. Graduates of DSST: Stapleton had a rate of 11%, which is the fourth lowest among public high schools in the state of Colorado. This ISHS was in the top 5% on this performance measure. In addition, the remediation that did occur was in English, reading, and writing. None was in the STEM fields. Most importantly according to the DSST CEO, when compared to the other schools that had this low of a remediation rate, "nobody in that list has anything close to the kind of diversity that we have."

2.3.1.4. Summary.

DSST: Stapleton offered all their students a rigorous science and mathematics program plus a Creative Engineering course and integration of technology use in all classes, while differentiating instruction to the needs and interests of individual students. This ISHS was working deliberately and thoughtfully toward incorporating more emphasis on technology and engineering to provide a solid foundation for any student wishing to pursue a college major in science, technology, engineering, or mathematics. The students followed a fairly traditional, but challenging, trajectory through mathematics and science that began as a highly structured program then shifted to an emphasis on application of STEM knowledge in an interdisciplinary learning environment relying on student self-motivation and individual responsibility—a process school staff called "gradual release." This process is discussed further in the section entitled *Emergent Themes*.

DSST: Stapleton teachers were constantly coordinating to ensure fidelity of curricular implementation. Additionally, the school and the DSST network in general continually examined their student outcomes and refined the curriculum to better meet the needs of their students and advance the goal of college readiness, including readiness for college studies in science, technology, engineering, and mathematics. When asked to identify the biggest success of DSST: Stapleton, the CEO, Bill Kurtz commented:

We have 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. I think that is one of the things we set out to do. In this country we [the public] say we are a land of opportunity, where kids can grow up to be what they want to be, that we have frankly run a selective science program in this country for the last 100 years. Essentially what we've [the public have] been saying to kids is that 'the only way you can study science is if you are smart. And if you're smart and you look generally like you are White upper class, yeah then you can study science, because you will test into one of these schools. But for the rest of you, maybe you can get some good science in your own schools, but really you're not capable unless you can test into a real science program.' So we [DSST] basically said, 'hey, we can create a great STEM school for all kids. And we can demonstrate that all kids can access great STEM schools,' and I think that's been very important. I think we can compare our outcomes against anybody. And we feel we have broken that barrier of saying that only gifted and talented kids can study STEM.

2.3.2. Reform Instructional Strategies and Project-Based Learning (CC2)

2.3.2.1. Definition.

STEM classes emphasize active, immersive, and authentic instructional practices/strategies informed by research. Opportunities for project-based learning and student production. Performance-based assessment practices that have an authentic fit with STEM disciplines.

2.3.2.2. Design.

DSST: Stapleton, like all DSST network schools, followed instructional strategies established by the DSST network. As described on the DSST website, these included both traditional (i.e., lectures, group and individual practice, discussion) and inquiry-based approaches—what DSST called a "balanced curriculum." The mix of traditional and inquiry-based instructional approaches gradually changed from a focus on learning content to applying content, with

responsibility for learning shifting to the student, a process school staff referred to as "gradual release."

DSST: Stapleton employed a mastery learning assessment system, in which students were required to master 70% of the learning objectives to pass a course. Student test data were analyzed to pinpoint individual student weaknesses, and additional learning opportunities were provided so that each student could reach that level of mastery.

DSST: Stapleton modeled its teaching practices on the *DSST Core Instructional Practices*. These network-wide practices were drawn from two principal books: *Brain Rule*s (Medina, 2010) which provided a cognitive science basis behind the instructional practices used at DSST, and *Teach Like a Champion* (Lemov, 2010) that described other teaching techniques to use in the classrooms, such as careful structuring of classroom teaching to support establishing and maintaining a classroom culture of learning. Core instructional practices related to acquisition and retention of content were informed by Medina (2010). To support memory retention of new content material, it was considered to be important that new material be covered in short segments so that students could maintain their attention, and that it be repeated with gradual introduction of additional new material. These segments were interspersed with other activities such as review of prior content and individual or group practice. This strategy of returning to new content and gradually incorporating new information aids long-term memory storage, according to Medina, who further recommended that this process be repeated at timed intervals. Thus, the DSST core instructional practices incorporated the spiraling technique within the context of a learning culture based on an established format of a series of short segments targeting different learning activities. With the practices espoused in these books, DSST aimed to support all of their teachers to be highly effective teachers.

2.3.2.3. Implementation.

In line with the design of their instructional practices based on the network-wide principles of a balanced curriculum and core instructional practices, the CEO at DSST: Stapleton reported that DSST took a deliberate approach to the structure of the instruction across all grades, with a view towards balancing the academic rigor of classes with activities that required an application of STEM principles to the real world. As the CEO explained,

[DSST] developed a philosophy of [being] very rigorous and a little more traditional in the early years of our program—to build that foundation in, so that when we get to application at the end in our Senior Academy program, [students] are going to have the rigor and the skills to do college-level work there and not 'fluff.' Our program migrates from what I would call a little more traditional program to a lot more application.

2.3.2.3.1. Ninth and 10th grade experiences. The school's philosophy of emphasizing mastery of subject matter content before application was reflected in the instructional practices observed at DSST: Stapleton's Prep Academy (ninth and 10th grades). The science and mathematics classes we observed for these grades appeared to be taught through relatively traditional methods (e.g., lectures, group and individual practice, discussion). In the ninth grade physics class, students covered acceleration and Newton's laws through mini-lectures, in-class and homework worksheets, and some laboratory exercises and projects. Similarly, in the 10th grade chemistry

class that we observed, instruction seemed to follow a structured framework, starting with "do now" hooks at the beginning of the class to capture students' attention and relate back to prior knowledge, and moving on to mini-lectures and classroom discussions where the teacher elicited understanding through active and thoughtful questioning of the students. This class included some traditional laboratory exercises, such as experiments demonstrating the principles around limiting reagents and percent yields. The chemistry teachers in a science teacher focus group estimated that they spent only about 5% to 10% of their class time in laboratory activities. One chemistry teacher indicated that the students were occasionally responsible for figuring out and writing up their own procedures for the laboratory activities, and that students used their knowledge of the chemistry content and their understanding of the goals and purposes of the activity to do so. As one of the chemistry teachers explained, early lab activities were often "similar to an experiment that they will have to do on their own later, which will be completely on their own, so this lab provides a foundation they will need to refer to later." Another science teacher indicated that she had introduced some more demanding inquiry-based projects into her class, with plenty of scaffolding put in place to support the students.

The science teachers talked in their focus group about working to include more project-based learning activities and adding more hands-on project work into their courses. They were thinking through how best to foster student collaboration on written lab reports while still maintaining their expectations for individual accountability. Another issue they talked about was the amount of effort that was required of teachers since DSST: Stapleton's teachers were responsible for developing their own curricula, with minimal reliance on published curricula such as textbooks. More details about this aspect of teacher work are included in the section entitled *Well-Prepared Teaching Staff*.

In contrast, the Creative Engineering class taken by ninth graders (added to the curriculum in 2011) was primarily taught through project-based instructional approaches. The Creative Engineering class met two to three times each week for longer periods compared to other STEM classes that met daily for a standard class period. The Creative Engineering teacher described the focus of this class as introducing students to the engineering design process and supporting them in learning how to plan out experimental designs and data collection processes. Other emphases were on the development of collaborative learning skills (the projects were done in small groups) and habits of mind such as planning and meeting deadlines.

In a focus group with engineering teachers, one teacher said that students were "not necessarily scored on knowing engineering facts or concepts," as subject matter content was not the main priority of the class. Nevertheless, they described projects assigned in Creative Engineering as incorporating important and relevant scientific concepts and processes. Physics, mathematics, and engineering concepts were covered through projects such as building mini-catapults and a scale model of the classroom. Additionally, engineering teachers indicated that students were given a lot of freedom on their approach to working through challenging projects, and they were required to problem solve and figure out how to overcome any obstacles in their design work via trial and error techniques, collaboration with teammates, and changes and revisions to designs based on collected data. They also reported that this open, project-based approach had successfully led their students to develop certain critical skills. For example, they said that incoming freshmen tended to be reliant on having very specific instructions for school

assignments, including prescribed, exact steps to take to achieve a pre-determined result. In Creative Engineering, students were not given specific step-by-step instructions on how to complete their tasks; they were instead merely given a project goal and time to complete it. The teachers said that, over time, their students had become better able to verbalize and articulate areas of confusion, rather than simply ignoring or giving up. However, the Creative Engineering teachers expressed some concern about students' learning of subject matter content. As one teacher explained,

I feel good about what is going in this class, but I also feel like it's hard to measure what's going on…A lot of the students might say they're learning how to work with other people and managing their time, but I wonder about the rigor, and whether we should be throwing in some harder stuff.

One change that this teacher reported implementing for the current year's class was to add a performance piece to the requirements for each project, which held the students accountable for creating a product that actually worked, such as the mini-catapult. The scoring rubric for these projects covered evaluations of issues including the students' processes in building the product, their use of data to inform their design, and an assessment of how well their products performed. In other words, rather than focusing completely on the group work and completion of the tasks, students were also accountable for the science that went into creating a working product.

In a ninth grade focus group, students said they appreciated what they learned from this Creative Engineering class, or as one student put it, "This class was really pretty legit." One of their teachers expressed the opinion that projects in this class also served to create a certain level of engagement and excitement about learning science for these freshman students, contrasting the experiences of students who advanced into DSST: Stapleton after attending the co-located middle school:

[The students] coming from the DSST middle school, they're tired of the repetition: every class has the 'do now,' the 'instruction,' the 'mastery check.' They feel more autonomous in this class because it's different. We don't usually do the 'do now.' It's more hands-on…I think it's the nature of the course, so different from other courses.

The other STEM teachers at DSST: Stapleton seemed equally aware of the instructional strategies that they implemented in their respective classrooms. For example, in a focus group mathematics teachers reported that they very deliberately employed spiraling techniques in their classrooms, allowing for constant reinforcement of the content that was covered in their classes. The Integrated Algebra teacher incorporated a variety of media through which students communicated mathematics concepts, including graphing calculators, paper and pencil graphs and sketches, and programs on their laptop computers. A biology teacher indicated in a post-observation interview that he used a partially flipped classroom model (cf. Tucker, 2012) for his instruction, with students doing some of their investigations into biological concepts at home, leaving class time available for group discussions and work. As he explained,

I don't believe in fully flipped classrooms—the problem is pacing, some kids go so fast, and the assessments get hard. If you go fully flipped, you also lose opportunity for peer support… I

prefer the version of flipping where some happens at home, but in class we work on the same things together.

He also built significant group work into his biology class, with a number of projects covering topics such as cell structures, mitosis, transcription, and protein synthesis. He said that his aim, in fact, was to incorporate one large project as a summative assignment every trimester, including a protein-folding project where the students would design and manipulate a real-world protein using a complex computer program. Students in the ninth grade focus group remarked that this biology course was very challenging, with many writing components in their assessments, but they also noted that they had many opportunities to display their work creatively through the projects that have been assigned in the class.

In addition to focusing on how their students learn the content matter of their courses, all of the teachers at DSST: Stapleton we spoke with seemed intent on making sure that their students developed strong non-cognitive skills such as perseverance or "grit" early on in their time at the school. As already noted, the engineering teachers talked about using students' initial frustrations and failures with first prototypes as learning opportunities for how to deal with such stress when there were no prescribed steps to follow for a solution. Additionally, an Integrated Math teacher said he encouraged students to persevere through the difficult equations and to initiate their own problem solving skills for overcoming obstacles when they were stuck, rather than depending on the teacher to provide the answers for them. The English teacher used writing projects to teach students critical thinking and research skills so that students could determine on their own which sources were credible. This drive toward student initiative and independence was something that seemed to permeate the school, and is discussed further in the *Emergent Themes* section.

2.3.2.3.2. Eleventh and twelfth grade experiences. The work that the teachers and students did in engaging in rigorous STEM-content-knowledge learning and the acquisition of critical thinking skills in the ninth and tenth grades was intended to set the foundation for the students' experiences in DSST: Stapleton's Senior Academy (11^{th} and 12^{th} grades), as mentioned in the beginning of this Implementation section. In Senior Academy, in addition to their required classes, students took on learning experiences that were designed to enable the application of their STEM content knowledge in real-world contexts.

In the 11^{th} grade, students were required to complete an internship outside of school. According to the Internship Coordinators who worked with the students during their internship work phase, these internships were evaluated on several components, including journals students kept throughout the experience and other written products they completed with their internship mentors. Most important, according to the internship coordinator, were the presentations that students gave, both in class and during a school-wide poster showcase after they completed their internships. For these events, students produced a trifold poster board and gave a five-minute PowerPoint or video presentation to the community. The showcase ultimately served as a celebration of their internship accomplishments. Through this work, and through the support provided by the school staff around the design and creation of effective presentations, the students could develop valuable 21st century skills of communication, collaboration, technology use, and creativity, in addition to the career experiences and skills they gained while at the internships.

The 12th grade experience for the students at DSST: Stapleton served as a culminating learning experience to encompass all of the content and skills that they acquired in their time at the school. To this end, seniors completed a senior project, and their work on this project made up a significant portion of their whole school year. In addition to their senior projects, 12th graders took one of two STEM courses: a combined biochemistry/biotechnology course, or a combined AP physics/engineering course. The latter was limited to students who had already completed pre-calculus, a graduation requirement for all students, and had passed or were taking AP calculus. As we learned in teacher focus groups and interviews with administrators, these Senior Academy courses, made up of two class periods, a content class and an application class, were much more explicitly oriented towards giving the students opportunities to apply their STEM knowledge to real-world contexts, and were reported to be more centered on project-based instruction than in earlier grades. The physics/engineering course, for example, was structured around five main projects over the course of the year. Students typically had one to two months to complete their projects, and there was very little direct instruction that the teachers provided. Instead, students were given the project goals and the rubrics for how they would be assessed, and the students were required to figure out how to complete the project. Throughout the year, the students were responsible for structuring their time and independently determining how to manage their projects, and building on the skills they learned during their ninth, 10th and 11th grade years. Similarly, the biochemistry/biotechnology course was more heavily weighted towards hands-on laboratory experiments than the introductory biology course. As an example, the curriculum included DNA sequencing and cloning lab activities, and the students were routinely working with professional level equipment as they grew specimens and inserted specific genetic sequences into bacterial plasmids. The teacher explained,

There are lab-based skills—I do want them to come out of this class knowing how to use various equipment, how to think like a scientist…understanding why you're doing a certain step. It's not just a cookie cutter lab.

For their year-long senior project, seniors were expected to explore a community-based topic in which they had a personal interest or a passion. All seniors were expected to immerse themselves in their topics, develop a rigorous understanding, and produce an authentic, tangible product. During first trimester, seniors took a civics class that helped them couch their project work into the real-world context of their topic. This project culminated in a 30-minute defense-style presentation to a panel of 4 to 6 adults for a summative grade. The senior projects covered a wide range of topics, including some that were STEM-related. For example, prior senior projects included a thesis on the relationship between cholera and cystic fibrosis, experimentation with slime mold, and an investigation into a local stream table. Further discussion of junior internships and senior projects occurs in the section *Blended Formal / Informal Learning Beyond the Typical School Day / Week / Year*.

2.3.2.4. Summary.

DSST: Stapleton was a school that employed a thoughtful, deliberate structure for its students to learn high-level, rigorous science content followed by a focus on application of that knowledge in authentic learning experiences. Although their ninth and 10th grade science and mathematics classes appeared to be relatively traditionally taught, the teachers at DSST: Stapleton appeared to

be very conscious of, and took great care in building on, students' prior knowledge, as well as developing habits of mind and non-cognitive skills supportive of learning rigorous content. This preparation was to come to fruition in junior and senior years, when student experiences extended into the application of the content knowledge they had acquired and more intense development of skills, such as science laboratory skills. The internship showcase presentation was designed to further develop 21st century communication and collaboration skills. Senior projects and 12th grade STEM courses incorporated more project-based learning and labs that built on the independence and critical thinking abilities that students had developed.

That said, teachers described constantly looking to improve their practices and build more innovative, project-based instructional practices into their classes. The ninth grade Creative Engineering class, with the project-based structure that defined the instructional approach in that course, was one visible example of this initiative. As the school's director described,

We will continue to push our engineering and applied math sciences to look outside of the classroom. We've done a good job making sure they're [the students are] academically ready, but let's go and see what's happening in those engineering and applied science and math courses to figure out what partnerships and experiences we can create…In the process, let's make it a more engaging school where there's more project-based learning [and] innovation for the students in the classroom. If they own their learning, it will be a good step for us.

2.3.3. Integrated Innovative Technology Use (CC3)

2.3.3.1. Definition.

Technology connects students with information systems, models, databases, STEM research; teachers; mentors; social networking resources for STEM ideas, during and outside the school day

2.3.3.2. Design.

DSST: Stapleton students did not take technology courses although there was one at the DSST middle school. DSST: Stapleton had a one-to-one laptop program, similar to all the schools in the DSST network. Technology managers interviewed indicated that these laptops were customized for DSST by their partner, Dell, to provide robust wireless connectivity to the Internet and support a variety of software tools. The student handbook and technology use agreement required students to follow DSST technology use protocols. Some requirements were fairly typical for a school setting, including prohibitions for emailing during class or playing music out loud during school hours. The technology use agreement also had more novel clauses such as "students will learn and exercise skills to undertake basic troubleshooting."

Technology was woven into the daily activities of instruction, assessment, and communication at DSST. Administrators and teachers described the ability to monitor student performance through the technology-based assessment and student data systems. For example, they tracked student performance in order to identify students who needed to attend Refocus or College Prep (see the sections *Well-prepared Teaching Staff* and *Supports for Underrepresented Students* for more information). This information was displayed on monitors at the entrance of the school each

morning. DSSST: Stapleton also relied on technology to communicate efficiently with teachers, students, and parents.

DSST: Stapleton had a dedicated technical support staff member who managed the technology systems and programs. School director Heffron discussed raising private capital to support technology in the network's schools. DSST: Stapleton also had a biotechnology lab funded by a $50,000 grant that included the equipment needed to conduct biotechnology labs as well as microscopes with built-in cameras. All classrooms had projectors and SMART Boards.

2.3.3.3. Implementation.

DSST: Stapleton students, teachers, and parents used information technology, as described in the following sections. Although we did not observe students making extensive use of instructional technology to learn science, math, or other subjects, there was strong evidence of technology's integral role in supporting communication and productivity within the school.

