Dozier-Libbey Medical High School: A case study of an inclusive STEM-focused high school in Antioch, California

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EXECUTIVE SUMMARY

This case study of Dozier-Libbey Medical High School (DLMHS) is the seventh in a set of eight school-level cases on inclusive STEM-focused high schools (ISHSs). In contrast to highly selective STEM-focused schools that target students already identified as being STEM gifted/talented, the goal of ISHSs is to develop new sources of STEM talent among a wide range of students underrepresented in STEM fields, and provide them with the means to succeed in school and in STEM college majors, jobs and careers. DLMHS is one such ISHS located in Antioch, California. The school was founded in 2008 with hardship funding provided by the State of California to construct the school. Additional funding from the Irvine Foundation supported the development of a district-wide linked learning pathway initiative which supported the healthcare focus on the school. This initiative identified a community interest in preparing students to enter the robust healthcare job market in Antioch which inspired the design of a medical themed “career technical education” (CTE) school.

This case study provides an in-depth look at DLMHS’s design, implementation, and outcomes, by examining the school using a framework of 10 candidate critical components that OSPri researchers located through a search of the research literature (Peters-Burton, Lynch, Behrend, & Means, 2014). In April 2013, a team of six researchers visited the school and systematically collected data from classroom observations, interviews, and focus groups, as well as examining public information documents and outcome records. This examination of DLMHS revealed valuable insights into a successful ISHS; the school provided a unique, college preparatory, innovative CTE approach to curriculum and instruction, different from that found in traditional, comprehensive public schools. This environment fostered a community of students and teachers who were engaged in creating new opportunities for students to learn STEM in the context of medicine and healthcare.

Analyses of the data collected showed that some of the 10 candidate critical components were more salient than others at DLMHS. Of the 10 candidate critical components examined in this study, all were evident at DLMHS, but our findings suggested that the STEM-focused Curriculum; Well-Prepared Teaching Staff; and, Inclusive STEM Mission were especially important. Furthermore, the OSPri researchers identified two emergent themes within the data. Career Readiness and Identity was the first theme identified through high expectations, structure, and support of the linked-learning medical pathway. Changing Resource Constraints was the second emergent theme that stemmed from school’s financial challenges due to its California context; a state experiencing education cutbacks due to state budget issues. This seemed to affect the school considerably.
1. INTRODUCTION

A new type of public high school is being implemented across the United States, the inclusive STEM-focused high school (ISHS) (Means, Confrey, House, & Bhanot, 2008). As some ISHSs have rapidly established records of success with students from groups underrepresented in STEM fields, these schools have gained national recognition, have been featured in reports of the National Research Council (2011, 2012, 2013), and highlighted as a recommended educational reform mechanism by the President’s Council of Advisors on Science and Technology in their report, Prepare and Inspire: K-12 Education in STEM for America’s Future (PCAST, 2010). The mission of ISHSs is to provide opportunities for a range of students who wish to focus on science, technology, engineering, and mathematics (STEM) fields. The goal of ISHSs is to purposefully prepare all students, including those from groups underrepresented in STEM fields, for college STEM majors and careers. Early ISHSs have demonstrated success in engaging and broadening participation of underrepresented groups in college preparatory STEM coursework (National Research Council, 2011). Currently, new school models are being designed and implemented across the country. However, to date, there have been few studies on ISHSs (National Research Council, 2011, 2012, 2013). This study, Multiple Instrumental Case Studies: Opportunity Structures for Preparation and Inspiration (OSPI) (Lynch, Behrend, Means, & Peters, 2011), funded by the National Science Foundation, seeks to identify and characterize successful ISHSs by examining their design, implementation, and outcomes within their unique contexts.

This case study of Dozier-Libbey Medical High School (DLMHS) is the seventh in a set of eight ISHS cases conducted by the OSPI project. Each school in the study varied by their geographic location, student demographics, and community context; although, all were focused on students underrepresented in STEM fields and had inclusive admissions policies. DLMHS is a healthcare-themed high school in a small urban public school district in northern California. The Antioch Unified School District decided on this theme for a new high school based on the growth in the healthcare industry in its region. Moreover, two of the three top employers in the area in 2009 were health-related institutions: Kaiser Permanente and Sutter Delta Medical Center (Antioch Department of Finance, 2012). More details about selection of this case are included in a later section, following an overview of the research framework.

1.1. Framing the Study

This case study of Dozier-Libbey Medical High School asks:

1. Is there evidence of each of the candidate critical components (shown in Table 1) in the design of DLMHS, the school that is the focus of the case study?
2. How are the candidate critical components implemented at DLMHS? 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 DLMHS’s design, implementation, and student outcomes?
4. How do DLMHS’s student STEM outcomes compare with those of the school district and state (e.g., STEM achievement measures, graduation rates, college acceptance rates)?
Our research approach is to explore three dimensions of an ISHS--design, implementation, and student outcomes--focusing on the 10 candidate critical components defined in Table 1. Note that the order of the candidate critical components in Table 1 is not intended to indicate relative importance. In addition to exploring these 10 components, data were analyzed for emergent themes – other aspects of the school that seemed to make an important contribution to student outcomes.

Table 1
Definitions of Candidate Critical Components

<table>
<thead>
<tr>
<th>1. STEM-Focused Curriculum</th>
<th>Strong courses in all 4 STEM areas, or, engineering and technology explicitly, intentionally integrated into STEM subjects and non-STEM subjects.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Reform Instructional Strategies and Project-Based Learning</td>
<td>STEM classes emphasizing 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.</td>
</tr>
<tr>
<td>3. Integrated, Innovative Technology Use</td>
<td>Technology used to connect students with information systems, models, databases, STEM research resources, teachers, mentors, social networking resources for STEM ideas; includes during and outside the school day.</td>
</tr>
<tr>
<td>4. Blended Formal/Informal Learning beyond the Typical School Day, Week, or Year</td>
<td>Learning opportunities not bounded but ubiquitous; learning spills into areas regarded as informal STEM education, including apprenticeships, mentoring, social networking, and doing STEM in locations off of the school site, e.g., in the community, museums and STEM centers, and business and industry.</td>
</tr>
<tr>
<td>5. Real-World STEM Partnerships</td>
<td>Students connecting to business/industry/world of work via mentorships, internships, or projects that occur within or outside the normal school day/year.</td>
</tr>
<tr>
<td>6. Early College-Level Coursework</td>
<td>Opportunities for students to take college level coursework and earn college credits, e.g., AP classes, online college courses, college classes at institutions of higher education; facilitated by flexible school schedule.</td>
</tr>
<tr>
<td>7. Well-Prepared STEM Teaching Staff</td>
<td>Teachers certified to teach in their STEM subject areas and having advanced STEM content knowledge and/or practical experience in STEM careers; opportunities for professional development.</td>
</tr>
<tr>
<td>8. Inclusive STEM Mission</td>
<td>Stated mission/goals to prepare students for STEM, with emphasis on recruiting students from underrepresented groups.</td>
</tr>
<tr>
<td>9. Administrative Structure</td>
<td>Various structures (e.g., school-within-a-school, charter school, magnet school), 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; various funding structures.</td>
</tr>
<tr>
<td>10. Supports for Underrepresented Students</td>
<td>Bridge programs, tutoring programs, extended school day, extended school year, or looping to strengthen student transitions to STEM-focused curriculum; altered, improved opportunity structures, i.e., students positioned for STEM college majors, careers, and jobs.</td>
</tr>
</tbody>
</table>

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1 Herein after referred to as critical components, with the understanding that they are hypothesized to be critical to the success of an ISHS.
This case study includes a brief summary of school selection and data collection methods. The reader is referred to the Research Framework document located on the OSPrI project website (ospri.research.gwu.edu) for a more detailed rationale for exploring the 10 components listed in Table 1, and methods for school selection and recruitment, data collection, and data analysis.

1.2. Selection of Dozier-Libbey Medical High School

The OSPrI study seeks to characterize “exemplar” ISHSs and conduct cross-case analyses to build a theory of action for ISHSs (Chatterji, 2002). In selecting cases for our research, there were three criteria: inclusiveness, STEM focus, and strong student outcomes for demographically similar groups of students, compared to the district and state statistics. In addition, the schools had to self-identify as STEM schools.

DLMHS served an ethnically diverse student body (38% Hispanic/Latino, 9% Filipino students, 16% African American, 10% Asian, and 22% White students) and about half of the students were classified as socioeconomically disadvantaged. The California Department of Education (2010) uses this term to mean either “A student neither of whose parents have received a high school diploma” or “a student who is eligible for the free or reduced-price lunch program.” The school met our selection criterion of inclusiveness because it used a lottery to select from all students who applied, regardless of their prior academic achievement. Each 9th grade class was selected by assigning spaces based on the percentage of eighth graders graduating from each of the district’s middle schools.

DLMHS met our criterion as STEM-focused. It required students to take more mathematics and science courses to graduate than district and state requirements. We expected that some STEM classes might be more integrated than found in traditional schools and that engineering or technology courses might also be required. DLMHS required all students to complete four years of mathematics (e.g., beginning with Algebra 1 or higher), one more year than the state and district graduation requirement. It also required four years of science, including college preparatory Biology, Chemistry, and Physics. This ISHS did not offer technology or engineering courses, but did offer specialized healthcare coursework, such as Physiology, Mathematics for Health Sciences, Medical Ethics, and other health science courses.

Finally, DLMHS met our criterion that it demonstrated stronger student outcomes (e.g., science and mathematics achievement test scores, graduation rates, college-going rates) than the averages for the school district and state. There is a section of the case study dedicated to DLMHS student outcomes that has additional information.

1.3. Data Collection

To begin to understand the school’s design and context, we collected data before the site visit to the school using publicly available data and documents found on the school and district websites. A school administrator completed two questionnaires prior to the visit and we conducted phone interviews with the administrator to follow up on questionnaire responses and asked open-ended questions using a semi-structured interview protocol. In addition, 25 teachers completed a
questionnaire that provided information about their academic backgrounds and their views on teaching at DLMHS.

To understand implementation of the school program focusing on the study’s 10 critical components, the OSPrI study team, comprised of six researchers working in pairs, collected data during a three-day site visit. We used classroom observation instruments, focus groups, and interviews of key individuals. Details of data collection activities during the site visit are shown in Table 2.

**Table 2**

*Data Collection Activities during DLMHS Site Visit*

<table>
<thead>
<tr>
<th>Classroom Observations</th>
<th>Non-STEM Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEM Classes</td>
<td></td>
</tr>
<tr>
<td>Algebra</td>
<td>English</td>
</tr>
<tr>
<td>Anatomy</td>
<td></td>
</tr>
<tr>
<td>AP Calculus</td>
<td></td>
</tr>
<tr>
<td>Biology</td>
<td></td>
</tr>
<tr>
<td>Chemistry</td>
<td></td>
</tr>
<tr>
<td>Health 3</td>
<td></td>
</tr>
<tr>
<td>Medical Ethics</td>
<td></td>
</tr>
<tr>
<td>Physics</td>
<td></td>
</tr>
<tr>
<td>Pre-calculus</td>
<td></td>
</tr>
<tr>
<td>Non-STEM Classes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Focus Groups</td>
<td></td>
</tr>
<tr>
<td>Teachers/Other</td>
<td>Students/Parents</td>
</tr>
<tr>
<td>Business Partners</td>
<td>9th Grade Students</td>
</tr>
<tr>
<td>Health Teachers</td>
<td>11th Grade Students</td>
</tr>
<tr>
<td>Science Teachers</td>
<td>Health Students</td>
</tr>
<tr>
<td></td>
<td>Informal Learning Students</td>
</tr>
<tr>
<td></td>
<td>Parents</td>
</tr>
<tr>
<td>Interviews</td>
<td></td>
</tr>
<tr>
<td>School Personnel</td>
<td>Non-School Personnel</td>
</tr>
<tr>
<td>Career Counselor</td>
<td>Antioch Unified School District Representative</td>
</tr>
<tr>
<td>Guidance Counselor</td>
<td></td>
</tr>
<tr>
<td>Work-Based Learning Coordinator</td>
<td></td>
</tr>
<tr>
<td>Special Education &amp; Resources Coordinator</td>
<td></td>
</tr>
<tr>
<td>Principal</td>
<td></td>
</tr>
<tr>
<td>Other Activities</td>
<td></td>
</tr>
<tr>
<td>School Day</td>
<td>After School</td>
</tr>
<tr>
<td>School Tour</td>
<td>N/A</td>
</tr>
<tr>
<td>Researcher Activities</td>
<td></td>
</tr>
<tr>
<td>Team Debrief – Day 1</td>
<td></td>
</tr>
<tr>
<td>Team Debrief – Day 2</td>
<td></td>
</tr>
</tbody>
</table>
2. CONTEXT