2.3.3.3.1. Student technology use. Students were loaned laptops three weeks into the school year for use in classroom and homework-related activities. Students were required to agree to a strict technology use code that outlined approved uses of laptops and other electronic devices. We witnessed some opportunities for DSST students to use technology in classroom learning activities. Teachers and students conveyed that science classes could use probeware, and an engineering class had incorporated Google *Sketchup*. One student described creating an animation to illustrate cell mitosis for biology class, and some use was made of *Geometer's Sketchpad* in mathematics classes. We also observed the usage of Khan Academy courses to help lower-performing students catch up to the rest of their class. Students in focus groups verified that they took examinations online and had online access to their scores and other grades. The school counselor also discussed using *Naviance*, a college-planning tool, with students. More sophisticated uses of technology were sometimes available through junior year internships. We were told about an internship at a flight museum where a student used Google *Sketchup* to design and optimize the floor plan layout for the museum.

2.3.3.3.2. Productivity. Teachers discussed putting all of their course materials on a digital shared drive. Students accessed these materials through their laptops and the school's high-speed network. The technology use agreement allowed all students to take their laptops home with them; however the special educator coordinator indicated that some students with a special education designation could also access the shared drive from home.

We observed several classes in which students opened up their computers and began working on a "Do It Now" assignment after they entered a classroom. These assignments included downloading a packet their teacher posted on the shared drive, reading a passage and answering questions. The school did not have a library room; essentially the Internet served as their library. School staff estimated that 70-75% of students had access to computers and the Internet at home even without the school's laptop program. Teachers claimed that they used to refrain from giving assignments requiring Internet access out of concern that some students would not have access at home, but it had become generally accepted to give such assignments because students could always complete them at school using DSST's wireless network.

2.3.3.3.3. Teacher technology use. Teachers in the focus group on use of technology described making heavy use of software for data collection and communication. In particular they described its use to support administering exams, storing data from these exams, sharing exam data with students, and analyzing exam data as part of reflecting on their practice. In addition, they regularly instant-messaged and emailed each other.

Teachers discussed using item generation, administration, and reporting software provided by DSST: Stapleton that made it easier to give frequent quizzes and keep track of where every student stood with respect to proficiency on each learning objective. They administered quizzes and examinations online. The *ExamView* software was used for constructing and administering tests. This software provided teachers with a summary of how well their students did on different instructional objectives collectively and individually. The school purchased *Kuda* software, which generated math problems for exams. They also used *ActivProgress*, a web-based data management system for taking exams and storing, analyzing, and communicating the examination results. Several teachers described using the data from online quizzes to plan differentiated instruction. One teacher provided each student with a customized report of the items he or she got incorrect on the quiz along with appropriate questions to review to address the standard covered by the quiz item. This practice required considerable upfront work as the teacher had to link exam questions to standards, and standards to alternative learning resources. One teacher suggested, "Without that [*ActivProgress/ ExamView*] platform, there's no way we'd be able to do this; no other way to track the standards." An English teacher described using *ActivProgress* to grade student essays and then set up differentiated learning stations where students who were weak in a specific skill could go work on that skill.

Teachers, however, did not claim to make comparable use of computer software for instructional purposes as for data collection and communication. One teacher expressed his attitude about this: "I am not a big fan of computers. Students use them to communicate but not about the math work." In contrast, another teacher commented that while the students used their laptops like notebooks, he had expected the school to make more innovative uses of technology.

Mathematics teachers mentioned use of Khan Academy and *Geometer's Sketchpad*, and uses of these learning tools were observed in a mathematics class, the former used by individual students in class working on a project. However instructional software use appeared to be relatively limited. One of the barriers to greater use of technology for learning or creating at DSST was the amount of time that such technology-based activities required. One teacher noted that each activity was evaluated with respect to how much time it required, "[It is] frowned upon to do activities that eat up the class period." A teacher in the same focus group reflected on a Google *SketchUp* activity (software for creating 3-D models) done the prior year: "That was cool but it was very time-consuming in that the kids didn't know how to use it [the software], and I didn't know how to use it, but I thought the kids created some pretty cool projects from that." Another teacher commented, "In [Prep Academy] physics, I can't say we use very much technology at all."

Some teachers appeared to recognize that they could do more with technology. For example, the biochemistry/biotechnology teacher described how a software program had been used for a protein folding activity the previous year and how he would like to build on this activity:

"Protein folding was random [last year] but this year it would be fun to try to manipulate and understand protein folding for real, with a computer program and real-life simulations." He noted that the online *FoldIt* game from the University of Washington would permit this.

The majority of the teachers who responded to the Teacher Survey administered before our research team visited DSST: Stapleton indicated that adequate time was available for training in technology use and that the technology was well maintained. They identified that the more limited time for integrating technology into school projects somewhat inhibited effective instruction using technology (see Tables 5 and 6).

Table 5

Access – technical considerations

Question – Rate your access to each of following	Scale 1-3*
Technical support for maintenance of technology	2.73
Technical support for student and faculty technology instruction	2.45
Time in the school schedule for projects involving technology integration	2.14
Student access to technology in their homes	2.59

[a]1= no access
2=limited access
3=adequate access

Table 6

Effect on Instruction – technical considerations

Question – Rate the effect of the following on your classroom instruction	Scale 1-5*
Technical support for maintenance of technology	4.22
Technical support for student and faculty technology instruction	4.26
Time in the school schedule for projects involving technology integration	3.64
Student access to technology in their homes	4.11

*1 = inhibits effective instruction, 2 = somewhat inhibits effective instruction
3 = neutral or mixed, 4 = somewhat facilitates effective instruction
5 = encourages or enables effective instruction

STEM teachers generally felt that the school had adequate hardware access for STEM instruction, but access to software and instructional technologies was more limited. However, they also indicated that these limits did not have a significant negative impact on classroom teaching (see Tables 7 and 8).

Table 7

Access – technology hardware and software

Question – Rate your access to each of following	Scale 1-3*
Access to calculators for STEM instruction	2.33
Access to computer hardware for STEM instruction	2.62

Access to computer software for STEM instruction	2.33
Access to other instructional technology for STEM instruction	2.00

[a]1= no access
2=limited access
3=adequate access

Table 8

Effect on Instruction – technology hardware and software

Question – Rate the effect of the following on your classroom instruction	Scale 1-5*
Access to calculators for STEM instruction	3.50
Access to computer hardware for STEM instruction	3.83
Access to computer software for STEM instruction	3.27
Access to other instructional technology for STEM instruction	2.78

*1 = inhibits effective instruction, 2 = somewhat inhibits effective instruction
3 = neutral or mixed, 4 = somewhat facilitates effective instruction
5 = encourages or enables effective instruction

2.3.3.3.4. Parent technology use. DSST: Stapleton used *Infinite Campus*, a program parents could log into to see their child's assignments and grades. A teacher told us that he believed approximately 65-70% of the parents had email access and received notifications about their child's progress.

2.3.3.4. Summary

Technology appeared to play an important role in DSST: Stapleton, but not the role that one might expect based on the inclusion of the word "Technology" in the school's name. Technology use for communication and as a means of data tracking was ubiquitous at DSST: Stapleton. Most members of the community were connected through the Internet, and students as well as their teachers, parents, and administrators could follow students' academic progress through the online data systems. Student lessons, some of which were individualized, were facilitated by an evaluation system linking standards, test and quiz items, and additional resources for review and relearning to achieve a 70% mastery level. Lab technology and software programs were used in some classes, but teacher survey responses indicated that DSST: Stapleton could do more to teach through technology or to teach technological design. However, none of the teachers indicated that this shortfall had an adverse effect on teaching.

2.3.4. Blended Formal / Informal Learning Beyond the Typical School Day / Week / Year (CC4)

2.3.4.1. Definition.

Learning opportunities are not bounded but ubiquitous. Learning spills into areas regarded as "informal STEM education." Include apprenticeships, mentoring, social networking and doing STEM in locations off of the school site, in the community, museums and STEM centers, and business and industry.

2.3.4.2. Design.

The founders of DSST: Stapleton claimed that they designed its academic programs to include a significant number of informal learning opportunities. This focus primarily manifested itself in DSST: Stapleton's senior year research project and junior year internships; however the school offered additional opportunities through its various extracurricular activities, including a robotics club, a service learning club, and career-related field trips. While some of these activities occurred during the typical school day, they often extended past core hours with the intent of using informal learning experiences to provide real-world learning.

2.3.4.3. Implementation.

DSST: Stapleton's implementation of its informal learning programs was perhaps even stronger than its design suggested. Specifically, teachers and local stakeholders supplemented the school's official offerings with additional informal learning opportunities designed to get students out of a purely academic environment to show them how their academic work fit into a larger world context.

2.3.4.3.1. Junior-year internships. DSST: Stapleton offered internships with nearby businesses as part of a formalized program for students in their junior year. These internships were offered at Siebold Engineering, Colorado University Health Services, Children's Hospital, Denver Museum of Nature and Science, Denver Zoo, and many other locations. Most internship placements occurred in STEM related organizations. DSST: Stapleton employed an internship coordinator who provided support during the students' junior and senior years. In order to plan for a successful internship, the internship coordinator met with each rising junior at the end of his or her sophomore year to discuss potential internship experiences, and students completed paperwork to indicate preferences. The internship coordinator then sought to make placements that would work for both the intern and the business, claiming a 97% success rate. While most internships were arranged through the internship coordinator, some ambitious students found opportunities on their own volition. For example, one student wanted to work at a TV station. He researched the local TV stations, contacted them on his own, gave them the relevant DSST: Stapleton paperwork, and eventually got the internship experience he desired through diligent self-advocacy.

The internship coordinator described how each year, the juniors were divided into three trimester internship groups that were predetermined by some of their coursework and other scheduling commitments—the level of Spanish they were taking, and their responsibilities to specific athletics teams. Each group engaged in their internship for one trimester, going to their internship site two days a week and meeting as a class at school one day a week. This class included discussion time with the coordinator of the internship program as well as the completion of a journal where students reflected on their internship experiences. Juniors were required to complete the internship program in order to graduate. If students did not pass the course, as judged by final presentations, or if they failed to perform or were not effective in their internships, they were removed from the program and were required to complete additional coursework in the summer.

Students had a wealth of experiences at their internships that varied in their depth and focus. There were some internships where students were primarily engaged in administrative activities. Other internships, particularly those in medical fields, could be much more in-depth. One

alumnus of DSST: Stapleton commented on the advantage his internships provided in helping him explore his career interests. While working at CU Medical campus, he said, "I did lots of cleaning & labeling test tubes, but also learned a lot about toxicology. That's why I'm a biochemical major now… I saw some really cool stuff and that got me more interested in engineering." He added, "It prepared me for college in that it was a lot of time management and a lot of work. But also it was genuinely fun."

In order to evaluate the depth of these internships, the internship coordinator administered a survey at the end of every year to find out whether the internship met the students' expectations. Additionally, the internship coordinator discussed being in close contact and engaging in on-going conversations with the students' advisors at their internship placements.

Once internships were completed, the students gave public presentations to the school community detailing their experiences. Leading up to this experience, students were given instruction and guidance on how to properly give presentations in their weekly coordinator-led internship course that met concurrently with the internship experience. By the time students participated in the public presentation, they had already given a classroom presentation, and prepared a slideshow or a video in which they talked about what they learned. Students were evaluated by the presentation in class, and on the poster night intended to celebrate their accomplishments with the broader DSST: Stapleton community.

2.3.4.3.2. Senior project. Students completed a project in their senior year that the senior project coordinator described as being designed to let them be a part of a large-scale project from start to finish. Students were supported in this project by a group of teachers acting as project advisors. While describing the senior project, one senior project advisor said that it targets project management skills, presentation skills, and critical and inquiry based thinking.

The senior project was based on a topic of the student's choosing and culminated in a 10-20 page paper and a thesis-style project defense in front of a panel that included a mentor, teacher/administrators, and knowledgeable others in the community. Administrators suggested that the initial goal of the 11th grade internship program and the senior project was for students to develop an idea for the senior project during the junior year internship experience, and then follow up in the development of this idea through the senior project. However, the internship coordinator claimed that only about 8% of students have continued work from their junior-year internships on to the senior project. Senior projects have tended to be highly diverse. Some examples include an alumnus who said he "did a thesis on the relationship between cholera and cystic fibrosis…and made an interactive iBook for the iPad." Another student built a solar powered go-cart, another built synthesizers, and still another completed a project focusing on predicting population density in the western United States.

The senior project helped to develop students' 21st century skills (e.g. communication, collaboration, technology use, and creativity) and other non-cognitive skills that DSST teachers and advisors found to be important in a students' development. A senior project advisor passionately argued,

When given the chance to do something on their own, the kids' ability does not always translate [directly]. The senior project tries to teach that your abilities don't determine whether or not you have grit, whether you can push through a challenge. Can you think on your own? Can you synthesize information? Can you push through things? Can you do all these things so that when someone says, "You can do anything you want on your own," can they figure out what to do?

The senior project was also designed to show students how their coursework could relate to and impact the real world. One teacher described the programs' strengths and claimed,

We will continue to push what engineering and applied math sciences look [like] outside of the classroom. We've done a good job making sure they're academically ready, but let's go and see what's happening in those engineering and applied science and math courses [in college] to figure out what partnerships and experiences we can create that will do more than prepare students for the real obvious test score matches. The broader academic exploration and innovation skills they're maybe missing. In the process, make it a more engaging school where there's more project-based learning, innovation for the students in the classroom. If they own their learning, it will be a good step for us.

Much like the junior internships, the senior project was designed to expose students to potential future careers. An advisor claimed "they might find that even though they were passionate about this topic in class, they would never want to do that for a job or career. The opportunities provide real life experiences for the students."

2.3.4.3.3. Extracurricular activities. One teacher at DSST: Stapleton suggested that the additional informal projects that students engaged in outside of school were even "more important than senior projects." This teacher suggested that these opportunities "expose our students to the world outside of our walls." These service projects included volunteering at a local food bank, and a yearly trip to Mexico. A frequent advisor and leader for these trips suggested,

These opportunities are here [for students] to learn that they can become leaders in our community, not just to learn how to be in school. To teach them that the learning has a purpose, it's not just to take a test. It's why I take 50 kids to Mexico to expose them to real poverty. Their[Mexico's] version of poverty is nothing like a slum in Denver. Versus showing kids living in shacks built with trash they found on the hillside… They learn that maybe this is a women's issue, maybe something else. We study a different issue every year… there are a lot of issues that we just don't deal with in a regular school day.

Additionally, some teachers scheduled trips to local cultural events. These included trips to nearby theaters to see Les Misérables, the Nutcracker ballet, the symphony, and other concerts to try to expose students to things beyond their immediate environment. DSST: Stapleton hosted fundraisers (e.g., bake sales) to fund these trips; however, students were often required to pay for these experiences. While these experiences were primarily focused on obtaining cultural experiences, they also connect to the school's STEM focus. One teacher gave an example of how these experiences related to the STEM focus of the school:

We help the students realize that they can be engineers in the arts. Could be a sound engineer, or do set design. They could be a design engineer or a musical technician. [These experiences] broaden the scope of what the students believe about the work.

2.3.4.4. Summary.

DSST: Stapleton's informal learning activities, especially the junior internships and senior projects, gave students insights into how their classwork could lead to careers and otherwise impact the world in beneficial ways. Some of these activities were related to the school's stated STEM-focus, but others, such as field trips and service projects, were simply focused on letting students interact with their world in a professional and social manner. The internships, senior projects, and extracurricular activities operated together to provide students with relevant experiences in the professional world, helping students become better able to succeed in college and more knowledgeable about careers they may want to eventually pursue.

2.3.5. Real-World STEM Partnerships (CC5)

2.3.5.1. Definition.

Students connect to business/ industry/world of work via mentorships, internships, or projects that occur within or outside the normal school day/year.

2.3.5.2. Design.

DSST: Stapleton administrators expressed their belief that all students should have real-world internship and research experiences. To that end, DSST: Stapleton developed partnerships with several local organizations. Representatives of these organizations sat on DSST's board of directors and offered internship and research opportunities for DSST: Stapleton students in the 11^{th} and 12^{th} grades. These partners were not involved in day-to-day curriculum development; however, they did help with board level decision-making.

DSST: Stapleton juniors spent afternoons approximately two days a week for one trimester on their junior year interning with local organizations. Seniors worked on research projects for a similar length of time that was meant to act as a capstone project. These internships and research projects were coordinated by DSST: Stapleton and the business partners themselves. Previous internship opportunities included working at universities like CU Boulder, labs, engineering firms, architecture firms, museums, and zoos. (For additional information about junior internships and senior projects, see *Blended Formal / Informal Learning Beyond the Typical School Day / Week / Year*.)

2.3.5.3. Implementation.

DSST: Stapleton made a strong effort to develop relationships with nearby organizations in order to provide improved learning experiences for its students. Some of these partnerships helped DSST: Stapleton with its internship program and its senior projects. Business personnel also served as panelists for student presentations, and welcomed students on field trips. As described in the *Blended Formal / Informal Learning Beyond the Typical School Day / Week / Year* section, DSST: Stapleton had partnerships with several organizations that included Siebold Engineering, CU Health Services, Children's Hospital, Denver Museum of Nature and Science, and the Denver Zoo. The internship coordinator at the school was proactive and continually

worked to develop new relationships with local organizations. The coordinator claimed, "We try to make connections, partnerships with a variety of businesses and opportunities."

This focus on partnerships extended to the administration as well. Bill Kurtz, CEO, recently said, "We need all the help we can get." This was echoed by another member of the Home Office team, "There's not an arrogance about how great we are. The room for improvement is so vast. We need help. We're here because this is a community-focused priority."

2.3.5.3.1. ***Partnership with CU Boulder***. DSST: Stapleton administrators described a very strong relationship with CU Boulder, and explained that representatives from the university were instrumental in the founding of DSST: Stapleton. This relationship provided DSST: Stapleton students with access to the university for tours, engineering experience days, and an automatic admissions process. One administrator at DSST's Home Office discussed this relationship:

We're different from a lot of [schools] in that way. It's a piece we've worked really hard on. We've created partnerships with universities; obviously CU Boulder has been our partner here. The medical campus is our partner for our second campus. We are really trying to integrate the resources, the opportunities, getting kids to really access those opportunities with those partners. CU has been a big part of our programming from the very beginning. The board had folks from CU on it, from the engineering school. They've been very helpful. So we think this is an important part of the model. They have great resources, and we want our kids to hopefully access that, so we want to lower those barriers. We have automatic admissions agreements with those schools. We're trying to lower those barriers for kids to enter STEM fields of study in college.

The university hosted an annual trip for the entire ninth grade class at DSST: Stapleton to travel to CU Boulder to do hands-on engineering work. A CU Boulder administrator described the trip:

They spend the whole day. They are incredibly demanding difficult days for us because we actually he have them [the students] building levies. For many of them this is the first introduction to a college campus. This is sort of what the partnership is. It's just bringing the kids to the campus for the day.