View of Dozier-Libbey Medical High School from a satellite image downloaded from the Internet (Google Maps, 2014). DLMHS (shown in the bottom right corner) was situated on the southern border of Antioch, CA, adjacent to the Kaiser Medical Center as shown in the top left corner (Google Maps, 2014).

The physical structure of DLMHS consisted of a campus with several long buildings containing the classrooms, lab spaces, library, gymnasium, cafeteria, and administrative buildings. OSPrI’s six-person research team arrived in April 2013 for the three-day site visit.
2.1. The School District and Locale

Dozier-Libbey Medical High School (DLMHS) is a public school in Antioch, CA. Antioch is located in the East Bay region of the San Francisco Bay Area and is situated near the San Joaquin-Sacramento River Delta. According to the 2010 United States Census (United States Census Bureau, 2010), Antioch had a population of 102,372. The racial composition of Antioch was: White: 48.9%, African American: 17.3%, Native American: 0.9%, Asian: 10.5%, Pacific Islander: 0.8%, other races: 14.0%, and two or more races: 7.7%. Hispanic or Latino of any race was approximately 31.7%.

Most adults in Antioch commuted to work in San Francisco and Oakland (Antioch City Planning Committee, 2011). However, there had also been a recent influx of job opportunities in Antioch related to healthcare. Specifically, health-related employment in Antioch increased by 79% between 2004 and 2009 (Antioch Department of Finance, 2012). Moreover, two out of three of the top employers in the area in 2009 were health-related institutions: Kaiser Permanente and Sutter Delta Medical Center (Antioch Department of Finance, 2012).

The third largest employer in the area was the Antioch Unified School District, which operated 14 elementary schools, 4 middle schools, 3 secondary schools, 3 charter schools, and 6 alternative education institutions with a total of 18,852 students (Antioch Department of Finance, 2012). Of those, 39.1% of the school district’s enrollment were Hispanic, 24.8%; Black, 19.9%; Caucasian, 5.2%; two or more races, 4.8%; Asian, 4.5%; Filipino, 1.0%; Pacific Islander; and 0.8% American Indian (Antioch Unified School District, 2013b). Sixty-three percent of the district’s students were classified as socioeconomically disadvantaged, which means either “a student neither of whose parents have received a high school diploma” or “a student who is eligible for the free or reduced-price lunch program” (California Department of Education, 2010).

2.1.1. California State Budget Complications and Changing Resource Constraints

During our April 2013 visit, our research team heard about (through interviews and focus groups with teachers and administrators) some of the effects of recent state level budget reductions to which the DLMHS and the school district were responding. In a 2012 budget report, the district stated:

Difficult budget reduction decisions were made over the last five years. Due to prolonged decreases in state revenue, and the expiration of one-time revenue allocations, significant ongoing reductions may be required in future years for the district to remain fiscally solvent (Antioch Unified School District, 2012)

The state school budget problem for California deepened during the 2012-2013 fiscal year. Governor Brown offered revisions to his proposed 2012-2013 budget in May 2012. The revised spending plan estimated that the state had a $15.7 billion budget gap, which was $6.5 billion greater than the amount the Governor had identified in his January 2012 proposed budget. The state’s budget problem had increased primarily because of lower tax revenues than projected, higher costs for schools, and the decision by the courts and federal government to block previously approved budget cuts in non-education related sectors (Antioch Unified School
District, 2012). In November 2012, California voters agreed to a tax increase that would fund California $6 billion a year over the next seven years through a one-quarter-cent increase in the state sales tax and income tax rate increases for those earning more than $250,000 a year; the increases would last four years and seven years, respectively. Without the increases, Governor Brown argued that he would have had to cut an additional $6 billion a year in spending, most of it from the public education system (State of California, Department of Finance, 2012).

When the research team visited DLMHS, it was a time of fiscal transition for the district. Over the previous five years, the school district had seen steep reductions in their education budget and the impact was pronounced. In addition, while the district received funds through the Irvine Foundation to help establish linked learning pathways (discussed further in the section, STEM-Focused Curriculum), this grant was in its final year at the time of our visit and the school staff knew they would soon have to operate without these funds. These two factors left many at DLMHS with questions regarding the continuity of programs, staff positions, supplies, and professional development for the next year. The Executive Director of Programs & Interventions for Antioch Unified School District explained that the money from state hardship funds were used to cover construction costs of DLMHS and that an Irvine Grant ($120,000-$130,000) was used to cover the start-up cost to open DLMHS along with another school, the Performing Arts Academy. Afterward, the district reapplied for ongoing funding and received a two-year grant for 1 million dollars, funding the school district through the end of the 2013-2014 school year. Through these grants, the district had been able to fund the development of a set of “linked learning pathways” at all of the district schools, including DLMHS. This pathway system will be explained in the section STEM-Focused Curriculum. The principal of DLMHS said these grants have been “really helpful with staff development money and providing really good quality staff development to our teachers around integrating curriculum.”

Since funds from the Irvine Foundation had been spent and the reduced funding from the state of California was expected to continue, teachers and administrators at DLMHS spoke with uncertainty regarding the positions, programs, supplies, and services that could be offered at DLMHS in the following year. When we asked the principal in a focus group what would happen to the work-based learning coordinator position after the grant phased out, she responded:

We are working on that right now. We are getting creative with our master schedule and we are waiting to hear from the district about the clerical funding. And you know, we have posed the question [of whether there will be funds for clerical positions] and if they are not, what do we do? If we are doing the pathways, this is an essential piece.

This was not the only example of DLMHS being affected by the budget. School supplies, travel and professional development were also reportedly cut. A science teacher said he was paying out of pocket for school supplies and an AP teacher was denied a request for financial assistance to attend an AP conference. In addition, many teachers requested further professional development on integration of medical themes into content areas, but with such a small budget, the only professional development that was available was district-led and given only three times a year on topics of the district’s choosing, rather than DLMHS teachers’ interest and needs.
In spite of these budget challenges, teachers at DLMHS strived to make the school work. One teacher had started a recycling drive that paid for lab supplies. He said in a focus group, “I have the kids gather the recycling and I drive it down to the center and that nets us $600-$800 a year and just pays for the supplies I need for AP Biology.” Teachers at DLMHS have tried to make the best out of the tough monetary situation in California. The AP Biology teacher added, “We make do with what we have. We make sure we take the extra step out of our pocket. If there is something we desperately want, then we go to Nancie [school principal] and she figures out a way.”

The California and district-level financial picture has been included in this case study because DLMHS, as it will be shown, was adjusting to budget issues at the time of the site visit. While the school was still functioning well, it had not entirely found ways to compensate for cuts in services it had come to expect in prior years, and was somewhat in flux. Thus, these economic constraints must be mentioned in order to understand the case study of DLMHS.

2.2. School History and Design

Dozier-Libbey Medical High School opened in August 2008 with a freshmen class of 212 students, adding a new ninth grade class of approximately 175 students each subsequent year. Two years prior to the school’s opening, the Antioch Unified School District had two large comprehensive high schools, but needed to open a new school to ease overcrowding. Several teachers, administrators, and local stakeholders formed a planning committee to open a new school and use open land owned by the district.

The Antioch Unified School District operated several of its schools using content-oriented programs called pathways. These pathways took the form of either a “Small Learning Community” (SLC), in which a small group of teachers worked with a common group of students to improve academic performance, or a “Linked Learning Pathway” (LLP) which was described as “a four year sequence of career technical courses that link the content across the curriculum and include career-based learning activities.” In other words, the SLCs focused on students who needed additional academic support while the LLPs were a four-year program designed around the principles of Career and Technical Education (CTE). The LLPs and SLCs for each school in the 2012-2013 school year are listed in Table 3.
### Table 3. 
**Linked Learning Pathways and Small Learning Communities available by school in the Antioch Unified School District (Antioch Unified School District, 2013b)**

<table>
<thead>
<tr>
<th>School</th>
<th>Linked Learning Pathway (LLP) or Small Learning Community (SLC)</th>
</tr>
</thead>
</table>
| Antioch High School                       | Academy for Engineering & Designing a Green Environment (LLP)  
|                                            | Environmental Studies Academy (LLP)  
|                                            | Media Technology Academy (LLP)  
|                                            | Leadership and Social Justice (SLC)                                                                                           |
| Dozier-Libbey Medical High School         | Medical Pathway (LLP)                                                                                                           |
| Deer Valley High School                   | Bio Technology Academy (LLP)  
|                                            | Law and Justice Academy (LLP)  
|                                            | Performing Arts Academy (LLP)  
|                                            | Academic Challenge & Enrichment (SLC)  
|                                            | Business Tech Academy (SLC)  
|                                            | Non-themed Smaller Learning Community (SLC)                                                                                     |

The land that was developed to become DLMHS was located directly across the road from a recently opened and very large Kaiser Permanente complex. The decision to provide a linked learning pathway in healthcare was based on the school’s proximity to the Kaiser Permanente facility and trends in the local job market for healthcare careers. Following this decision, the DLMHS planning committee visited school districts that had similar healthcare CTE models, such as the Sacramento City Unified School District. The committee also formed an advisory team that included industry representatives from nearby healthcare organizations.

The DLMHS planning committee sought someone to take on the leadership role for the proposed new school. It found within its ranks Nancie Castro, a former middle school principal, and hired her as DLMHS’s principal. Nancie Castro and the rest of the planning committee spent the following two years surveying local parents and students, contacting education experts (e.g., Connect Ed and the Gates Foundation), other pathway-oriented schools (e.g., Health Professions High School in Sacramento, CA) to develop a plan for DLMHS.

#### 2.2.1. Student Admissions and Lottery Description

Students applied to the DLMHS through an application that was available on both the DLMHS and the Antioch Unified School District websites. DLMHS accepted students proportionate to the size of the Antioch Unified School District middle schools. For example, if a given Antioch middle school’s 8th grade population accounted for 22% of the 8th grade population in the entire district, then 22% of the names chosen for acceptance at DLMHS would be from that middle school. Students living outside of the Antioch Unified School District boundaries could submit an application along with an inter-district transfer request, but would only be considered if space were available. A lottery was then conducted by an external entity and notifications of acceptance were mailed out each January. Applicants not selected were placed on a waiting list.

#### 2.2.2. Student Demographics

DLMHS served a diverse body of students with an ethnic/racial composition of 37.9% Hispanic/Latino students, 22.5% White students, 16.4% Black students, 9.7% Asian students,
8.8% Filipino students and 0.5% Pacific Islander students. More females (64.3%), than males (35.7%) attended DLMHS. The administration of the school was aware of this disparity and was actively working to close this gap through their middle school recruitment efforts.