Students from DSST: Stapleton were offered "guaranteed admission" if they reached a series of performance benchmarks in their studies. This automatic admissions process benefited the university as well as the DSST: Stapleton students. One university administrator suggested that their student population's GPA had been positively affected by the influx of DSST: Stapleton students. The university had some concerns about being regarded by DSST: Stapleton students as "too easy to get into," however an administrator at the university said "We've got to look at the big picture. We're not doing it as a pipeline to us. We are doing it as a transformative model that can be replicated around the nation."

2.3.5.4. Summary.

DSST: Stapleton had partnerships with business, industry, and academia primarily to support its students in their internship and senior project experiences. Some of these relationships began through original members of the board and others developed as students and teachers reached out

into the community. DSST: Stapleton sought new partnerships with nearby organizations in order to ensure that students were given access to real-world work opportunities, which in turn supported both the formal and informal learning structures at the school. DSST: Stapleton's industry partners had a strong impact on the school in its early days, specifically in terms of providing support for its founding and by working on the DSST network's board. At the time of the visit, the school's partners primarily operated as a resource for current students. These relationships typically took the form of job/internship opportunities or through unique college-related opportunities. Thus, DSST: Stapleton drew from the broader community of local organizations to help its students develop skills and gain knowledge of the world of work or, in some cases, the world of academic research.

2.3.6. Early College Level Coursework (CC6)

2.3.6.1. Definition.

School schedule is flexible, and designed to provide opportunities for students to take classes at institutions of higher education or online.

2.3.6.2. Design.

Administrators at DSST: Stapleton explained that its primary goal was not to promote students taking college level courses during high school but rather to ensure that students were prepared through solid foundational coursework to enter college and to graduate from college. To that end, the intent was to offer a rigorous program of high school science and mathematics courses while providing differentiated instruction and support to meet the needs of the majority of the students. Students who excelled in their academics had opportunities to participate in college level work through a few Advanced Placement course offerings or an equivalent DSST version designated with an "X" (explained below), or through courses taken at the local community college.

2.3.6.3. Implementation.

Administrators explained that although DSST: Stapleton did not offer a wide variety of Advanced Placement (AP) courses, the school did offer several options for AP credits along with additional college level opportunities. In mathematics, students had the opportunity to take AP Calculus, with both AB and BC courses offered. Because students entered DSST: Stapleton's ninth grade with a range of mathematics achievement, they began their mathematics coursework at either the typical Integrated Algebra/Geometry I level or at a more advanced level, such as Integrated Algebra/Geometry II, or Algebra 2. Those students who started at this advanced level were able to take the AP Calculus AB or BC course their senior year, with the remaining students taking Pre-calculus, which was required for graduation at DSST: Stapleton. Additionally, a few DSST: Stapleton students who excelled in AP level mathematics coursework could choose to take more advanced college level coursework at the local community college. During the 2012-2013 school year, there were five students taking advanced mathematics classes at the community college. The community college was 15 minutes away, and students signed out of the high school during the day to attend the community college classes.

In the sciences, students who were co-enrolled or previously enrolled in AP Calculus were able to take AP Physics C: Mechanics. The Biology-X teacher noted that the AP curriculum was turning away from breadth and going toward depth. Teachers could, therefore, focus their AP

curriculum on topics they liked and go in depth on those topics. The physics teacher was pleased that the College Board was finally doing this since he had already been using this instructional strategy. In biology, although there was no official AP Biology course offered at DSST: Stapleton, students interested in accelerating in biology – and who received a recommendation from their sophomore year chemistry teacher – enrolled in "Biology-X" their junior year and Biochemistry their senior year, both of which included advanced coursework with some at the college level. The *"X"* in the course name indicated that the curriculum was intended to prepare students for the AP exam. The stronger emphasis on the AP Biology exam on genetics, interactions, and biological patterns conformed well with the way DSST: Stapleton teachers were already teaching Biology-X, and they accordingly expected to see their students perform as well as or better on the revised AP exam. Previously, the school made a conscious decision not to label the accelerated biology course as "AP Biology" because, wanting flexibility to select more varied curricula, they chose not to conform to the AP prescribed curricular requirements.

Like the teachers of the AP Physics and Biology-X courses, the Biochemistry teacher created the course curriculum based on his own strengths and passions, combining microbiology with biochemistry and neurobiology topics. The teacher described the power of this approach, linking it to the success of their students on the AP Biology exam:

I put a course together of the best things I've ever taught...It's a conglomeration of things that I like to teach. One thing I noticed with things like AP Bio here is that you teach what you like, you do a really good job with it, the kids see your passion, it translates over to their passion - so you like what you teach, as opposed to someone telling you to teach to a test. This is what you have to cover, etc. We had the best results ever in AP Bio because of that passion and what I like and do really well, and they did really great.

In the humanities, DSST: Stapleton offered a course designated American History-X, which prepared students to take the AP US History exam. Students did not get additional GPA weighting on their school transcripts for these AP classes. Depending on a particular class, there may have been before or after school support for additional AP exam preparation support.

2.3.6.4. Summary.

Taking college courses during high school was not a priority at DSST: Stapleton. The rigorous college preparatory curricula—supplemented with opportunities for additional rigor through individualized honors agreements for particular courses or AP level courses in STEM content areas, as shown in Table 4—was designed to meet the needs of DSST: Stapleton students in preparing them to be ready for college, including STEM majors. Additionally, although heterogeneous grouping was the norm in core classes except mathematics, school administrators explained that adequate differentiation was provided within the classroom to enable interested students to take AP exams in several subjects. After completing core coursework, as described in the section *STEM-Focused Curriculum*, students could take college level coursework in Biochemistry/Biotechnology, or for those demonstrating strength in mathematics, AP Calculus AB and BC and Advanced Creative Engineering/AP Physics. Therefore, administrators asserted that there was little if any need for a DSST: Stapleton student to seek additional college level science or mathematics classes elsewhere; the few students who did exceed the school's offerings were able to take appropriate courses at the local community college.

2.3.7. Well-prepared Teaching Staff (CC7)

2.3.7.1. Definition.
Teachers are qualified and have advanced STEM content knowledge and/or practical experience in STEM careers.

2.3.7.2. Design.
The DSST website described a geographically diverse teaching staff with a collective calling to DSST's mission and collaborative approach: "[DSST teachers come] from all across the country with a deep belief in our mission and a desire to work collaboratively to reach it."

In addition, DSST's website highlighted a strong culture of teacher mentoring where teachers "receive a tremendous amount of feedback and support on their mission to become the best educators they can be." In their job descriptions, DSST: Stapleton described a search for teachers motivated to join a community of educators to challenge students, to be willing to work with some autonomy, and to contribute to the overall school learning environment. They sought:

[teachers] with a track record of raising student achievement to join a team of educators dedicated to providing a rigorous college preparatory program to a diverse population. At DSST Public Schools, teachers are leaders who are responsible for developing and implementing DSST's curriculum. Teachers also play an integral role in ensuring student success through the support of our school culture, the development and instruction of a rigorous core curriculum, and the use of data to drive their daily practice.

As a *100K in 10* partnership school, DSST identified a commitment to "providing resources to support the training and retention of great STEM teachers to help further the craft of STEM teaching." As such, the DSST website articulated the importance of learning throughout the community when they say, "As a learning organization, DSST is committed to making sure that we can continue to learn from each other at all levels, across all campuses." The DSST Core Values (see section 2.1 First Impressions), also listed on the school website were intended for the whole community:

2.3.7.3. Implementation. The DSST: Stapleton administrators explained that the teaching staff was intentionally and thoughtfully hired. Candidates were sought out who had strong content knowledge in their fields, a passion for teaching, and an interest in carrying out the DSST mission and vision in a collaborative and cooperative environment. The DSST: Stapleton teachers worked "in an environment that upholds high expectations for students in their actions and their academics" (DSST website). Teachers described engaging in continuous and ongoing reflection on student performance to drive decision-making and actions to both support and challenge students in their learning. Like their students, teachers also described being held to similarly high standards, as they were observed regularly by the deans and school director, provided guidance on the effective use of learning strategies, and given thoughtful feedback to enable them to become the best teachers they could be.

During our site visit, we observed that DSST: Stapleton community members seemed to live and breathe the school's philosophy, with the most significant translation occurring in classrooms. The DSST Core Values were visible on the walls of every classroom, and appeared to permeate the school culture, providing structure and direction for teachers' as well as students' efforts.
According to the DSST network CEO, as a public charter school, the DSST network had the flexibility to hire teachers who were philosophically aligned with DSST. Looking for teachers with about 3-5 years of teaching experience, who were high achievers and high performers, DSST additionally sought out those with a demonstrated history of persistence and "grit" in their teaching, whom the CEO described as those who "won't take 'no' for an answer," and "are able to push through" challenging circumstances.

The Director of Curriculum and Instruction explained that the Home Office began the teacher hiring process of recruiting, screening, and narrowing down the pool of applicants. After an initial screening of applications, the candidates who appeared to possess the necessary characteristics were asked to respond in writing to a series of questions asking why the Core Values and the school's mission were appealing to them. DSST looked for "a total fit" in the teachers they selected—solid content knowledge, mission-driven efforts, and a collaborative work ethic. The school directors joined in to participate in second round interviews and to make final teacher placements.

One particular group of teacher candidates who were perceived to possess many of the characteristics DSST sought were *Teach for America* alumni. One Board Member described the reasoning for this preference: "Last year TFA had 50,000 applicants for 6000 slots, a 12% admission rate…and most of the kids applying for TFA are really in the top of their college classes at elite universities. That's pretty steep competition." Since many of the TFA teachers work in challenging environments—many in urban districts—this preparation was viewed as "trial by fire" before they even came to DSST. The teachers who persisted through TFA, maintaining an interest in teaching, demonstrated the grit that was foundational to teaching at DSST.

2.3.7.3.1. Who were the teachers? Thirty-one DSST: Stapleton teachers overall responded to the Teacher Survey administered before the researchers began the site visit. Fifteen of these teachers identified themselves as STEM teachers. The STEM teachers included five females and 10 males, with 93% of the total self-identifying as white and 13% as Asian. These numbers add up to greater than 100% because it was possible for individuals to select more than one race. With an age range from under 25 to 49, the majority of respondents were in the 25-29 age range, had been working as a STEM teacher for an average of 6.2 years, with a median of 4.5, a mode of 3, and a range from 2 to 20 years. The teachers were a cosmopolitan array coming from colleges and universities across the country. Most held bachelor's degrees and teaching certifications in the subject areas they were teaching. About a third of the STEM teachers had significant research experiences, and many had previously worked with youth in summer camps, field experiences, as academic or athletic coaches, or as tutors. According to survey responses, many teachers sought out DSST: Stapleton because of its STEM focus, its integrated community, or its culture.

2.3.7.3.2. Teacher responsibilities. Teachers and administrators at DSST: Stapleton described teachers undertaking a variety of responsibilities that went well beyond independent teaching in

an isolated classroom. In addition to preparing and carrying out lessons that clearly differentiated instruction for the heterogeneous levels of student ability in their classrooms, teachers were responsible for staying on top of student performance, both academic and behavioral, on a daily basis. The structure of immediate accountability formed the foundation of the school environment and each classroom experience, especially in the Prep Academy (grades 9 and 10). At the beginning of the day, or the class, student completion of homework was assessed and any incomplete work was immediately met with an assignment to a *College Prep* session meeting that afternoon after school for the student to finish it. Behavioral infractions were met with formatted and predictable teacher response, and could lead to an assignment to an after school *Refocus* session, or other disciplinary response addressed by the academic deans. The structure of classroom time, which might appear constraining at first, was prescribed and organized to achieve maximum time on task. This predictable structure, which began in the middle school, diminished as students moved into the Senior Academy, but rights, responsibilities, and consequences were never far from everyone's focus. One Senior Academy teacher commented that the consistently reinforced behavioral and academic structures carried out throughout the students' earlier years at DSST: Stapleton, allowed him to spend the majority of his time on teaching because other problems simply ceased to exist.

2.3.7.3.3. Curriculum and standards. While the standards for teaching were clear and well defined, the curriculum for each class at DSST: Stapleton was less so. The administrators and teachers described standardized pedagogical approaches, especially for teachers new to DSST, and particularly those teaching in the Prep Academy. All teachers were aware of the local and state content area standards, and courses were designed with college success in mind, but teachers reported having much autonomy in how the course content was taught within their individual classrooms. There were structured requirements for planning and preparation, again particularly for new teachers, that included the use of common language and processes for classroom management, and instructional differentiation for the heterogeneous classroom.

When asked about course curricula, a mathematics teacher commented, "Most everything used in this grade is created by me… and I am always trolling and finding different things." When speaking about the use of standards, a science teacher stated, "We have, over the years I've been here, largely written the standards ourselves very much based on national standards and Colorado standards; we use those as a very strong guideline." An English teacher added, "I mostly use self-created materials. I will access all that's available now from [other DSST] teachers. I'd say the class does not subscribe to any outside program."

This lack of curricular standardization and structure was met differently by teachers at either end of the teaching-experience spectrum. The opportunity for autonomy in curriculum development invigorated the more experienced senior teachers, but was found to be demanding and challenging for a teacher fresh out of a science content background with minimal teaching experience. Several less-senior, but certainly dedicated teachers questioned whether they would be able to keep up the pace of writing multiple levels of lesson plans for every class without a solid curriculum to work from. Creating everything from scratch with limited educational experience presented fairly significant challenges. As stated by one of the newer teachers, "Having a set curriculum would have been helpful, especially as a new teacher. At least to start with."

The freedom from standardized curriculum energized those teachers who have had a chance to hone their skills, providing autonomy by allowing creative interpretation of the standards, and teaching to one's expertise. One teacher described his experiences, "I was worried coming in to DSST that it was too rigid…but it's not that way in reality once you get more experience." And another teacher appreciated the flexibility "that you teach what you like, you do a really good job with it, the kids see your passion, it translates over to their passion—so you like what you teach, as opposed to someone telling you to teach to a test."

2.3.7.3.4. Teacher professional development and support. The Director of Curriculum and Instruction explained that teachers new to DSST began with three additional days of training before the school year started, an instruction day, a culture day, and an application day, when they worked on projects such as curriculum maps and culture plans. In addition to this formal system at the beginning of the year, there were new-teacher training sessions each month, sometimes run by home office and others at the school level. Also, beginning teachers were regularly observed in the classroom. As described by one newer teacher, "The new teachers spend a lot of time with administration; get provided a lot of feedback and observation time so they can grow." New teachers generally felt that they had significant emotional support, and were well versed in the structures for classroom management, but felt less supported when they struggled with course content or curriculum design as mentioned previously.

Professional development for all teachers included regularly occurring in-house workshops led by the Home Office or the school on a perceived topic of significance such as using student data to write lesson plans, building quality assessments, or bringing literacy into the content-area classrooms. On the Teacher Survey, the majority of the teachers said that their recent professional development experiences either confirmed what they were already doing or caused them to change their practices with respect to research-based practices. The influence appeared to be more significant when the professional development was related to practices such as problem-based or project-based learning, inquiry/investigation-oriented teaching strategies, or the use of engineering or design concepts and activities. Interestingly, the effects of this professional development on STEM content knowledge, understanding student thinking in STEM and helping students perform STEM related research appeared to be stronger among the *non*-STEM teachers than the STEM teachers. The AP workshops attended by teachers who taught any of the AP courses seemed to be universally appreciated.

Referring to their level of confidence in using various strategies in the classroom, teachers were generally confident that their abilities supported their efforts to engage students in reform-based practices and encourage interest and participation in the STEM fields. (See Table 9.) Teachers were relatively less confident in involving parents in the STEM education of their students.

Table 9

STEM Teacher data for Pedagogical Strategies

Question - I am confident in my ability to:	Scale 1-5*
Lead a class of students using investigative strategies	3.7
Manage a class of students engaged in hands-on/project-based work	4.0
Help students take responsibility for their own learning	4.1

Recognize and respond to student diversity	4.2
Encourage students' interest in science	3.9
Use strategies that specifically encourage participation of females and minorities in STEM	3.6
Involve parents in the STEM education of their students	2.6

*1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree

Based on the Teacher Survey and subsequent discussions with teachers at DSST: Stapleton, while they felt confident using a variety of teaching strategies, the STEM teachers generally identified a desire to receive more STEM content support. In particular, teachers cited wanting professional development that would target additional content knowledge to teach the courses they were teaching, pedagogy on how to teach specific content areas, learning about different lab techniques, and knowledge about new advances in their fields. They also sought knowledge about research and practices in education outside of DSST, feeling that professional development on reform-based instruction such as inquiry teaching, project-based learning, and creative/design thinking instruction would be useful. In addition, a couple of the non-STEM teachers cited wanting more professional development on specifically incorporating engineering, blending the arts and sciences, and the use of project-based learning in their classrooms.

In addition to regular professional development to enhance the teaching experience, there was a pathway for teachers to advance into the administrative ranks if that was of interest to them. Administrators described the Emerging Leaders Program (ELP) as an offering within the DSST network that was designed to guide, train, and support teachers who were interested in taking on increased leadership roles in the schools. This program is discussed further in the section *Administrative Structure.*

2.3.7.3.5. Collaborative teaching. The teaching environment at DSST: Stapleton was collaborative. While there was little formal team teaching, teachers of similar courses, even those in different DSST network schools, described working toward the same standards and usually the same end-of-trimester exams. Teachers of sequential courses described collaborating to ensure that students were prepared for each subsequent course they took. Teachers described having regular time during the school day to plan together; departments met a couple of times a month, and grade-level teams met at the end of each trimester to use student exam performance and standards printouts correlating exam questions with course content standards to respond to individual student needs with respect to content mastery. In addition, school administrators described two weeks of scheduled teacher planning time during the summer before the school year began.

The above statements are reflected in data from the Teacher Survey in Tables 10 and 11 where teachers were asked to comment both on the time available for and the impact of various collaborative experiences. Teachers generally felt that they had adequate time to plan and prepare lessons and that this time effectively supported their instruction. They were slightly less positive about the time they had available to collaborate with each other, but felt that time they had was effectively used to enhance instruction. Time for professional development was perceived as slightly less than adequate, and teachers were not as positive about the effects of those opportunities on their classroom STEM instruction.