Almost 50% of DLMHS’ students were classified as socioeconomically disadvantaged, which meant either “a student neither of whose parents have received a high school diploma” or “a student who is eligible for the free or reduced-price lunch program” (California Department of Education, 2010).

3. EXPLORING THE DESIGN AND IMPLEMENTATION DIMENSIONS

The following section discusses DLMHS’s design (what the school had built into its plans) and implementation (what we observed on the visit) through the lens of the candidate critical components (see Table 1). A dedicated section on emergent themes concludes this portion of the case study.

3.1. STEM-Focused Curriculum (CC1)

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.

3.1.2. Design.
As a career pathway program, DLMHS offered students an academic program focused on medicine and health. In addition to English, Social Studies, World Languages, and Physical Education, all students took four years of science (normally Biology, Chemistry, Physiology, and Physics) and four years of mathematics (usually Algebra, Geometry, Algebra 2, Pre-Calculus, AP Statistics, AP Calculus, or Mathematics for Health Sciences). A student’s typical course of study is shown in Table 4. The school did not offer any technology or engineering classes, but students met the University of California’s A-G requirements (a set of required coursework California students need to meet to enter the University of California).

Students also had an opportunity to earn the DLMHS certificate. To earn this certificate, students were required to have grades of C or better in all classes, take required English and social science classes, and take four years of math, four years of science, four years of health science, and medical terminology.

As part of Dozier-Libbey’s healthcare-focused curriculum and in addition to the courses listed above, all students took three years of health science courses, and a medical ethics course in their fourth year. DLMHS students also took a medical terminology course in 9th grade, which was articulated with the local community college and earned college credit if they obtained an A or B in the course.

If students chose, they could also take honors English, honors Chemistry, or AP World History rather than the regular “college prep” offerings at DLMHS, which were offered as separate sections. Other electives often taken by DLMHS students were offered through the county’s
Regional Occupation Program (ROP), taught by teachers recruited by the County and not by Principal Castro. The ROP courses taught at DLMHS included sports medicine and emergency medical careers.

Table 4.
*DLMHS Course of Study (Antioch Unified School District, 2013a).*

<table>
<thead>
<tr>
<th>Subject</th>
<th>DLMHS Course of Study</th>
<th>Elective Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9th</td>
<td>10th</td>
</tr>
<tr>
<td>English</td>
<td>English 9</td>
<td>English 10</td>
</tr>
<tr>
<td>Mathematics</td>
<td>Algebra 1</td>
<td>Geometry</td>
</tr>
<tr>
<td></td>
<td>Geometry</td>
<td>Algebra II</td>
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<td></td>
<td>Algebra II</td>
<td>Pre-Calculus</td>
</tr>
<tr>
<td>Science</td>
<td>Biology</td>
<td>Chemistry</td>
</tr>
<tr>
<td>History and Social Science</td>
<td>World History</td>
<td>AP World History</td>
</tr>
<tr>
<td>Foreign Language, Art and P.E.</td>
<td>2 years Foreign Language (3 years recommended)</td>
<td>2 years Physical Education</td>
</tr>
<tr>
<td>Work Based Learning Opportunities</td>
<td>Medical Site Visits, College Tours, Career Speakers, Career Day, HOSA, Professional Portfolio</td>
<td>Professional Portfolio, Medical Site Visits, College Tours, e-Mentorship, Practice Interview, Career Speakers, HOSA</td>
</tr>
</tbody>
</table>

As part of Dozier-Libbey’s design, students participated in cross-curricular projects at each grade level. Each grade had its own theme. Grade 9 explored nutrition and fitness; Grade 10 explored complementary and alternative medicines; Grade 11 explored the cycle of life; and, Grade 12 explored medical ethics. Readings, projects, class discussions, and activities for students in each grade were connected to these yearlong themes, and culminated in an integrated presentation or project.

A new element of the academic program’s design was the requirement of a senior defense, which began for seniors in 2013. Each 12th grader was required to provide evidence, as depicted in their work since 9th grade, to show they had met the school-wide learning outcomes called VITALS (see the section to follow on Reform Instructional Strategies and Project-Based Learning for more information). They were required to demonstrate they were prepared for college. Students displayed this evidence in a portfolio and delivered a summary of their work publically to
teachers and community members. In defending their portfolios, students were expected to demonstrate to evaluators that they were effective communicators, critical thinkers, competent with technology, academically proficient, and leaders with strong characters.

3.1.3. Implementation

**Cross-disciplinary projects.** Students and teachers in focus groups emphasized their engagement with projects, particularly the cross-disciplinary projects that organized each of the four years of study. The principal explained in an interview that at every grade level, there was both a theme and an integrated project examining that theme. Throughout the 9th grade curriculum, class activities revolved around the theme of nutrition. The theme culminated with an open house event of community members and parents where students presented their project related to nutrition.

The principal explained that the 9th grade projects during the term we visited “[ran] the gamut from the effects of drinking soda, to osteoporosis, to heart disease, to fatty diets.” Students reported in a focus group that while these projects were longer than the work they might do at other schools, they found value from this type of effort. At the end of a two month effort preparing for the nutrition open house event, students claimed “we accomplished something,” and “it was fun explaining what the topics were about and being an expert on that topic.”

Several teachers in interviews reported that coordination of the cross-disciplinary projects took place across entire grade levels at DLMHS. In addition, some of these cross-disciplinary projects began as a project for one class, but over time, have evolved to be a project between multiple classes. For example, Project EDDIE (Envision, Discover, Design, Invent, Execute) was a project that involved all the teachers, but began solely in 12th grade Physics. The Physics teacher said:

*The first time I ran EDDIE it was a Physics project. Students had to select a disability and design something or improve it to help those people. The first time was just in Physics class. Over the summer, we took EDDIE and we now have it live in multiple classrooms.*

When students completed a cross-disciplinary project, students would often receive multiple grades for a single project. For example, every senior took Medical Ethics, English, Physics, and Government, and completed one project which would be assessed on “four different aspects” based upon these courses. One teacher explained this process in an interview:

*If a student is going to write a paper, that [paper] must be relevant to multiple courses of study and that student will get grades for each course. We write the assignment in a way that the student is getting at the content from multiple points of view and in multiple courses. And then a team of teachers assesses them instead of just one.*

The one subject area that was most challenging to incorporate into projects was mathematics. A teacher said, “The kids really think of it [mathematics] separately. They think that math is really a separate pocket.” A mathematics teacher explained:
Math is a little harder [to integrate] because kids are at different levels of math so it’s harder to get it integrated. The Spanish teachers have gotten good at integrating with mixed grade levels, but math is harder because the district required them to cover certain amount of material and they can’t deviate.

One of the more remarkable aspects of this widespread use of projects was the commitment to which the teachers approached the coordination process required for cross-disciplinary projects. DLMHS teachers suggested that other schools in the area did not typically use this method of teaching, so teachers did not come to Dozier-Libbey with experience in designing or using extended, cross-curricular projects. They were realistic about the state of the project designs, as evidenced by one teacher claiming “we’ve developed 9th grade really well with a nutrition unit. 10th is in pretty good shape with the second opinion unit. 11th still needs some work.” The teachers valued the experience such projects provided for both teachers and students. One teacher shared:

The main focus here is breadth and depth. I worked at [another] high school for seven years and I didn't see a lot of that. There was no teamwork like we have here. We try to relate concepts to students across the subjects instead of just silos.

**STEM vs. Health focus.** The focus of Dozier-Libbey was unique in that it provided a pathway experience for health-related careers, with a strong emphasis on mathematics and science. While the school did not offer engineering or technology courses, the curriculum contained specialized medical courses including Medical Terminology, Health Science I, II and III, Medical Ethics, and Regional Occupational Program (ROP) career preparation courses including Sports Medicine and Emergency Medicine. In an interview, the principal expressed a desire to offer Medical Engineering, but saw this as unlikely since there was another engineering academy elsewhere in the district.

The school had an advisory committee of representatives from local hospitals and health care settings that met quarterly to support and connect the focus of the school to authentic health careers and local employers. Several of these advisors were also parents of DLMHS students. The leader of the advisory committee, a teacher and work-based learning coordinator of DLMHS, had strong professional relationships with the advisors and others in the health care community through her previous experience at several local hospitals (discussed further in the sections Blended Formal / Informal Learning Beyond the Typical School Day / Week / Year and Real-World STEM Partnerships). The advisory committee helped the school to connect its offerings to careers by providing feedback on curriculum. The work-based learning coordinator gave an example, saying, “We created a new class, can you look at this topic? What are we missing? What should we include?” The advisors also helped the school keep up to date on workforce requirements, stay informed on what types of health jobs were “hot,” and suggested resources for the school. For example, the school used a PowerPoint presentation developed by a local hospital to train their staff on cultural competencies within the Health Science II class.

**Rigor.** While DLMHS is a career pathway school, it also had a mission of college preparation. The school had the same number of instructional days as all other high schools in the district, but required 250 credits (rather than the district’s 220). To receive the Dozier-Libbey Certificate of
Excellence at graduation, students were expected to pass all their classes required by DLMHS, with a grade of C or better.

In an interview, the academic counselor who served DLMHS and another school said, “I really like this program. I am at two high schools, so I can see the difference in the students, in the rigor.” In requiring four years of both mathematics and science, she added that: “We make sure every student who graduates is A-G ready [the minimum entrance requirements for the University of California and California State University]. They take the required classes so when they leave, if they are keeping up with their grades, they should all be ready for college.”

Ninety-five percent of DLMHS’s first class of graduates met the University of California’s A-G qualifications, which was significantly higher than the district average of 25%. The counselor continued, “It’s clear we do the right thing. Our graduates are telling us they are [college] ready.”

Within these required courses, the expectations were high. One parent said:

*Everyday, all day, Dozier-Libbey seriously prepares the students for college. Myself being a college student while my daughter is in school, I could relate. They’re giving her all the tools and preparing her for college, the presentations, and just numerous projects. Professional dress. There's so much they get from this school that they won’t from a regular high school. ... Higher expectations come from when they first arrive; they're expected to get higher grades... When you push kids to do that, they don’t want to be in the middle of the pack. The standards are high.*

Students agreed with their parents, as evidenced by a 9th grader’s response in a focus group: “I think it’s much harder because at other schools the teachers don’t care as much about students’ learning. Here, it’s better that they do care.” Another student in the focus group added,

*This school is harder because we have harder classes but we have the ability to retake. Other schools don’t have that option. This school is focused on mastery. The other schools don’t let you retake. We have this thing called code blue. You get one late assignment per class. This school is really about giving you chances, letting you have the ability to retake, and just get better at it instead of just saying you didn’t do well on the first time so you’re done. This school wants you to actually learn the concept. ‘We don’t want you to fail’.*

One challenge to the rigor of the school was staff stability in Chemistry. When asked specifically about the rigor of their science, the staff and school leader respond with confidence. One teacher said:

*I think from top to bottom, from freshman year to senior year, the science curriculum is awesome; it is way beyond what the standards entail. The one caveat is that Chemistry is our weakest area; we have had a new teacher every year.*

Perhaps for this reason, Chemistry, along with mathematics, was also an area that had been difficult to integrate into the year long, cross-disciplinary themes.
Finally, another potential challenge to rigor that some schools face is the inclusion and support of students designated as “special education” students. At DLMHS, however, this was not an issue as special education students took the same courses as other students. An academic counselor reported:

Even our special ed [students] are taking the same courses, just with support. [At] other high schools, the special ed students are not taking A-G classes but at this school I have seen a great success rate. That is one thing that I am amazed at is the special ed students are being challenged. ... To me that was amazing when I was looking at their transcripts, especially when I’m used to lower end students from other programs.