Table 10

Time for Collaboration

Question – Rate your access to the following resources:	Scale 1-3*
Time available for teachers to plan and prepare lessons	2.7
Time available for teachers to work with other teachers	2.4
Time available for teacher professional development	2.4

*1=no access, 2=limited access, 3=adequate access

Table 11

Value of Collaboration

Question – Rate the effect of your access to the following on your STEM instruction	Scale 1-5*
Time available for teachers to plan and prepare lessons	4.4
Time available for teachers to work with other teachers	4.0
Time available for teacher professional development	3.5

*1 = inhibits effective instruction, 2 = somewhat inhibits effective instruction
3 = neutral or mixed, 4 = somewhat facilitates effective instruction
5 = encourages or enables effective instruction

2.3.7.3.6. Teacher Evaluation. The DSST: Stapleton administrators explained that teachers were on a year-to-year contract, and the school was run somewhat as a meritocracy with individual accountability. Teacher success was compared between class sections, and student performance—both value added "growth data" and performance scores – represented 50% of the teacher evaluation. However, the comparison was used to help all teachers improve, with the comparisons used to determine what it was that one teacher did to help students be successful that other teachers could do to achieve a similar level of success. The intent was that these data would encourage collaboration rather than competition. The Dean of Curriculum and Instruction, who was responsible in part for hiring and training incoming teachers, was also responsible for ongoing support and teacher evaluation. In addition, teachers were evaluated by administrators, students, and peers in a "360" type evaluation process.

One teacher commented, "We are ranked all the time; we get lots of numbers" by students, observations by administrators, and peers. He also indicated "numbers and rankings can be degrading and depressing for teachers who genuinely want to do well." He alternately suggested that instead of numbers, comments on where improvements could be made with genuine feedback from colleagues and peers would be more helpful in a teacher's progress toward becoming a better teacher. Suggestions teachers gave on how to make the evaluation process better included the idea of expanding the DSST program to include a training school for teachers, where teachers would get training that was more supported than a typical "sink or swim" experience. Another teacher suggested, "We need to do better at celebrating teachers; we keep pushing for better and better, but we need to be careful with how we do that."

That said, teachers at DSST: Stapleton generally identified feeling that they belonged to a supportive community that was working toward a common goal, where they could share their concerns with the school administration, and they would be heard. Last year, according to one of

the deans "our teacher retention rate was 90% system-wide, network wide," which certainly spoke to a positive working environment for teachers. A comment from a board member summed up the teaching and learning experiences at DSST: Stapleton:

I would say that the school is a hard environment for teachers; the demands on them are so high, and staying the course is very, very tough. There isn't anything such as good enough [at DSST: Stapleton]. It's a hard school, but you're in an incredible learning community where everyone is learning. The teachers help each other; the teachers are part of a community that is so strong.

2.3.7.4. Summary.

Carefully selected teachers philosophically aligned with the DSST model worked with passion and diligence to carry out the school mission and vision through the school's Core Values. The teachers arrived at DSST: Stapleton with solid academic content area backgrounds and experiences, and were supported by the structures that normalize behavioral and pedagogical approaches within the classrooms and the school. The core values of DSST appeared to provide a formatted structure for teachers' behavioral and academic expectations of the students. However, there was freedom in academic curriculum design, which was advantageous to experienced teachers, but more challenging to those who were beginning their teaching careers. All teachers were focused on the goal of preparing students for college success and all standards and end-of-course exams were designed to guide the classroom teacher in shaping the learning experience in their classrooms. Like the philosophy of "gradual release" experienced by students as they progressed through the grade levels earning more responsibility as well as increased freedom, teachers also gained autonomy to infuse their own unique experiential knowledge and instructional strategies as they demonstrated their abilities to maintain student performance at the mastery levels. The culture of accountability left no community participant out of the equation, and teachers were held accountable for ensuring that students met their goals. Overall, a qualified STEM teaching staff was recruited and those we observed demonstrated high competence in helping students master difficult STEM coursework.

2.3.8. Inclusive STEM Mission (CC8)

2.3.8.1. Definition.

The school's stated goals are to prepare students for STEM, with emphasis on recruiting students from underrepresented groups.

2.3.8.2. Design.

DSST: Stapleton did not have a school-specific mission, but instead shared a mission and vision with the rest of the DSST network. The mission statement published in the Student Handbook was a network-wide statement that specifically identified preparing all students for success in college and modern society: "DSST Public Schools transforms urban public education by eliminating educational inequity and preparing all students for success in college and the 21st century."

DSST: Stapleton's vision statement echoed the mission statement, while also self-identifying as a school focused on mathematics, science, and English achievement through an innovative school model that "helps to redefine the American high school experience." Their vision

statement further elaborated their goal to "create an innovative school where students acquire a rigorous academic foundation that they can apply to the community and world around them in meaningful ways." In fact, as a public charter network, DSST had a charter contract with the Denver Public Schools with the following goals: (1) "To increase the number of underrepresented students who succeed in math, science and technology at the high school level, including girls and students from low-income families; and (2) to prepare all students to earn four-year college degrees."

2.3.8.3. Implementation. The two aspects of the school's mission—inclusiveness and STEM-focus—are discussed in the following subsections.

2.3.8.3.1. Inclusiveness. DSST: Stapleton guaranteed admission to students who graduated from a DSST middle school. One middle school was co-located with Stapleton High School and there were two other standalone middle schools. Other ninth and 10th grade slots were filled via a lottery conducted through the district. There were 1,400 applicants in the most recent year and the 40% of the slots were required to be filled with low-income students, as designated in DSST's charter. DSST: Stapleton's student body was 45% low income the year of our visit. Girls were not preferentially selected in the lottery but the school's student body was 52% to 53% female. Two-thirds of the students were minority students, including roughly one-third African American and one-third Hispanic. The remaining one-third identified as White or Asian. Thus, DSST: Stapleton High School did indeed serve a high percentage of students from groups underrepresented in STEM college majors and careers. DSST administrators felt their model demonstrated that academically average students could achieve in STEM education. According to the DSST CEO:

We basically said, 'hey, we can create great STEM schools for all kids. And we can demonstrate that all kids can access great STEM schools,' and I think that's been very important. I think we can compare our outcomes against anybody. And we feel we have broken that barrier of saying that only gifted and talented kids can study STEM.

DSST: Stapleton served special education students, although the school director indicated that DSST: Stapleton could not accommodate extremely high needs students since there was no pull-out program. There was one Special Education teacher who described serving about 20 students, about 4% of the student population. The school also served English language learners (ELL; see *Supports for Underrepresented Students*). One mathematics teacher described how she supported these students: "We just found out that of the 20 ELL ninth graders, I have 18 of them. The Word Wall [a visual learning strategy to support student learning of use of content terminology] will help and I want to work up a new format for note taking, using a graphic organizer."

Parents and students talked about how diverse and integrated the student body was. They took pride in their school and appreciated the lack of cliquish behavior. One parent attributed this to the fact that everybody took challenging classes, which held all students to the same high expectations. Teachers described how students monitored and addressed poor behavior among themselves, in terms of the school's core values. This was an indication that students lived the core values and held themselves and their peers accountable. Large banners were prominently displayed in the commons area citing the school's Core Values: Courage, Doing Your Best,

Respect, Responsibility, Integrity and Curiosity. The core values were also displayed in the classrooms. Violations of the core values were addressed through all-school assemblies (partially led by students) since the school community recognized that violations impacted all members of the community including classmates and teachers, in addition to the individual.

2.3.8.3.2. STEM-Focus. DSST: Stapleton offered a rigorous college preparatory program to all students, as described in the section entitled *STEM-focused Curriculum*. It also offered advanced courses in calculus, physics, engineering, and biotechnology, but not all students took these courses. When planning the school model, there was a conscious decision to prepare students for enrollment and success in four-year degree programs, as elaborated by the DSST CEO:

So, in the end, I think we came to a couple of key model conclusions. One is that we were going to be clear that we are going to be a '4 year college preparatory school for all.' We were going to be somewhat elitist in that outcome, in that we are looking for four year, not two year, not post-secondary plans. We are looking for every kid having the opportunity to go to 4 year. We felt like in STEM, if you don't set that bar, you're not going to get into the really innovative, kind of value-added STEM fields, engineering, in biomedical science. You could certainly go down the path of 2-year certificate programs, but we felt there was a much greater need, particularly for diverse kids, to into a professional degree kind of program. This is what was needed more than anything.

DSST: Stapleton administrators reported a 100% student college acceptance rate, with about 45% of the graduates intending to pursue STEM majors. The school had an articulation agreement with CU Boulder for admission to their engineering program (as well as a couple of other programs), as described in the section entitled *Real-World STEM Partnerships*. To prepare students for success in STEM college majors, DSST: Stapleton administrators described purposefully implementing a mathematics course of study that included a pre-calculus minimum bar, so that students could be competitive in applying to four-year engineering and calculus-based science majors.

School leaders described DSST: Stapleton's success in terms of their culture. The DSST: Stapleton model was grounded in values with the goal to build character, as described by one administrator:

I think that culture—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, that collectively challenge kids to be their best, to help each other succeed. I think that's a foundation of everything.

2.3.8.4. *Summary.*
DSST: Stapleton intentionally sought to prepare students underrepresented in the STEM fields to be successful should they choose to pursue STEM majors in college. It was a mission both of inclusiveness and of STEM-focus. The student body was diverse and well integrated, and all students were held to the same high standards of learning. Beyond the well-articulated goal of preparing all students for college success, students were explicitly introduced to STEM careers

and learned through field trips, student internships, and senior projects of the preparation required and the possible pathways to enter them.

2.3.9. Administrative Structure (CC9)

2.3.9.1. Definition.

The administrative structure varies (school-within-a-school, charter school, magnet school, etc.). Affected by the school's age and provenance, i.e., whether the school was converted from another model or was created "from scratch" as a STEM school. Funding structure varies.

2.3.9.2. Design.

DSST: Stapleton was a public charter high school that was a part of a network of charter schools. DSST: Stapleton was the first of the two high schools and four middle schools operating in the Denver School of Science and Technology network at the time of our site visit. Opened in 2004 with about 130 ninth graders in a temporary site, in 2013 it housed about 500 students in ninth through 12th grade in a building constructed expressly for this STEM school. Their first graduating class was in 2008. As a result of its charter status, DSST: Stapleton was not mandated to use the DPS curriculum or district-level assessments, but students did take Colorado statewide tests. Their teachers had a different pay structure and were not unionized.

In 2001, with a vision of creating a school that "transforms urban public education by eliminating educational inequity and preparing all students for success in college and the 21st century," (DSST Mission Statement), the governor of Colorado appointed David Greenberg and a founding board to lead the development of the Denver School of Science and Technology. A national search for the first school leader brought Bill Kurtz, who had a demonstrated record of school reform from the northeast, to be the first school director. The original effort, with support from the Bill and Melinda Gates Foundation raised $10 million to start the school. Denver Public Schools also contributed $5 million as part of their bond for building construction, and Hewlett Packard helped start the laptop program. DSST was awarded $1 million from Oprah's Angel network, and has additionally received funding from the Morgridge Family Foundation, Forest City Stapleton, Gates Family Foundation, Barton Family Foundation, and others. In 2008 a Middle School Director was hired to start the middle school, and from there a growth plan was devised to open eight more DSST schools in Denver for a total of 10 schools on 5 campuses by 2020.

DSST had a Home Office administrative team that included President Bill Kurtz (the first School Director of DSST: Stapleton), a CFO, and several managers and coordinators. DSST schools had a Cross Campus Collaboration (CCC) program that connected DSST staff working on common content areas across different campuses. This program was described as connecting teachers, deans, administrators and non-instructional staff in order for them to help each other and develop additional skills. There was also an Emerging Leaders Program (ELP) to guide, train, and support teachers looking to take on increased leadership roles in the schools, and to provide experience and mentoring for new and rising school directors.

Even though DSST: Stapleton was a charter school, the relationship between the charter network and DPS was increasingly supportive and collaborative. Described as "pretty extraordinary" and

"a true partner in expansion" by DSST administrators, DPS, described by a board member, was seen as being

Agnostic about the type of school. They simply want outcomes for kids, and call it a charter, call it an innovation school, call it a traditional district school, they don't really care. It is about making sure that we are providing better opportunities for students, and whoever can do that the best, that's who they want.

2.3.9.3. Implementation.

2.3.9.3.1. Administration. Kurtz, the first school director and now DSST CEO, who jokingly described his job as "chief dog catcher," said his role expanded as the network grew. At the time of our site visit in 2013 it included supporting and coaching school directors, managing the Home Office, setting directions for DSST, raising money, and directing the organization—rather "like being a CEO of a small organization that is growing rapidly." DSST was in the process of increasing the size of the Home Office Team, the administration behind all DSST schools. A Chief of Schools, a new role within DSST, was recently hired to help manage the schools and school directors.

Each school in the DSST network had a School Director, one Director of Curriculum and Instruction as long as the school had two or more grades, and a minimum of two academic deans. One of the deans at DSST: Stapleton also served as the network Dean Coordinator and was responsible for training and mentoring all deans within the DSST network.

Based on our interviews with administrators, it appeared as if the School Director in a DSST school was the person who ensured that the mission and vision of DSST were part of the school fabric. A deep and abiding commitment to the school's mission and values were a key characteristic of all school directors along with a demonstrated prior track record of excellence. When hiring new school directors, the DSST CEO described a particular search for people who additionally had the ability to lead adults, lead instructionally, lead culture, and had an understanding of how all of these pieces come together within a single school building, and how a team of people could help realize the DSST mission. Increasingly, the focus on school leaders was on management skills—those who could help bring a school "through difficult situations with great confidence and stability."

DSST: Stapleton School Director Mark Heffron was aided by an administrative team that included a Dean of Students for the Senior Academy, a Dean of Students for the Prep Academy, a Director of Curriculum and Instruction, a Director of Internships and Athletics, and a Director of College Placement. Heffron described being responsible for the overall curriculum and the larger picture of the school's operation, and meeting monthly with school directors from throughout the entire DSST network.

The Director of Curriculum and Instruction (DCI) described being accountable for the teachers in both a supportive and an evaluative capacity, beginning her relationship with the teachers at the start of the hiring process and continuing in a guiding and supportive role with new teachers,

following on throughout a teacher's tenure at DSST: Stapleton. All DCIs from throughout the DSST network met once a month.

The Deans of the Prep and Senior Academies described being primarily responsible for the day-to-day routine surrounding academic and disciplinary matters in the school. They made sure that students were getting both the academic curriculum and the supports they needed to be successful. In addition, they worked to ensure maintenance of the school's culture, a culture of accountability and a culture of care and concern, also attending to matters of discipline and working, where necessary, to modify behaviors.

The Deans of the Prep and Senior Academies described being the part of the academic team that focused on academic and social life from the students' perspectives. They worked with both students and faculty to shape positive classroom learning experiences, attending to student behaviors as well as the interrelationships between students and faculty that facilitated productive learning environments. Regular classroom observations by the deans served two purposes; they provided the deans with first-hand knowledge of the students' experiences, and provided data for conversations with teachers to devise plans for support and improvement—for both students and faculty.

2.3.9.3.2. Emerging Leaders Program. Mark Heffron was DSST: Stapleton's second school director following Bill Kurtz. First a baseball coach, subsequently adding math teacher to his job description for three years, then moving to a dean's role, he finally, for the past four years, served as the school's director. This pathway from teacher to leader followed a model seen in other charter schools that was a fixture within the DSST network of schools. This model encouraged, supported, and trained new leaders from within the ranks of the DSST system. Teachers could move into roles as Deans or Directors of Curriculum and Instruction (DCIs), and Deans and DCIs interested in moving on to school leadership in some capacity, as well as all Directors in Training (those who will be directors of DSST schools the subsequent school year) could participate in the Emerging Leaders Program offered within the DSST network. The DSST CEO explained that school directors were hired the year before they took over leadership in a school and spent a year in residence on one of the DSST campuses while training and preparing for their new positions. The Emerging Leaders Program was primarily facilitated by Bill Kurtz to develop leadership skills and capacities.

According to the CEO, when searching for new school directors, DSST first looked for people with a deep and abiding commitment to the school's mission and values, as well as a demonstrated prior track record of excellence and an ability to lead adults, lead instructionally, lead culture, and have an understanding of what that means. Increasingly they looked for emotional constancy, and the ability to manage through difficult situations with great confidence and stability. In addition to honing those skills, the Emerging Leaders Program also considered what an incoming director might need in terms of management skills in order to successfully take over the reins of a DSST school.

2.3.9.3.4. Daily school structure. The days of the week were broken into a semi-block schedule, where some classes met every day, others met every other day, and Fridays were usually assessment days. Within the unified space of the high school were a Prep Academy for ninth and

10th grade, and a Senior Academy for 11th and 12th grades. With different bell schedules, teachers, academic deans, and academy meetings, these academies were entities unto themselves. However, the school appeared to be very much a unified whole through its common mission, regular full-school assemblies, common faculty meeting times, and common school leadership.

The explicit daily school structure, built around DSST's Core Values, provided students with a predictable set of expectations for academic and social behavior, along with their allied consequences. Students who attended the middle school appeared to get a jump-start on the structure, but by the end of ninth or 10th grade, everyone in the school was fully cognizant of the operating procedures, and the rules started to relax a little with what DSST: Stapleton described as "gradual release." The teachers explained that 11th and 12th grade students were afforded greater freedom from the structure, but the high academic and behavioral expectations remained in place, with the burden of fulfillment gradually moving onto the student and the student body as a whole. Teachers and administrators described the consistency of expectation and the regular formatting ensured that everyone was on the same page, affording more time for learning. One senior level teacher commented that with the structures ingrained in every student by the time they got to senior year, all he had to do was teach, saying, "What makes it sustainable for me is the kids have had the systems shaped and I teach upper class who have been formed."

Students met in various advisory capacities throughout the week. Twice a week they met in small groups of approximately 10-15 students with their teacher advisor. Typically, they also met two mornings a week as part of the Prep Academy or the Senior Academy, and one morning a week as an entire school. When meeting in these large groups in the common meeting space in the school, students organized themselves according to advisory group and were positioned with their teacher advisor who took attendance and otherwise monitored student behavior.

2.3.9.3.5. Sense of common purpose. There was a commonality of purpose and a pervasive sentiment of "we can always do better" that was part of the environment of DSST: Stapleton. Led by Bill Kurtz, the original School Director for DSST: Stapleton, now CEO of the DSST network of schools, the mission and vision were lived and breathed by every individual in the school. One of the founding board member's comments describes the focus of DSST, not just on its own network, but also to thinking at the district level:

What makes Science and Tech magic is that it really embraces the concept of a learning community. [We ask ourselves] how do we get better all the time? Not arrogant. Never arrogant. Again Bill's leadership. Bill never lets us get too arrogant. We get some really great results. But can they be better? Yeah. Do these kids deserve more? Yeah. Do we want to influence the district so kids across the district do better? Yeah. Do we want to push neighborhood schools so they do better? Yeah. We want the district to be better, the whole idea is to lift the whole boat, raise the ocean level. Science and Tech really embraces this.

2.3.9.3.6. Relationship with Denver Public Schools. Denver was one of sixteen Gates Foundation "Compact Communities" where a relationship was forged between public charter and district public schools to foster ongoing collaboration including initiatives such as:

- joint professional development for teachers in charter and district schools;

- implementing the Common Core State Standards with aligned instructional tools and supports for teachers;
- creating personalized learning experiences for students;
- universal enrollment system for all public schools in a city; and
- common metrics to help families evaluate all schools on consistent criteria (Gates Foundation, 1999-2013).

Already, there was equity of opportunity and access to resources, with funding flowing through the DPS district as the Local Education Agency (LEA). About 50% of the public charter schools were in buildings belonging to the DPS district. In addition, the district worked closely with the charters to serve students with special needs, providing resources to serve both English Language Learners and Special Education students. At DSST: Stapleton, there was a full-time special education coordinator, a part-time school psychologist and a part-time medical nurse. The district also supported both a regional support specialist and a regional supervisor to supplement the work in the individual schools. All schools were held to the same standards of the published school performance framework leading to equity of accountability. There was also a unified school choice system in place throughout the district. In addition, schools were working on a more networked transportation system where buses would stop at all of the schools, as well as the library, to increase equity of access.

Mark Heffron described the relationship that DSST had with DPS as "pretty extraordinary" in that DSST considered DPS to be a true partner in the expansion of DSST that was underway. DSST will grow to 5 campuses and 10 schools by 2020. The building that housed DSST: Stapleton was the only building that DSST owned, and DPS had built or was building all additional facilities and recently included DSST in a successfully passed mill levy. When asked whether DPS saw DSST as competition for students, the Chief of Staff commented admirably on DPS's "equity proposition" where

The [DPS] district is agnostic about the type of school. They simply want outcomes for kids, and call it a charter, call it an innovation school, call it a traditional district school, they don't really care. It is about making sure that we are providing better opportunities for students, and whoever can do that the best, that's who they want. That's the partnership.

A member of DSST's home office team indicated that DSST paid "quite a lot of money to the district" and in return was provided with services, which included use of the student information system, *Infinite Campus*. In addition, there were responsibilities or expectations about how DSST would play additional roles in the DPS system.

2.3.9.3.7. Retention and reenrollment. Because DSST's goal was that students would be prepared to both enter and successfully complete college, and all core requirements were necessary to ensure that students were given the strongest possible foundation to support this possibility, the DSST CEO explained that they did not socially promote students. All students were required to pass all core courses at a minimum level of 70% in order to move on to the next grade. Students who failed one class had the opportunity to re-take that course in the summer; students who failed more than one class would repeat the grade. According to the CEO, in DSST: Stapleton's first year, they "had to keep 25 kids back in ninth grade because they weren't prepared and we weren't going to cheat them out of what they needed." Significant also,

however, was that DSST: Stapleton was not expelling students; they were providing them with an avenue to be successful. With re-enrollment rates [rates of all DSST: Stapleton students returning for a subsequent year] at DSST: Stapleton of about 90% [which they acknowledged was not as high as they would like], they were several percentage points above the district average of 83% and in fact had the highest re-enrollment numbers among all high schools in the district. As the CEO stated, we "think helping kids persist through the academic challenges is really important." In fact, one of the reasons for starting a middle school was to ensure that students were better prepared and less likely to need to be retained.

2.3.9.4. *Summary.*

DSST: Stapleton's administrative structure facilitated its growth and replication. Teachers, deans, and school directors all could be groomed in-house for climbing the administrative ladder and filling roles with different or increased leadership responsibility as the network grew and expanded to fill its niche within the DPS system. The core leadership at each school resembled all others, with a school director, academic deans, and several directors responsible for different domains of academic, athletic, social, and cultural life of the school. DSST philosophies were consistent across the network, ensuring a behavioral and pedagogical structure that facilitated learning for all. The DSST Home Office served as the umbrella administration supporting the individual schools as they carried out the DSST mission. Regular meetings of administrators across the network ensured commonality of purpose and a supportive team of similarly-minded and similarly-driven individuals from which to learn and grow.

2.3.10. Supports for Underrepresented Students (CC10)

2.3.10.1. Definition

Supports such as bridge programs, tutoring programs, extended school day, extended school year, or looping exist to strengthen student transitions to STEM careers. Altered, improved opportunity structures, i.e., students are positioned for STEM college majors, careers, and jobs.

2.3.10.2. Design.

DSST: Stapleton's mission was to ensure that all of its graduating students were college ready. According to network's website, DSST: Stapleton was structured as a four-year college preparatory school for all. Furthermore, the DSST: Stapleton's goal was for every student to gain admission to a four-year college, as opposed to a two-year school. DSST: Stapleton's curriculum included high-level courses like engineering and biotechnology, and the aim was for every student to complete pre-calculus in the mathematics sequence, or higher. A student with fewer courses would not likely be successful in college STEM courses. DSST: Stapleton administrators indicated that the school set the mathematics bar high because success in mathematics is most highly correlated with college success.

As a result of that commitment, DSST: Stapleton had constructed supports for students to achieve the goal of admission to a four-year college. The school culture promoted a value system of perseverance and personal responsibility, often referred to by teachers as grit (c.f., Duckworth, Peterson, Matthews, & Kelly, 2007). The CEO of the DSST network believed that DSST was a values-based institution and there was a huge focus on non-cognitive skills. The school was intent on building character, as well as STEM outcomes. The CEO wanted to instill the notion in

students that "you guys are part of something much larger than yourselves; you are part of a community that has expectations for you to meet. You have responsibility." The culture challenged students to do their best, and to help each other to succeed. However, one teacher pointed out:

The challenge is that we have a real variety of skills and backgrounds [among the students]. Most STEM schools are magnet schools where students test in. Our kids come to school with the opportunity to go to college, and some kids are way ahead and some are really struggling. It is a challenge to address all these different skills. We have different sections of classes to help address this…this is a huge and unique challenge.

The CEO of the DSST network was eloquent and ardent in explaining the school's goals and framing them against the school's intentionally diverse student population:

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 we have 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 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.

The CEO went on to say that the four-year graduation rates were high, about 75%, but that they wanted to improve. Most significantly, the school was not seeing differences in graduation rates between low and high-income students, an important equity issue.

To meet the challenge, DSST: Stapleton designed various structures and systems. There was a course mastery system in place; students were required to receive a grade of C or higher or they had to re-take the course. There were many students who had to repeat courses, although this did not have the stigma as might be found in other schools. Students reported that they knew that if they were in "regular" schools they would be passed along without mastery or really learning the material well enough to perform well in subsequent courses. Many saw the value in re-taking courses. In addition, DSST: Stapleton had added a middle school to its campus. Students from the DSST: Stapleton middle school may be better prepared to handle the demands of DSST high school than students who came from other middle schools. Teachers noted the differences in preparation. In addition, there were counselors who helped the students with college applications and who were available if students needed other types of counseling.

2.3.10.3. Implementation.

The staff at DSST: Stapleton described purposely putting into place what they referred to as structures and systems to support students. By this they meant that the supports were not haphazard, but institutionalized, and everyone in the school was aware of their existence and how they were designed to work. The structures and systems may have been facilitated by the

use of communications technology linking student data with supports designed to assist students before they got into academic trouble. Students, parents, and teachers all said that the systems were there so that students were not allowed to fall through the cracks. It is important to note that not only were problems being caught through this system, but also a series of possible solutions were at hand to solve the problems that arose at DSST: Stapleton.

2.3.10.3.1. Data systems. DSST: Stapleton used data systems to track and understand student progress. Teachers described using standards-based assessments to help identify where students were struggling or successful, and help was offered by targeting specific standards. Final course trimester exams provided additional information and allowed for adjustments for targeted instruction in specific areas the following trimester. Teachers described being given two professional days for data analysis and to plan instruction for the subsequent month to meet student needs. All students took the ACT exam in the fall of their 11th grade years. State assessments given in the spring provided information that helped place students in performance bands. Lower performing students were targeted for help in math and reading before school began in the fall. DSST: Stapleton used data systems to identify incoming students whose scores indicated that they were not likely to succeed without some extra help. These students, mostly ninth and 10th graders, came in during the summer for intense work in reading or math to catch up. About 40 students attended the program during the summer of 2012.

The school director explained that DSST: Stapleton also attempted to follow students' progress the year following graduation in order to understand how they were doing in college.

2.3.10.3.2. Orienting students to DSST. When students first arrived to DSST, there was an orienting period. In the past year, the focus of the first week of school was on school culture. There were team-building activities in their advisories, classes, and in the Prep Academy. The Prep Academy was originally divided into four houses, but that system had broken down somewhat because ninth graders were more dispersed among upper and lower level classes.

2.3.10.3.3. Advisories. DSST: Stapleton administrators described students being placed in advisory groups with 10-15 of their same-age peers and one staff advisor. These groups were constructed to be all-male or all-female groups and were either for ninth and 10th graders in the Prep Academy or for 11th or 12th graders in the Senior Academy. The advisories met twice per week throughout the year to discuss any issues students might have in order to ensure that they stayed on track to graduate and attend college. The advisor checked grades and whether students had been attending afterschool sessions designed to address academic or behavior problems. The atmosphere in one advisory session our research team visited could be described as business-like, as when a teacher surveyed a group of ninth grade boys, sitting in a circle, about their concerns about upcoming exams. The teacher strategized with the each boy about how to approach the exam, or if he was failing, how to persevere. The teacher asked struggling students whether they had attended tutoring sessions or how they were handling their problems, given the resources provided by the school. Afterward, there was free time for board games, and the boys immediately picked up where they had left off in a previous advisory. The teacher played chess with one boy.

2.3.10.3.4. Mastery and retention. Because students were required to pass courses with a C or better, some students had to repeat an entire year if they failed courses. About 10% of students fell into this category, and DSST: Stapleton had many "5-year-graduates" or students who took five years to successfully completely the DSST requirements at the level required by the mastery system. There was less of a stigma attached to this than at other schools, because DSST's emphasis on the importance of learning, the sequential and developmental nature of course sequences, and the pervasive support provided to students. Even so, it was reportedly still a major reason that some students left DSST: Stapleton and returned to neighborhood schools. About half of the students held back ended up leaving DSST: Stapleton. But if they came in reading or doing math at 5th grade level, they might need additional time to catch up in order to be successful. A university partner who worked closely with DSST: Stapleton made the case:

Are you more harmed by being held back because you are not performing up to level as a 14-year-old who can't drop out of school or as a 11th grader who can? What happens when you find out that you are behind in 3 years of courses [needed to graduate] and that you have been socially promoted [passed onto the next grade without having fulfilled all requirements] …there's zero chance of graduating in 12th grade? It is better to deal with it at age 14.

Both the school psychologist and special education teacher could work with students who had been retained for a course failure to help them see the benefits of persisting for social and academic growth. A teacher pointed out, "Many students don't see the value of staying for an additional year and repeating; many students choose to leave or their parents pull them out." This has an effect on their eligibility for sports because they would be both eligible for sports and passed along at another school.

Teachers thought about the supports developmentally, and struggled with the balance between too much help and too little. One teacher reported:

Teachers bend over backwards here [to support students] and it's a weakness as well. We put a lot of safety nets in place for students. Students do experience failure, many are retained [need to repeat a course], but they are supported by the trimester system, so they can bomb one trimester and work up the other two.

2.3.10.3.5. Tutoring. DSST: Stapleton had two afterschool activities designed to help students who might be struggling. A well-developed student data system facilitated this. One activity was called "College Prep," meeting from 3:45 to 4:30 pm, and consisted of mandatory tutoring for students who did not do required work. This response was immediate, usually on the same day that an assignment was missed. The school data system might have initiated a phone call to parents notifying them that their child would be coming home late and the reason for this. The second afterschool intervention program was called "Refocus" for students who had behavioral infractions. Students were asked to sit quietly and reflect on their behavior in a quiet room on a Friday afternoon after school. Infractions might have included violations of the dress code, chewing gum, inappropriate use of technology, or disrespect.

In addition, there was voluntary tutoring and mandatory tutoring for students during the school day (lunch) and before and after school, organized in such a way that sessions in different

subjects did not conflict with one another. This was typically done in a one-to-one student-to-tutor environment, and was quite popular with students, including those who might not actually have been struggling.

The data system made it possible to easily keep parents up to date about their child's progress, but the student was supposed to do this as well. Students had easy access to their grades; they were a "click away from knowing what your grade is" as described by a student. The school could send out an automated email to parents if there were any problems in student performance in a given class.

2.3.10.3.6. College Preparation Program for ninth and 10th graders. Students, parents and teachers whom we interviewed all 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. The small school size was designed to ensure that students did not fall through the cracks as they sometimes did in larger schools. In addition, if students had attended the DSST middle school, they had heard about college from sixth grade on, as well as being introduced to STEM careers. Parents saw this emphasis on college as huge, in particular for first generation families, and appreciated the supports in place.

Not only did a number of students come from families where they would be the first generation to graduate from college, many would be the first generation to graduate from high school. These students had to learn the terminology and the mindset about college admissions. It was something that needed to be taught to students and their guardians as well, and there was a person at DSST: Stapleton assigned to work on scholarships and financial aid. There was a "ninth Grade Counts" program designed to help students see the big picture of college planning. It used software called *Naviance* as a college planning tool, and was based upon personality assessment. 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. During 10th and 11th grade, College Success classes occurred during students' English or history classes once each month. The 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.

2.3.10.3.7. College admissions, support and follow-up for 11th and 12th graders. As students entered the upper grades, more was expected of them academically and teachers talked about supports being provided and gradually removed in a developmental fashion. Students were assisted with college admissions and financial aid. One alumna said that she really wanted to go to an expensive private university, but that the finances were not feasible, so the 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 20 colleges that might be good matches [for my goals]." An alumna pointed out that there was a drop-off of academic support when she entered college, but

that DSST 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 said that former DSST students who were currently in college were all breezing through.

DSST tried to follow up graduates in the first year of college. Graduates anecdotally reported that three major activities/projects helped to prepare them for college success; the senior project, the thesis, done in senior year, and upper level science courses, although the work done in preparation for those activities laid the groundwork that allowed student success. A teacher said,

We hold their hands a long time in this school, so we have to let go in senior year…without a doubt there are kids who you think will not make it [graduate] but they manage and are successful in college. Sometimes they have to leave the nest…the idea of gradual release.

2.3.10.3.8. Special education. There was one special education teacher assigned to DSST: Stapleton, and she supported all of the students with Individualized Education Programs (IEPs) [about 20, and a lower proportion than the national average] in the school who were mainly placed in inclusion or "regular" classrooms. She described working with teachers and with students directly. The perception among parents with whom we spoke was that DSST: Stapleton was inclusive and that everyone took the same classes and was treated in the same way. However, teachers noted that students entered the school with a wide diversity of background skills and knowledge, and that some may have needed to catch up in order to be successful. Some students were eligible for special education services and had IEPs. Consequently, the school provided one intervention math and reading class each in ninth grade for students in the lowest quartile according to results from standardized tests. The teacher's goal was to first gain the trust of the students and to get to know their strengths and weaknesses. She worked with them so that they could become more proficient in self-advocacy, with the notion of gradual release of support as they got into the junior and senior year and eventually college. Although the special education teacher was new to DSST and had only one set of graduates to date, she stayed in touch with them and reported that all were doing well in college.

2.3.10.4. Summary.

DSST: Stapleton set out to deliberately achieve an elusive goal—to create a school in which a diversity of students in the Denver area would be able to graduate from a strong STEM school and go to college. That Denver Public Schools and the State of Colorado struggled with high numbers of high school dropouts made this goal extremely challenging. DSST: Stapleton was a school that responded to the challenges by providing a rigorous mastery based STEM curriculum, a well-defined school culture, and a demanding set of expectations. However, for every expectation and demand, the school had support systems in place that allowed students to be successful, as well as a teaching staff aware of the developmental needs of the students and their academic needs. The school relied on data-based decision making and communication that was immediate and responsive. Students with grit were provided a way to succeed and achieve their goals through the systems and supports.

2.4. EMERGENT THEMES

The research team initially set out to examine how and to what extent the 10 previously identified critical components were in evidence at DSST: Stapleton. However, we also looked

for additional areas on which DSST: Stapleton focused that could not be placed into one of the critical components. Based on the collected data, we identified the following emergent themes that further helped to explain how DSST: Stapleton operated.

2.4.1. Grit.

The single word that probably best exemplified the philosophical underpinnings of DSST: Stapleton was *grit.* Hard work, determination, and the gutsiness to press on and power through were as much parts of conversations in the hallways as they were demonstrated in the commitments the school made to its students, and those made by the students themselves. High expectations, and the encouragement to meet them, were in place for every group within DSST: Stapleton, from the board, to the administration, to the teachers, and finally the students, and grit was the most clearly articulated characteristic to meet this pervasive challenge.

In their report describing the effects of non-cognitive factors on student performance, Farrington et al. (2012) describe two concepts of grit as "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).

The CEO set a high bar for himself as well as for the board that served the school. A board member spoke to the grittiness demanded of the DSST board when she described the CEO as "a driver" for transformational change, saying that while "it's hard to be one of his board members … he holds everybody to a high standard, nobody more than himself."

Teachers too strove for continuous improvement, constantly assessing their teaching methods and student outcomes to determine how to work collectively and independently to guide students' success. As a board member described:

The school is a hard environment for teachers. The demands on them are so high….You can never be good enough. There isn't anything such as good enough as Science and Tech. They have an incredible learning community. The teachers help each other, the teachers are part of a community that is so strong, that is magic there. But it's hard to be good enough.

This hard working, high-powered environment of gritty determination was the one in which students experienced learning. Everyone from the top on down was committed to the hard work necessary to ensure student success in college, and much of this would be met by sheer determination. The CEO stated: "I think helping kids persist through the academic challenges is really important." A mathematics teacher described that one of the biggest skills the students would need to learn was how to persevere, "to push through difficulties" in order to succeed at problem solving, saying "when you get stuck, go look in your notes and figure out a way to proceed." In Creative Engineering, students learned that the first prototype they designed probably wasn't going to be a perfect product and they would have to revise and rework until it did. According to the teacher, this was a class where the students could learn to "handle frustration and be comfortable with failure."

A teacher who worked with students during their internship experiences suggested that grit could

make the difference in outcomes from such independent opportunities. He stated,

Your abilities don't determine whether or not you have grit, whether you can push through a challenge. Can you think on your own? Can you synthesize information?" Can you push through things? Can you do all these things so that when someone says, "You can do anything you want on your own" can [you] figure out what to do?

Teachers commented that when students made the conscious decision to attend DSST: Stapleton, they knew they would have to work hard. And even when students knew that they might not be successful the first time through a course, they would maintain a positive work ethic, go to tutoring sessions, and "pick up that need to persevere." In some cases, students would need to repeat courses or even entire grades, which could be a challenge for students who knew they could return to their neighborhood schools and be passed along to the next grade despite failing a course. Teachers described the formation of strong relationships in the school as useful in helping students come to trust the system that would support them as they persisted until they succeeded and graduated.

This grittiness could have a dark side as was exhibited in the pressure felt by many in the system to perform ever better and to continuously strive. Teachers and students alike cited concerns about the challenges of meeting expectations. Teachers described the beginnings of teacher "burn-out" and concerns about being able to keep up the pace. Students likewise described pressures or exhibited behaviors consistent with stress, especially at the time of our visit at the end of a term with many deadlines looming. That said, while the expectations were high, they were high for everyone, and they were high with good reason. There was support throughout the system to help each person develop the grit to meet lofty but achievable goals. A board member made a good point for the high expectations and not giving up on students when she said:

We get some really great results. But can they be better? Yeah. Do these kids deserve more? Yeah. Do we want to influence the district so kids across the district do better? Yeah. Do we want to push neighborhood schools so they do better? Yeah. We want the district to be better, 'the whole idea about to lift the whole boat, raise the ocean level.' Science and Tech really embraces this.

2.4.2. Gradual Release.

The learning structure at DSST: Stapleton moved from highly prescribed and formatted to increasingly student-directed in a process DSST: Stapleton referred to as "gradual release." The core content subjects were designed to ensure that students had the foundational background to meet future academic challenges. Students entered ninth grade into a system of continuous accountability; it was not possible for students to slip through the cracks, because the cracks were chinked with multiple back-ups and the constant vigilance of teachers, deans, and administrators.

Eventually though, students came to share the burden of responsibility, becoming increasingly accountable to themselves for their work. This system was not as well-refined as many would have liked; one teacher explained: "We hold their hand a long time in this school, so we have to

let go in senior year." However, the school was mindful of this need and was working diligently toward this articulated goal. One teacher described gradual release as being,

Ultimately about students finding what we call 'the elements', where personal passions meet natural talents. 'You've been told how to learn, now you tell us how you want to learn and what you want to learn.'"

Until this year, gradual release had been targeted primarily through students' experiences in their internships and senior projects, where they engaged in real-world experiences of their own design, and where students had the additional responsibilities of providing their own transportation, tracking their working hours, and being "a young adult." This experience could be challenging for students who prior to this experience had not had many opportunities to fully take responsibility for their own learning. As one teacher described, "When the world's their oyster, they kind of freak out," suggesting that without adequate preparation for the freedom and responsibility, the students can't take full advantage of the experience.

Teachers and administrators described working toward a greater scaffolding of gradual release, providing earlier experiences for students to create their own timelines, as in the Creative Engineering class, and through the seminar class that paralleled students' Senior Projects, guiding and supporting them as they worked to become increasingly self-reliant.

2.4.3. Data-Driven Decision-Making.

Teachers and administrators provided examples of data being collected throughout DSST: Stapleton that were used to adjust the curriculum, teaching strategies, and support structures for struggling students. School-wide data collection allowed comparisons between groups of students and their teachers to help teachers take advantage of the skills within the building, to learn from each other, and make adjustments in programming. Individual student data collection facilitated the targeting of student supports to more directly address areas needing remediation or enhancement.

A school "data team" was responsible for collecting and analyzing data to inform the school on its performance and progress. While some of the data collected could have been used to tell the school's story to the broader community, a school administrator said,

We very much let other people tell our story." Sharing the successes of DSST: Stapleton with the public is not something they must do for themselves: "We don't have anything to do with those reports [in the press]. That just happens.

The school data team focused its energy on utilizing data for the improvement of the education occurring within the DSST network classrooms. An administrator described,

We use in-house data for our own decision-making. Our data team is really looking at a low level, like how are teachers performing in certain subject areas; how do we correlate our internal benchmark exams to success on the state exam? We're still trying to get that right.

Individual student-level data were used to inform a variety of classroom interventions and adjustments. Many exams were administered through Active Progress [an online system of test design and administration that allowed tests to be created from databases of questions, which individual subject-area teachers had previously aligned with DSST: Stapleton standards]. This kind of administration allowed students and teachers to see printouts of student performance relative to the standards addressed, to indicate which standards were successfully learned and which needed more work. A teacher said:

We use a lot of data to figure out where kids are. Standards based assessments – we can identify students who are struggling in some areas, on some standards and being successful on others. We can offer targeted education with respect to individual standards.

Teachers used information from the standards-correlated tests and quizzes to design targeted learning experiences to address students' learning gaps. Describing the use of responsive assignments to help students prepare for an end of trimester test, a teacher spoke of the advantages of designing personalized worksheet items and providing links where a student could access exercises that would specifically address standards the student had missed on preparation quizzes:

Each quiz has standards that we have to cover; each question covers a standard. When they take a quiz, they'll see which standards they get wrong. Then I wrote other questions that help them explore each standard. So if they miss a particular standard, they have a question that addresses that specific standard and helps them review it. … So what they do—I think they really like this—everyone gets different questions wrong on the quiz, but they get a very personalized review for the standards they miss. Instead of me standing in front of the class explaining a standard that half the kids have no problem with … if you miss particular standards, you get specific questions to review. … By the time I get them, they understand the value of this … but they get the value of it because they see where they improve, because they see the particular standards they missed and need to review.

Student data were also used to cluster students in learning situations that would enable teachers to address similar strengths or similar challenges. One teacher described,

We group students who are all struggling within math or within reading. We categorize students. After final exams, we can look at the standards data and see how the kids did, or how students did over time, [and] figure out what we should target in instruction.

In a physics class, much of the course was taught to a heterogeneous group of students, but to allow for greater differentiation of instruction than could be achieved within a single classroom and to facilitate instruction of some "high-level kids" two teachers made some adjustments to their own schedules. One of these teachers added, "We realized that we both have the exact same schedule… we could just trade kids so one teacher could focus on one set of objectives for some kids, and the other could give support."

At DSST: Stapleton, data were not only collected, but they were rigorously utilized to affect curriculum and instruction. Teachers worked with individual student data to personalize

instructional supports. The administration evaluated classroom level and school level data to focus on instructional strategies and teacher professional development. This pattern of decision-making culminated each summer as course standards were revisited to ensure that the course curricula were appropriately targeting the content needed to provide students the education they needed to meet the school's mission and vision.

2.4.4. School Culture.

Each school develops a unique culture based on a variety of factors including the school-wide philosophies, the people living out these philosophies, and the context in which the school finds itself (Deal & Peterson, 1999). A school culture can often be felt from the moment one enters a school and it can affect community relationships and learning. A school's reputation is in part based on the culture as perceived by the broader community, and the expectations students have as they enter the school to join its ranks.

DSST: Stapleton's Student Handbook proclaimed to all, "Culture is King." According to parents and community members, DSST: Stapleton had the reputation of being a challenging school and one with strict rules and codes, but also one of support. Expectations were high both for behavior and academics, as evidenced in part by the comprehensive student handbook of rules and guidelines. It outlined explicit instructions on student dress code, rules for behavior and consequences for infractions, and appropriate technology use, as well as expectations for academic performance. The rules were practiced from the moment students entered DSST: Stapleton, and were well rehearsed and part of the students' lexicon well before a student graduated.

DSST: Stapleton administrators described a deliberate intention to create a strong culture to guide its students and staff. With its formal guiding statements for goals and conduct, DSST: Stapleton created several structures to support its culture. For example, upon enrollment at DSST: Stapleton, all students were placed in advisory groups with 10-15 of their peers and one staff advisor. These groups worked together and met throughout the year to discuss any issues that arose in order to ensure that the students stayed on track to graduate high school and attend a four year college, and also to ensure that they acclimated to the DSST: Stapleton school culture. A dean at the school claimed that advisory consisted of "a lot of culture building, [and helped students] get used to DSST: Stapleton." The school also used to have a summer program and a "culture week" for incoming ninth grade students; however by the time of our visit that program had been disbanded with the recent development of the complementary DSST middle school housed in the same building. Moreover, interviews with ninth-grade level teachers and advisors indicated that students who came out of the DSST middle school typically required less guidance on following the cultural norms than their counterparts who entered DSST from a different comprehensive middle school in the nearby area.

The most frequent and enduring reinforcing structure for DSST: Stapleton's culture of accountability and support appeared to be the way the school dealt with disciplinary issues in its daily morning meeting. Each day, the school director rounded up half of the student body and sat in a circle in the main meeting area of the building. There, the director announced the news of the day and provided students and teachers a chance to also make announcements. This "ritual" featured several behaviors that included songs, specific handclaps, and chanting of certain key

phrases the school believed in. Once the announcements were over, the director moved on to the disciplinary issues of the day. First, any student or teacher who had entered the building late publicly apologized to the school by saying "I apologize to the community for being late." After this run-through of apologies for being late, the group dispersed and the school day began.

When there were more serious cultural transgressors, such as those that might otherwise warrant a suspension, the morning meeting continued on for a longer period of time, even at the cost of shortening classes for the rest of the day. If a student had been given a suspension, he or she was required to address the entire school community by standing in the center of the circle to apologize to the entire DSST: Stapleton population. The student then provided a lengthy description of what happened and reflected on who they felt they were as a person, how they wanted to be seen in this school, and went on to provide a proposal for how they would act in the future. The student would then identify specific people—fellow students, faculty, administrators, or other community members—who could help him or her in the future if similar circumstances arose. Students and others in the community were then given time to ask clarifying questions of the student to better understand what occurred and what the student was willing to work toward in the future. The whole school then voted on whether or not to "welcome the student back into the community." If the community did not vote unanimously to let the student back in, the student would have to address the concerns of those who voted negatively and repeat the process subsequently until the community believed that the student fully understood the consequences of his or her behavior and could ensure the community that he or she could and would improve. Outsiders of the school viewing this experience might have considered this disciplinary process to be extreme; however interviews with school deans and guidance counselors suggested that they believed in the power of this system and structure to help students truly understand they could be both responsible for their actions and have the ability and facility to make amends. In addition, students who transgressed did not have to prepare for this presentation alone, they were supported by counselors, teachers, and advisors as they reflected on their actions and wrote the speech they would present to the community.

These structures of rules, regulations and practices within the DSST: Stapleton culture might seem oppressive, and from the outside, this reputation existed to some extent. However, most students and community members agreed that this structure actually provided freedom for learning. As one student described: "the environment is less stressful because everyone is going through the same thing, [we] have to do the same thing—everyone [is] working." A DSST: Stapleton academic dean noted that the structure was couched in a supportive environment, saying that DSST: Stapleton's was "a culture of accountability and a culture of care and concerns." And this was reflected in comments from an alumna, "When you're there, it's hard and there's a lot of rules, but it's very loving and supporting."

Students and teachers formed strong relationships that helped all feel a sense of belonging to a community, feeling that they were working collectively toward something larger than themselves. An administrator described opportunities to engage with students in important non-academic ways:

We do get a chance to interact with all of the students. Almost everyone in the building has an advisory, which is an intimate way to get involved with the students. I'm also the advisor for the

multicultural club. I'm known for helping with dance. I have lunch duty, so one day a week I'm with kids at lunch.

The academic deans described having the job of character building and community building, dealing with "holistic accountability for the students." This "culture of accountability," of holding individuals responsible for their impacts on the community, was practiced and evidenced particularly in the school framework that dealt with behavioral infractions. As discussed earlier, when students violated one of the major school codes, they were not suspended out of school. Instead they were asked to give serious reflection, not only about their direct behaviors, but also about how this behavior affected their classmates, teachers, and the school community at large. They were given "in-school reflection assignments where they read relevant literature, interviewed adults, and then wrote a two-page reflection of what happened as they sought to better understand the issue and their behavior." This reflection was taken one step further where the student was asked to come before the entire school body to "describe and explain the infraction as well as provide a personal reflection of how the behavior impacted the community, and how the student would personally adjust." This process also asked the student to articulate how he or she would seek support from the community to be more successful in the future. This process held the student fully accountable for behavioral infractions, but also highlighted the role of community in helping every member achieve success.

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."

As the CEO described:

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, so I think that culture: '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, that collectively challenge kids to be their best, to help each other succeed. I think that's a foundation of everything.

2.4.5. Summary.

Above and beyond the 10 critical components identified through the literature review, rise the four emergent themes of *data-driven decision-making*, a *school culture unique to DSST: Stapleton*, *grit*, and *gradual release*.

There was a culture of high expectations coupled with the support to realize them. Initially, this support was in the form of structures imposed by administrators and teachers, then through the process of gradual release this responsibility was slowly, but deliberately transferred to the student, who must utilize personal grit to persist in the face of challenges.

Data collection provided the foundation for decision-making whether it was for determining individual student plans for learning, school-wide curricular changes, or for targeted teacher professional learning and development.

Atypically high standards of expectation for the population of students served, coupled with the determination that *every* student would achieve mastery of college-level content in order to graduate, *and* unflinching and persistent support for the acquisition of this goal characterized the DSST: Stapleton school culture. The mission and vision of the school were realized through grit exhibited by all community members from student through administrator. Each individual played an important role within the community, and every role required commitment, effort, and the dedication to see a challenge through to a successful end.

2.5. EXAMINING STUDENT STEM OUTCOMES

There is an overall agreement that ISHSs should improve underrepresented students' preparation in STEM in ways that inspire and provide requisite background knowledge and skills, instilling confidence and desire to seek more STEM education, jobs, and careers (Means et al., 2008; NRC, 2004). Having explored the design and implementation dimensions in the above sections, the study now examines the outcomes of students attending and graduating from DSST: Stapleton. To capture this student outcome information for DSST: Stapleton, OSPrI compiled data on near-term outcomes such as demographics, attendance rates, and assessment scores from state databases. The study also gathered information on longer-term outcomes such as high school graduation rates.

2.5.1. Inclusive Demographics: Who is DSST: Stapleton serving?

Table 12 below compares the demographic data from Fall 2012 for DSST: Stapleton, the nearby comprehensive East High School, Denver Public Schools (DPS), and the state of Colorado. [Note that all comparisons are for 9th through 12th grade students except for the state of Colorado, which includes students from pre-Kindergarten through 12th grade.] East High School was selected as a comparison school because it was one of the high schools located closest geographically to DSST: Stapleton. As part of DPS's school choice and enrollment procedures, parents and students have the opportunity to list their top five school preferences. While all students are guaranteed a spot at their neighborhood boundary school, they are free to list their boundary school as their top choice, one of their five choices, or not at all (see http://schoolchoice.dpsk12.org/wp-content/uploads/2012/10/Secondary-English-Enrollment-Guide-FINAL1.pdf). Denver's School Choice process enrolls students in their highest preference school with available space, and for the purposes of making rough comparisons, we selected the nearby East High School to serve as the "boundary school" for students living in the Stapleton area as a reasonable comparable school.

As Table 12 shows, DSST: Stapleton's student body reflected a relatively even distribution of Hispanic/Latino, Black/African American, and White students that was not seen in the comprehensive high school, county, or state. Whereas those comparables each enrolled one student group that far outnumbered the other two, DSST: Stapleton enrolled a higher percentage of African American students than the county or state while also serving significant numbers of

Hispanic and White students. Additionally, DSST: Stapleton enrolled a higher percentage of female students than the comparables, a number that was substantially higher than 50%. Finally, while DSST: Stapleton's Free and Reduced Price Lunch (FRPL) population was lower than in the surrounding county, it exceeded that of the neighboring comprehensive high school and the state overall.

Table 12

Fall 2012 Student Demographics Comparing DSST: Stapleton, Comprehensive High School, County, and State

	DSST: Stapleton [a]	East High School [a]	Denver County (DPS)[b]	Colorado
Students Served	508	2,383	20,174	245,876[c]
Grade Levels	9-12	9-12	9-12	9-12 [c]
American Indian/Alaskan Native (%)	0.8	0.4	0.9	0.9 [c]
Asian/Pacific Islander (%)	3.0	2.0	3.0	3.4 [c]
Hispanic/Latino (%)	34.8	23.2	57.5	29.9 [c]
Black/African American (%)	26.2	24.3	16.6	5.0 [c]
White (%)	27.6	45.1	18.1	57.8 [c]
Two or More Races (%)	7.7	5.0	2.9	2.9 [c]
Male (%)	46.3	49.3	51.0	51.3 [d]
Female (%)	53.7	50.7	49.0	48.7 [d]
Free or Reduced Price Lunch (%)	45.9	36.0	68.6	41.6 [d]

[a] 2012 9-12 Pupil Enrollment by School, Grade, Race/Ethnicity and Gender
[b] 2012-2013 9-12: http://communications.dpsk12.org/facts.html
[c] 2012 9-12 Dataset prepared for OSPrI by Colorado Department of Education
[d] 2012 PK-12 Free and Reduced Lunch Eligibility by District and School" from Colorado Department of Education (retrieved from cde.state.co.us/cdereval/pupilcurrentschool.htm on July 8, 2013)

Denver County Public Schools also implemented a School Performance Framework (SPF), described as "a comprehensive system for evaluating schools, [taking] into account a wide range of factors to give ratings on how well each school supports student growth and achievement and how well each school serves its students and families" (see http://spf.dpsk12.org/default.html). With this system, high schools were evaluated in seven categories of performance: Academic Growth, Academic Proficiency, College & Career Readiness, Improvement in College & Career Readiness Over Time, Student Engagement, Enrollment Rates, and Parent Satisfaction (see http://spf.dpsk12.org/default.html). For 2011-2012, DSST: Stapleton earned 206 out of a possible 257 points in the seven categories above, an 80% rating that led to a "Distinguished" overall rating for the school, which is the highest designation that a school can earn in this evaluation system. East High School earned 195 out of a possible 275 points, a 70% rating that led to a "Meets Expectations" rating for the school overall.

Additionally, as shown in Table 13 below, the SPF Scorecards for each school list certain student demographic data points that differ slightly from the data provided by the Colorado Department of Education above. These data, however, are helpful in providing some sense of the Special Education (SPED) and English Language Learner (ELL) populations that DSST: Stapleton

served. Compared to East High School, DSST: Stapleton served a smaller percentage of SPED students, but more ELL students.

Table 13

Student Demographics from School Performance Framework 2011-2012 Stoplight Summary Scorecard Comparing DSST: Stapleton and Comprehensive High School

	DSST: Stapleton	East High School
Students Served	495	2,313
Free or Reduced Price Lunch (%)	44.0	35.5
Minority Combined (%)	64.2	48.9
English Language Learner (%)	5.3	3.8
Special Education (%)	2.4	8.2

Source: "School Performance Framework 2011-2012 Stoplight Summary Scorecard" from DPS website (retrieved from http://spf.dpsk12.org/spf_high.html on July 8, 2013).

2.5.2. Attendance Rates: Attendance as an Indicator of Student Engagement.

The important role that student attendance plays in promoting academic success is widely acknowledged and accepted (see, for example, Bryk, Sebring, Allensworth, Luppescu, & Easton, 2010). Table 14 shows comparative data for DSST: Stapleton, the comprehensive East High School, Denver County, and Colorado. DSST: Stapleton's attendance rates were higher than those for the comprehensive East High School. DSST: Stapleton also compared well with the county and state attendance rates, although it should be noted that the county and state numbers encompassed all grades, not just the high school grades.

Table 14

2011-2012 Attendance Rates (%) Comparing DSST: Stapleton, Comprehensive High School, County, and State

	DSST: Stapleton	East High School	DPS	Colorado
All Students	95.2	92.2	93.0	94.4

Source: "2011-2012 School-by-School Truancy Rates" from Colorado Department of Education website (retrieved from http://www.cde.state.co.us/cdereval/truancystatistics on August 26, 2013).

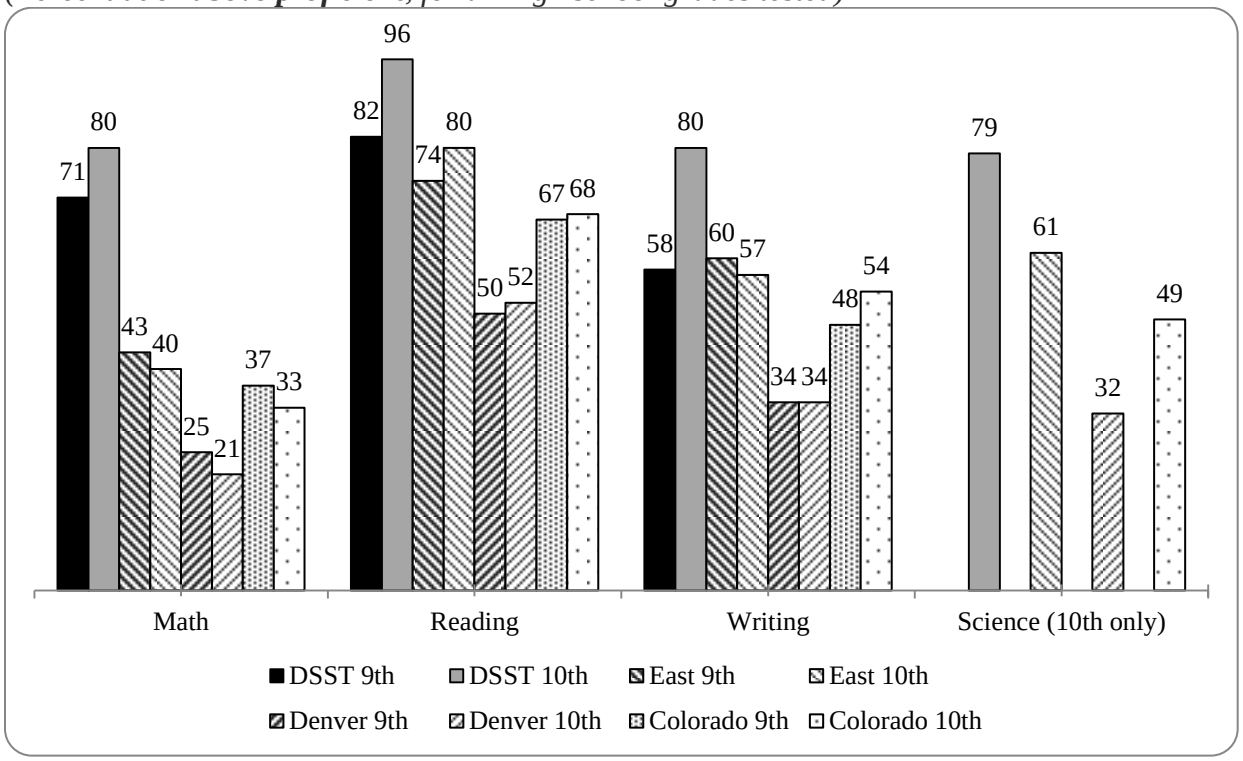
2.5.3. Assessment Scores: How are DSST: Stapleton Students Progressing and Achieving Academically?

In December of 2009 and August of 2011, the State Board of Education in Colorado adopted new Colorado Academic Standards, which replaced the older Colorado Model Content Standards. With the new standards came new state assessments based on those standards. For sixteen years, Colorado administered the Colorado Student Assessment Program (CSAP), which was based on the older standards; the CSAP was administered for the last time in 2011. Beginning in 2012, the Transitional Colorado Assessment Program (TCAP) served as Colorado's standards-based assessment, "designed to provide a picture of student performance to schools, districts, educators, parents and the community" (see http://www.cde.state.co.us/assessment/CoAssess-About.asp). TCAP was developed through a partnership between the Colorado Department of Education, CTB/McGraw-Hill, and the Colorado teaching community.

According to state law, every Colorado student enrolled in a public school is required to take either the TCAP or Colorado Alternate Assessments (CoAlt) in the appropriate grade levels and content areas. TCAP assesses the same content areas and grades as CSAP did previously: Mathematics, Reading, and Writing in grades 3 through 10; and Science in grades 5, 8, and 10. Figure 1 and Figure 2 compare DSST: Stapleton's performance on the 2012 TCAP assessments, broken out by content area and grade level across the comparison points. Figure 1 shows the percentages of students achieving at or above the "proficient" level. Overall, higher percentages of DSST: Stapleton students, especially the 10th grade students, passed the assessments for each of the subjects than in the comprehensive high school, DPS, and the state of Colorado. These differences were particularly sizable for the Mathematics assessment.

Figure 1

*2012 TCAP Results for DSST: Stapleton, Comprehensive High School, County, and State (Percent **at or above proficient**, for all high school grades tested)*

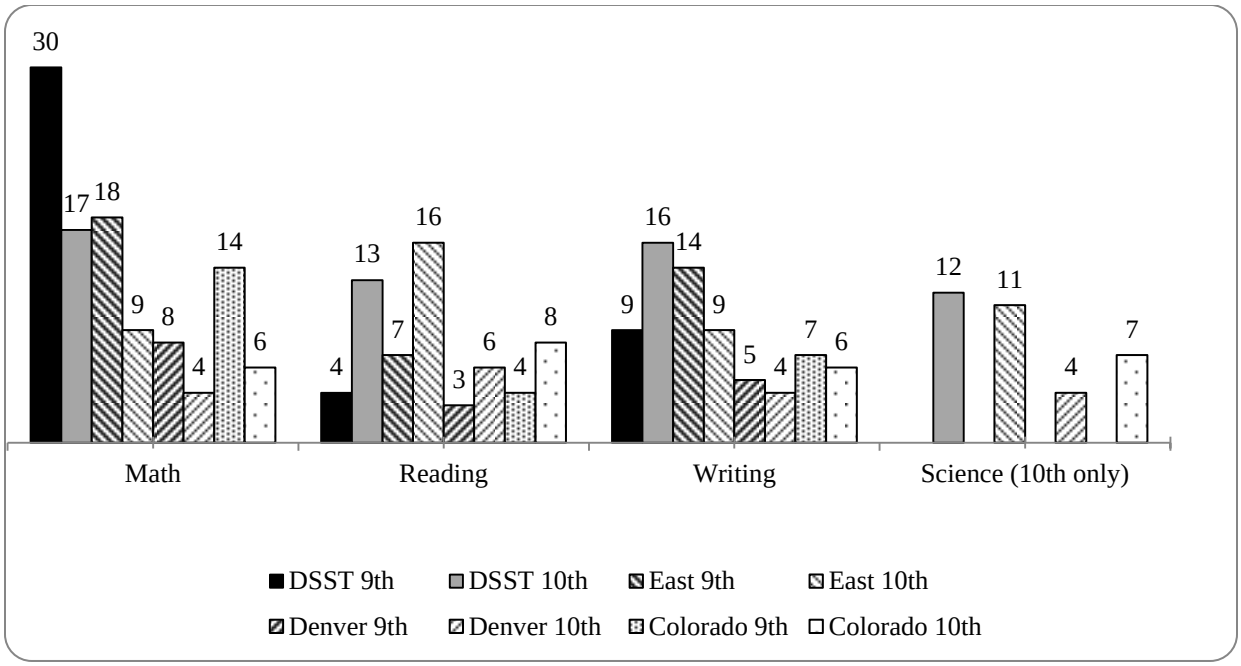


Source: "2012 TCAP School and District Summary Results" from Colorado Department of Education website (retrieved from http://www.cde.state.co.us/assessment/CoAssess-DataAndResults.asp on July 8, 2013).

Figure 2 shows similar comparative information, but focusing instead on the percentages of students achieving at the "advanced" level. Here, the differences were less uniform. DSST: Stapleton still outperformed all of the comparables in the Mathematics assessment, but they were outperformed on the Reading assessment and were essentially even on the Science assessment with the comprehensive high school.

Figure 2

*2012 TCAP Results for DSST: Stapleton, Comprehensive High School, County, and State (Percent **advanced**, for all high school grades tested)*

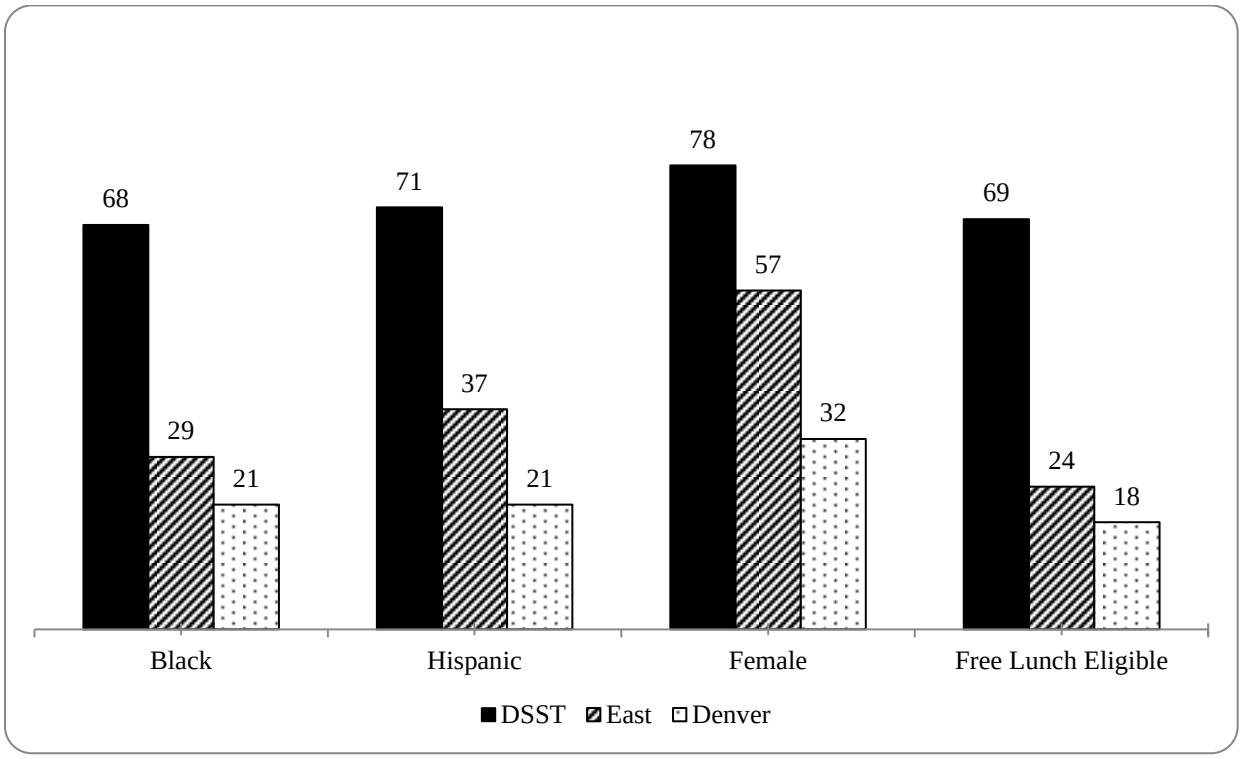


Source: "2012 TCAP School and District Summary Results" from Colorado Department of Education website (retrieved from http://www.cde.state.co.us/assessment/CoAssess-DataAndResults.asp on July 8, 2013).

DSST: Stapleton's mission and charter agreements espoused an overarching goal to support those student groups that are traditionally underrepresented in STEM fields, as described in the section *Inclusive STEM Mission*. Accordingly, a more detailed look at how certain student demographic subgroups performed on the TCAP assessments is informative. Figure 3 displays the percentages of students in four demographic subgroups that are traditionally underrepresented in STEM that achieved at or above the "proficient" level for the Science TCAP assessment in 2012: Black/African American, Hispanic/Latino, Female, and Free Lunch Eligible. The Science assessment is highlighted here because of its obvious ties to the STEM focus of DSST: Stapleton, but also because unlike the other TCAP assessments, only one high school grade—the 10th grade—takes the Science tests, making a disaggregated comparison more precise here. Because Colorado's Department of Education does not publish disaggregated data for those subgroups with fewer than 16 students, there is insufficient or unreported data for students with Individualized Education Programs (IEPs), eligibility for Reduced Price Lunches, or English Language Learners. Nevertheless, for the four subgroups below, DSST: Stapleton outperformed the comprehensive high school and the county on the Science assessment.

Figure 3

2012 TCAP Science Results for DSST: Stapleton, Comprehensive High School, and County (Percent at or above proficient, for all high school grades tested, disaggregated)

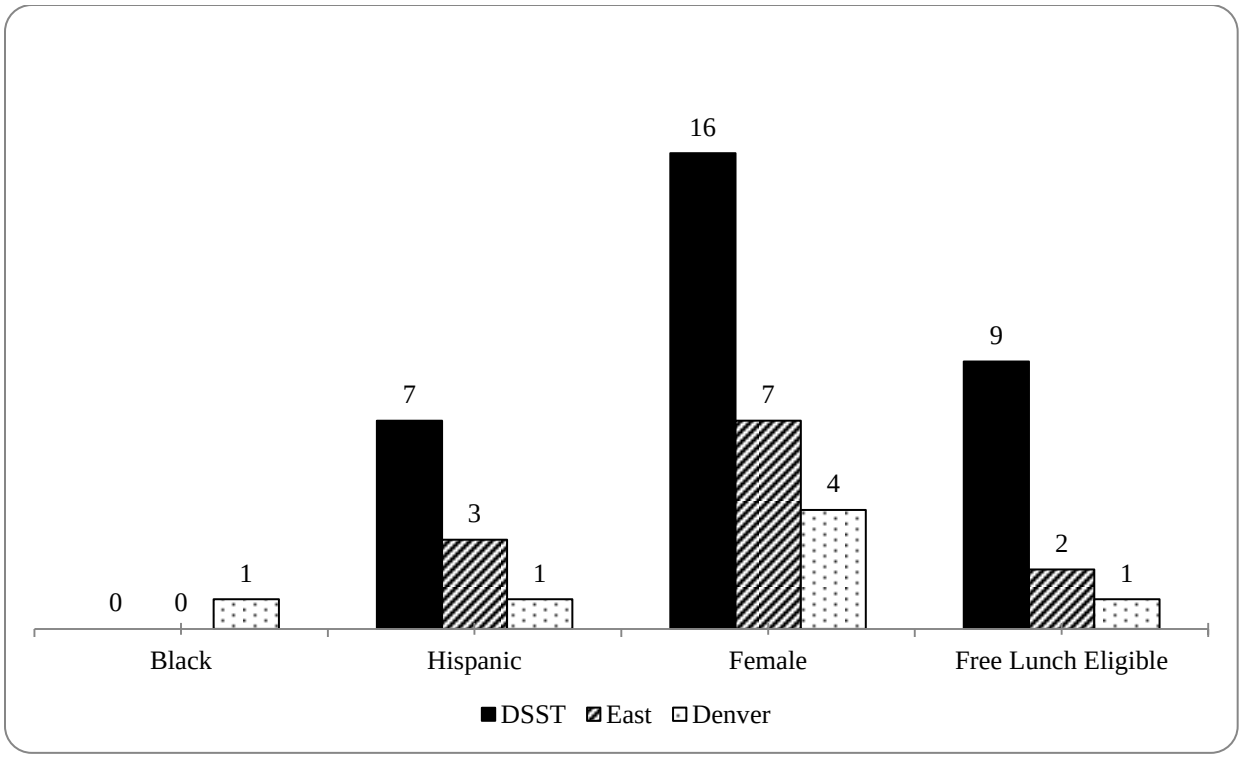


Source: "2012 TCAP School and District Summary Results" from Colorado Department of Education website (retrieved from http://www.cde.state.co.us/assessment/CoAssess-DataAndResults.asp on July 8, 2013).

Figure 4 displays similarly disaggregated data, but with percentages of students achieving at the "advanced" level. Black/African American students had low percentages across the board, but for the Hispanic/Latino, Female, and Free Lunch Eligible student subgroups, DSST: Stapleton appeared to serve its students quite well in bringing them to an advanced level of achievement on the Science assessments.

Figure 4

2012 TCAP Science Results for DSST: Stapleton, Comprehensive High School, and County (Percent advanced, for all high school grades tested, disaggregated)

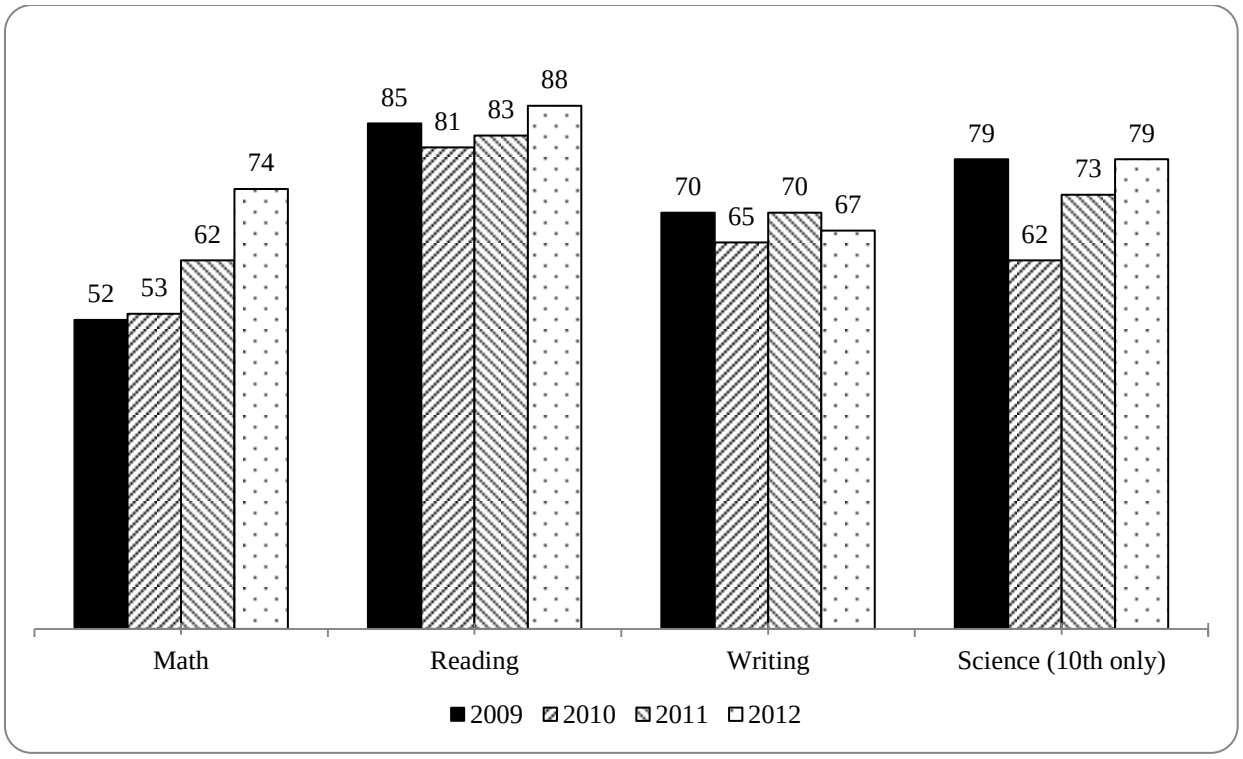


Source: "2012 TCAP School and District Summary Results" from Colorado Department of Education website (retrieved from http://www.cde.state.co.us/assessment/CoAssess-DataAndResults.asp on July 8, 2013).

One final perspective on DSST: Stapleton's state assessment outcomes comes from a review of the past four years of test scores. Figure 5 displays the percentage of students achieving at or above "proficient" in each of the four content areas between 2009 and 2012. Generally, DSST: Stapleton's achievement level was relatively consistent across the years, with the notable exception of the Mathematics assessment. The school's overall achievement on this assessment over the past four years shows a distinct upward trend, perhaps signaling a targeted focus on Mathematics instruction in the school by the administration and the teachers.

Figure 5

2009-2012 TCAP/CSAP Results for DSST: Stapleton (Percent at or above proficient, for all high school grades tested)



Source: "2012 TCAP School and District Summary Results" from Colorado Department of Education website (retrieved from http://www.cde.state.co.us/assessment/CoAssess-DataAndResults.asp on July 8, 2013).

The college entrance exam taken by Colorado students is the Colorado ACT (CO ACT), an 11th grade ACT assessment administered once in April and once in May. The academic assessment portion of the CO ACT covers the areas of English, Mathematics, Reading, and Science, and students receive a composite score along with scores for each of the skill areas. Table 15 details the numbers and percentages of students in DSST: Stapleton, the comprehensive high school, county, and state taking the CO ACT in the Spring of 2012, the most recent data available. Although in absolute numbers, DSST: Stapleton had far fewer students taking the CO ACT, their percentages were comparable across the board.

Table 15

Numbers and Percentages of Students Taking CO ACT in Spring 2012, Comparing DSST: Stapleton, Comprehensive High School, County, and State

	DSST: Stapleton	East High School	Denver County	Colorado
Total # of 11th Graders in 2011-2012	114	564	4,211	58,993
# Students taking CO ACT in 2012	108	533	3,952	52,498
% 11th Graders taking CO ACT in 2012	95	95	94	89

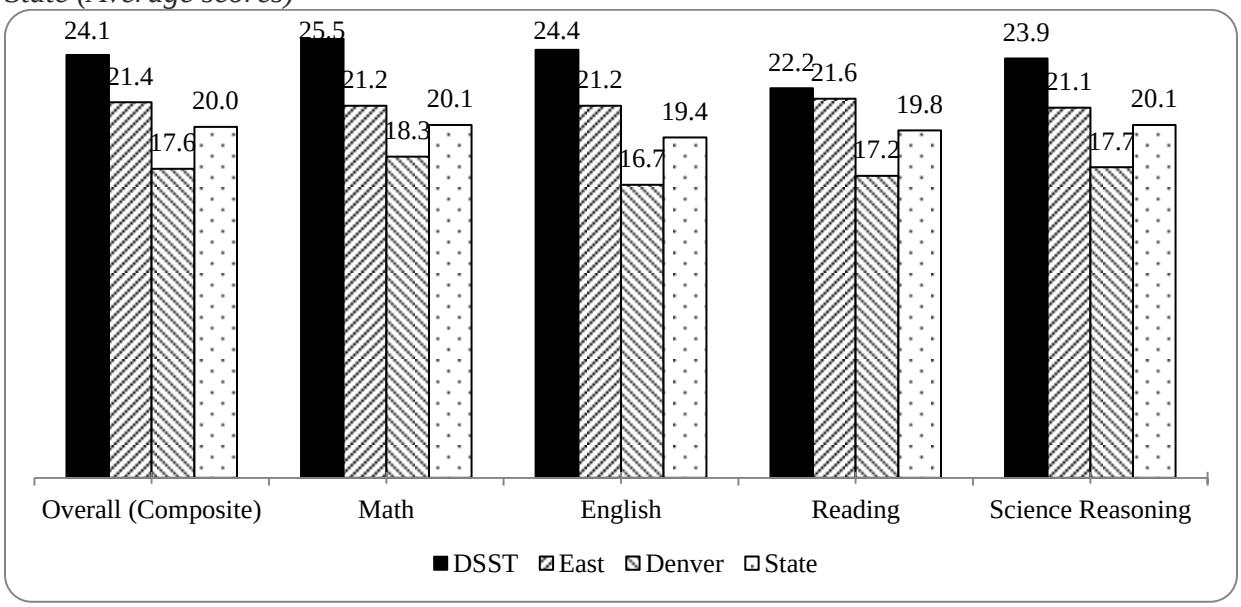
Source: "Pupil Membership by School and Grade Level" and "Pupil Membership by District and Grade Level" from Colorado Department of Education website (retrieved from http://www.cde.state.co.us/cdereval/rv2011pmlinks.htm on July 8, 2013); "2012 Colorado ACT State Status Summary and District and School Results" from Colorado Department of Education

website (retrieved from http://www.cde.state.co.us/assessment/CoACT-DataAndResults.asp on July 8, 2013).

Of the students taking the CO ACT in Spring 2012, DSST: Stapleton's students outperformed those students from the comprehensive high school, county, and state in the overall composite score and in each of the content areas, as shown in Figure 6.

Figure 6

2012 Colorado ACT Results for DSST: Stapleton, Comprehensive High School, County, and State (Average scores)



Source: "2012 Colorado ACT State Status Summary and District and School Results" from Colorado Department of Education website (retrieved from http://www.cde.state.co.us/assessment/CoACT-DataAndResults.asp on July 8, 2013).

2.5.4. High School Graduation: Longer-Term Outcomes.

The Colorado Department of Education adopted a new four-year on-time graduation rate definition in 2009-10 for all of its schools and districts. They defined "on-time" as including "only those students who graduate from high school four years after transitioning from eighth grade" (see http://www.cde.state.co.us/cdereval/gradcurrent.htm). In other words, the anticipated year of graduation was determined by adding four years to the year that a student moves to the high school from eighth grade. For the Class of 2012, the full formula used to determine this four-year "on-time" graduation rate, was: (Number of students receiving a regular diploma during the 2011-12 school year, within four years of transitioning from eighth grade) divided by [(Number of students transitioning from eighth grade at the end of the 2007-08 school year) + (Number of transfers in) – (Number of verified transfers out)].

Table 16 compares the four-year graduation/completion rates and extended graduation rates for the class of 2009-2010 at DSST: Stapleton with a comprehensive high school and the total of all traditional high schools in the DPS system, which include public and charter schools, but not

alternative schools. Noted is that the on-time graduation rate for DSST: Stapleton and East High School are similar, and both higher than DPS. However, DSST: Stapleton's extended graduation rates close in on 100% by the 6th year, a testimony to DSST: Stapleton's commitment to support students to graduate from high school.

Table 16

Four-year and Extended Graduation/Completion Rates 2009-2010, for DSST: Stapleton and Comprehensive High School

	DSST: Stapleton (9-12) (n_{2011} = 98) %	East High School (9-12) (n_{2011} = 502) %	DPS (9-12) [a]Traditional (n_{2011} = 3813) %
4-Year Graduation Rate	80.7	80.7	61.7
On time Completion Rate	83.1	82.1	68.6
Extended Graduation Rate – by 5th year	90.7	88.9	76.4
Extended Completion Rate – by 6th year	97.4	90.1	79.4
Dropout Rate – per year grades 7-12	0.8	1.2	5.7

All DPS and DSST data from http://communications.dpsk12.org/facts.html

[a] Traditional schools include charter schools but do not include alternative schools

Table 17 compares the graduation rates for DSST: Stapleton, the comprehensive high school, the county, and the state for the 2011-2012 school year. For this year DSST: Stapleton either matched or exceeded the graduation rates for the county and state both overall and for the various student subgroups. It is interesting to note that the comprehensive high school had a higher on-time graduation rate overall and for many critical student subgroups, including those traditionally underrepresented in STEM fields. This may be a result of DSST: Stapleton's relatively strict policies around student retention, which would result in a lower four-year "on-time" graduation rate, as defined by the state of Colorado. Nevertheless, their graduation rates did exceed those of the county and the state, and DSST: Stapleton's extended graduation rates are close to 100% indicating that students who persist are most likely to graduate at DSST: Stapleton.

Table 17

Four-year On-time Graduation Rates for 2011-2012, for DSST: Stapleton, Comprehensive High School, District, and State

	DSST: Stapleton	East High School	Denver County	Colorado
All Students (%)	80.0	89.6	58.8	75.4
Females (%)	86.4	92.1	67.0	79.5
Males (%)	74.1	86.5	50.8	71.4
American Indian/Alaska Natives (%)	n/a	50.0	36.8	57.7
Asian (%)	100	88.2	69.1	82.9
Hispanic (%)	75.6	85.3	55.2	62.5
Black (%)	80.0	89.2	58.2	66.2

Native Hawaiian/Pacific Islander (%)	n/a	n/a	50.0	70.1
White (%)	80.0	92.6	67.5	82.1
Two or More Races (%)	100	88.0	71.4	80.4
Limited English Proficient (%)	57.1	73.3	52.7	53.3
Economic Disadvantaged (%)	77.6	81.3	53.7	61.4
Students with Disabilities (%)	33.3	75.6	38.3	53.7
Homeless (%)	50.0	68.4	33.6	49.1

Source: "Graduation Data for the Class of 2011-12" from Colorado Department of Education website (retrieved from http://www.cde.state.co.us/cdereval/gradcurrent.htm on July 8, 2013).

2.5.5. Summary.

By most measures, students from DSST: Stapleton either matched or outperformed comparison groups in standardized test performance and graduation rates. DSST: Stapleton served a broader demographic of minority students than comparison groups, and when performance was disaggregated by demographic group, DSST: Stapleton's students still tended to outperform the comparison groups. The one area where DSST: Stapleton appeared to be less successful was in graduating students within four years of entering high school. This outcome was consistent with the school philosophy of not graduating students until they have demonstrated proficiency in all required courses. If we look at DSST: Stapleton's five and six year graduation rates (see Table 16) we see that graduation rates approached 100% of students enrolled. DSST: Stapleton's goal was to ensure that all students graduated with adequate preparation to enter STEM majors in college. Given that all students who persisted would graduate fulfilling DSST: Stapleton's graduation requirements, which included mathematics to a pre-calculus level, this goal was being fulfilled. DSST: Stapleton welcomed all students through an open lottery application, ensured that at least 40% of its applicants came from economically disadvantaged families, served a broad and mixed demographic population, supported all of its students in achieving the graduation requirements, and produced students who were able to perform at or above comparison groups on standardized assessments.

It is worth emphasizing, however, that this OSPrI study is not presenting these student outcome data as causal evidence that DSST's design and implementation have led directly to any particular positive student outcomes. These data do not allow such inferences, because the comparisons are at times statistically inexact, relying on existing data but without a carefully drawn sample for an experimental comparison group. Such a study would need to take into account such factors as differences in students' achievement or STEM interest prior to entering high school, among others. Such an effectiveness study is beyond OSPrI's scope. Instead, these comparisons merely mirror the rough comparisons and estimates that schools and districts often use in looking at trends and general indicators to judge a school's successes.

2.6. CONCLUSION AND IMPLICATIONS

This case study detailing DSST: Stapleton is the fourth of a set of cases on inclusive STEM-focused high schools. DSST: Stapleton is the first to open of a network of Denver charter schools with an intentional STEM focus, and mission to prepare all students to enter college STEM majors, along with 100% college acceptance and success. In comparison with local and state averages, DSST: Stapleton boasts a lower dropout rate and higher on-time and extended high

school completion and graduation rates (see Tables 12-14), while maintaining an open acceptance policy.

The data collected and analyzed support the existence of each of the 10 critical components proposed by the researchers and supported by education literature (see Table 2). Our findings suggest that the *Administrative Structure* and *Supports for Underrepresented Students*, along with the *Inclusive STEM Mission*, and *STEM-focused Curriculum* played the most dominant role in characterizing the school. The school's *Well-Prepared STEM Teaching Staff, Integrated, Innovative Technology Use*, and its *Blended Formal/Informal Learning Beyond the Typical School Day, Week or Year* certainly supported the dominance of the first four components. Of lesser significance, but still important in the overall manifestation of this successful inclusive STEM-focused high school were *Reform Instructional Strategies and Project-Based Learning*, *Real-World STEM Partnerships*, and *Early College Level Coursework* as defined in the research proposal. Themes that emerged from the data that were not covered with the critical components include a *School Culture* of high expectations, structure and support; a common focus on *Grit* and determination to meet the demands of this challenging environment; intentional *Gradual Release* to help students take increasing responsibility for their actions and successes; and *Data-driven Decision-making* to ensure that all actions are validated through documented need.

While DSST: Stapleton's performance is the result of many factors, we identified several areas that we believe the school emphasized, which helped to guide its functioning.

When examining the school across our 10 critical components and the emergent themes, DSST: Stapleton's most prominent and impactful features were the emphasis the school placed on its:

1. Administrative structure. DSST: Stapleton had a strong administrative structure with defined roles and relationships reaching from the DSST Home Office to each school director, dean, teacher, or other staff member. This administrative structure helped to instruct new employees and assimilate them to the organization so that they might eventually be promoted from within. For example, the DSST network provided targeted professional development dedicated to improving leadership skills. The network's administrative structure also allowed for staff members in similar roles at the different DSST network schools to meet and engage with one another so that each school could learn from the network's collective experience. This in turn provided a synchronous experience that could be tweaked and modified with reasonable facility to respond to new developments. Moreover, the administrative structure formed many of the formal and informal organizational structures that help to promote DSST's core beliefs.
2. Supports for underrepresented students. DSST: Stapleton's admissions policies worked to ensure that the school population was comprised of the targeted diverse group of students. In alignment with its mission, the school provided a structure dedicated to preparing all of its students for college graduation and ultimate success in future academic and professional pursuits. Given the history of DPS and the State of Colorado having struggled to achieve high percentages of students graduating high school and attending college, DSST: Stapleton focused on providing the means for students from all backgrounds to achieve these goals. DSST: Stapleton designed its institutional structures to support underrepresented students throughout their four years of high school. This was best exhibited by the school's emphasis on advising and college readiness. All students

were held to high standards and were given a great deal of support to accomplish these standards After visiting DSST: Stapleton and talking to administrative figures, it was apparent that the school intended to graduate all of its students and that all of its students would be well prepared to complete four years of college.

3. Focus on grit. DSST: Stapleton's core values and overall philosophical guidance system were built upon the notion that students needed to develop a strong sense of grit. Students must persevere through the challenging courses and multiple rigorous projects if they were to graduate from DSST: Stapleton. Unlike other schools that might socially promote its students, DSST: Stapleton was very much unafraid of holding students back if they did not meet yearly grade standards. Consequently, it was not entirely uncommon for students to graduate from high school in five or six years instead of the more common four. Grit emerged as a strong philosophical point for the school and was reflected throughout the school community in conversations with administrators, teachers, students and parents.
4. School culture. DSST: Stapleton truly believed in its motto: "Culture is King." DSST: Stapleton's school culture guided all other aspects of the school, from its official policies to how students acted in the hallway. DSST: Stapleton's school culture valued accountability and support, while also establishing a sense of professionalism. Elements of the school's culture were constantly visible, whether it was the core values that were hung at the school's entrance, the motto painted in a mural in a stairwell, the dress code, or any number of other features. Moreover, DSST: Stapleton had developed programs like its advisory and Refocus periods to help students get accustomed to the new cultural environment that they experienced at school. The school culture factored significantly into the hiring process for prospective teachers. Given its omnipresence, DSST: Stapleton's school culture was one of the defining characteristics of the school.

While these critical components and emergent themes best characterized DSST: Stapleton's functioning and success, the remaining critical components and emergent themes served in supporting roles for the components and themes that rose to the top in significance. The DSST network created a high school at DSST: Stapleton that offered their students the opportunity and support to master a strong STEM-focused curriculum While DSST: Stapleton did not put a significant emphasis on the completion of college level classes during high school, it instead invested its energy to make sure that all students were well prepared for the rigors of college once they got there by instituting a system of gradual release so that students took ownership of their academic progress. The academic program, however, did not constrain those students who sought to advance academically. Teachers were well prepared. They came from a variety of backgrounds and were supported in learning the pedagogical routines and norms by the DSST network, that in turn supported student learning. Classroom environments were fairly traditional in feel and facilitated the building of content knowledge base, and students were supported in developing professional, and other non-cognitive skills through their internships and senior projects. DSST: Stapleton's emphasis on technology helped students to develop the computer and technological skills they needed to succeed in college and modern work environments. All of the work that DSST: Stapleton did to build its opportunity structures was with the intent of helping local Denver students of all backgrounds succeed in college and beyond.

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