However, as DLMHS is a school of choice, special education services were somewhat constricted; this may mean that students with more challenging disabilities did not choose to apply to the school.

“No D Grade” Policy
A highly contentious topic related to rigor was the school’s “No D Grade” Policy, established and maintained for four years following the school’s opening. The rationale for this policy was that it required students to master curricular material by earning a grade of C or above in the course. If students received the equivalent of a D grade in a course, they would get an F and be required to work until they earned at least a C grade, or retake the entire course. During the four years that this policy was applied, a few families appealed to the school and district to change it. During the year of the site visit, the policy was changed by the district; family appeals were upheld so that students could pass a course with a grade of D. This was a controversial decision that was later revisited (see Epilogue of this case study.)

The district policy change that required DLMHS to allow students to pass a course with a grade of D was unpopular with the school staff. Teachers reported that they felt it undermined the school’s high expectations. A parent who did not support this change added, “Up until recently, the ‘no D’ policy was really helpful. Now it’s hurting people, [since] people can’t get enrolled in summer school and can’t retake classes where they got Ds and want better grades.” In an attempt to end the controversy, the district later revised the policy to allow students with D grades the chance to retake many of the courses over the summer through an electronic program called Cyber High (for more information, see section Integrative Innovative Technology Use).

3.1.4. Summary.
DLMHS offered all students a rigorous science and mathematics program through the medical themed linked learning pathway. This school worked deliberately and thoughtfully toward incorporating health-themed interdisciplinary projects to provide a solid foundation for any student wishing to pursue a college major in STEM subjects.

The students followed a fairly traditional, but challenging, trajectory through high school mathematics and science and were required to take additional health classes as part of their pathway program. When compared to other STEM subjects offered at DLMHS, mathematics was less integrated in the school’s various year long, cross-curricular themes and projects.
DLMHS had a mission of college preparation for all students and maintained a high level of rigor through the use of their medical-linked learning pathway. This medical-linked learning pathway engaged students as they began to discover and formulate their individual career interests by learning about health related careers. Students learned that many of these careers required advanced education in STEM subjects and DLMHS worked with students to help them prepare for health-oriented STEM careers.

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

3.2.1. Definition.
STEM classes emphasize active, immersive, and authentic instructional practices/strategies informed by research. Classes offer opportunities for project-based learning and student production. School utilizes performance-based assessment practices that have an authentic fit with STEM disciplines.

3.2.2. Design.
DLMHS’s academic program was founded on the idea of small linked learning pathways. The district wanted to create linked learning pathways that would, “bring relevance to the kids” and require that these linked learning pathways be “at least a technical career or a career path sequence that leads to a high wage, tech paying job”. DLMHS was founded in 2008, before any linked learning pathways were developed in the Antioch Unified School District. DLMHS led the district in the creation of linked learning pathways with their medical theme pathway, the largest of the pathway programs in the Antioch Unified School District.

3.2.3. Implementation.
*ConnectEd and VITALS.* The principal at DLMHS was in charge of researching the medical themed pathway to develop a curriculum and instructional program for DLMHS. She began this investigation into developing a new medical themed pathway by meeting with ConnectEd, an independent nonprofit organization established in 2006 with a $6 million grant from the Irvine Foundation (for more information on this partnership, see Real-World STEM Partnerships, CC5). ConnectEd served as a hub for innovative practice, policy and research and has developed a number of different thematic linked learning pathways. ConnectEd defined these linked learning pathways as:

*An approach to education that transforms the traditional high school experience by bringing together strong academics, a demanding technical education, and real-world experience to help students gain an advantage in high school, postsecondary education, and careers* (Connect Ed, 2014).

ConnectEd has been used by DLMHS to provide professional development for teachers in addition to expertise in designing many of the initial themed grade level projects. The principal said in an interview,

*At every grade level we have a theme and at least one integrated project. Some of the project ideas came from Connect Ed, but they have been revised to meet our needs. We love the units they created, but we wanted to make them our own.*
Many of these cross-disciplinary grade level projects have been incorporated into the Expected School Wide Learning Outcomes of DLMHS which are required for accreditation. DLMHS has incorporated these learning outcomes into their instructional program through a program called VITAL Signs (see Figure 1). These VITAL Signs are a list of criteria that are “research-based guidelines of systemic school improvement that ensures that every school has a clear understanding of its purpose” (WASC, 2013). These VITAL Signs are the Expected School Wide Learning Outcomes and they require every student at DLMHS to be: verbal, intellectual, technological, academic, and a leader. To measure and assess that students have met these criteria, DLMHS teachers had their students use evidence from their classroom projects over their four years at DLMHS to present and defend their VITAL Signs during a senior year defense.

Figure 1.  
Dozier-Libbey Medical High School: VITAL Signs.

Source: “Expected Schoolwide Learning Results- VITALs” from Dozier-Libbey Medical High School Website (retrieved from http://dlmhs-antioch-ca.schoolloop.com/vitals)

During an interview, the principal explained how this process was implemented at DLMHS:

Starting this year, we are telling students at all four grade levels to start saving their artifacts [projects and reports] for their senior defense. So next year they will have artifacts from two years, the following year from three years, and ultimately from all four years. In their portfolio they also have a professional section where they have a cover letter, resume, and letters of recommendation.
The principal explained that for the Senior Defense, each student would do a 20-minute presentation and create a portfolio of what they learned during their time at DLMHS. The year our team visited was the first year the VITAL capstone project was being implemented, so the DLMHS staff was still working out some of the details. One English teacher said in an interview,

*If we were a perfect world, the 9th grader would hear about the defense and create their profile and in a class they would complete a project and upload their project and do a reflection and by the time they were in 12th grade they would have an amazing profile and they could see the growth.*

**Integration of the Medical Theme.** The teachers and the principal at DLMHS noted that every grade level had a theme and an integrated project. The project ideas came from the teachers at DLMHS. In an interview, the principal described in detail the 9th grade health and nutrition integrated unit. She explained that Health 1 students:

*Are learning about nutrition in all of their classes, looking at it from different perspectives. In Health Science they learn the make-up of food, including vitamins, minerals, fat content and calories. They study daily caloric intake and output and develop healthy diet menus. The also learn about eating disorders and other topics related to nutrition.*

She also described the students’ physical education classes:

*The students have heart rate monitors and measure their heart rate and BMI on a regular basis. They set personal fitness goals and journal their progress daily. After their PE activity for the day they write in their journals about what they ate that day and reflect on how they felt physically. They learn about brain health and that what they put into their body has an impact on their performance, both physically and academically.*

She also described how this project was integrated into students’ English classes through reading:

*In English the students read “Chew on This”, which is by the same author as “Fast Food Nation”. It is the same topic, just geared toward teenagers. They study issues related to fast food, how it has affected society and their own personal health. They learn what is actually in the fast food, and if it is nutritious or not. That’s a big eye-opener for the students.*

She also explained how students experimented with the knowledge they were learning in Biology class:

*They do a lab rat experiment. One rat is given a healthy rat food diet, and the other is given a junk food diet of Gatorade and cookies. The students track the development of the rats over time and end up writing a research paper on their results, reflecting on their original hypothesis. After the project the students adopt the rats as pets.*

Lastly, she discussed the culminating event of this project:
The culminating event is an Advocacy Project. Working in teams, students choose a topic related to nutrition and develop an awareness campaign, including a presentation, display, slogan, and other artifacts. The topics range from the effects of drinking soda to osteoporosis, to fad diets. We have an open house type event where the students present their projects to parents, health care professionals, and our community.

This ninth grade project was just one example of the many thematic integrated projects at DLMHS. Ninth grade students in a focus group agreed that projects and group work were an instructional focus at DLMHS. One student said, “The big group projects are hard. Our freshman project spanned over two months.” While this integration was certainly a focus at DLMHS, the mathematics classes were often not integrated with these thematic projects. The rationale provided behind not including mathematics in this integration was that these thematic projects were integrated at individual grade levels while the mathematics classes included students of multiple grade levels in any given class. Students in a ninth grade student focus group agreed that the mathematics classes were less project oriented. One of the students said, “We don’t really do projects in math.” While mathematics was not included in the integrated projects, the mathematics classes still tried to tie in health themes as much as possible. For example, in a pre-calculus class we observed, a mathematics teacher tied in the topic of chemotherapy into a practice problem for students to complete. When we asked the teacher in an interview how she integrated health themes, she responded:

When I came here I pulled out all of the health-related problems. For example, this one was about how much oxygen your lungs can hold. What happened is I just came out of the hospital and they were checking different things and I thought, “I bet all of the kids who have asthma have seen it,” so they could connect to the material. When we were doing summations we drew out a smoking example. For example, if you smoked this much per day and each pack cost this much, how much would it cost if you smoked over 5 years.

Health Science Instruction. Project-based learning was observed to be the primary instructional approach for health science courses. The curriculum and unit topics for the health science courses were mainly recommended by their healthcare advisory partners (more information on DLMHS’s advisory partners, can be found in the section titled STEM Partnerships). In the following vignette of an observed Health Science III class, we describe a teacher that effectively employed a project-based learning instructional approach for the “Death and Dying” unit:

In today’s Health III class, the students have a “work day” to work on their public service announcements (PSAs) of a health topic related to death and dying. This project serves as a summary project for material they have learned over the course of their unit.

At the beginning of class, the teacher walked into the room and quickly addressed the class to go over some reminders and immediately proceeds to tell them to, “Get to work!” At this sign, the students got out of their desks to find their other group members and continue work on their group project. On this particular day, the students were already far along on their projects and most were at the very end stage where they were required to film their PSA. I walked over to one of the groups and asked them “What did you do leading up to the filming?” The students
responded that they had to choose their topics and that these topics ranged from “a bucket list” of things to do before dying to expressing sorrow for someone’s loss.

Today, most students were in the filming phase of their project and they were spending the day filming their PSA using flipcams and a moviemaker software. The students were allowed to exit the classroom and they could film their PSA in almost any location on school grounds. Students were choosing a variety of locations to shoot their film including the outdoor areas between classrooms, around picnic tables in the middle of the campus, or in the library. While many groups were filming today, there were some groups that were behind and the teacher worked with these groups. I observed her sitting down with the groups and asking the group members questions to help them think about their project in different ways. It seemed some groups were having trouble coming up with ideas for their PSA, and for these groups, the teacher showed them examples of PSAs from previous years to help spark some ideas. At the end of the class period, the groups reconvened in the classroom and the teacher circulated between the groups discussing the progress and current status of each group on the assignment.

At the end of this classroom observation, we met with the teacher and discussed how she went about planning for this unit on death and dying:

*I bring in some speakers, I show some PSAs from last year to kind of get them ready for topics. There are a lot of articles out right now from healthcare dealing with this issue. It wasn’t as big five years ago, but a lot of people are encouraging families to come up with a plan, so there are a lot of articles out there. A new thing I found this year, was a conversation starter kit, so an organization is just dedicated to helping families start having conversations about what do you want to have happen as your life was coming to an end. So there are a lot of things out there that help.*

We spoke to the Health III teacher during an observation debrief, and she described the health science instruction as a blend of guest speakers, individual research, and project-based learning centered on health topics that were developed in partnership with their community advisory board.

**Science Instruction**

In comparison to the PBL instructional approach in the health science classes at DLMHS, the instruction in the science classes were more traditional. Science teachers were more inclined to use direct instruction, such as a lecture, to introduce new material that was followed by a laboratory exercise to reinforce concepts. It should be emphasized that this traditional style of instruction is not a criticism, but simply an observation of the style of instruction employed by many of the science teachers at DLMHS. In this section, we will use two vignettes: one from a Human Anatomy & Physiology class and one from a Biology class to capture the science instruction observed at DLMHS.

In the following vignette of an observed Human Anatomy & Physiology class, we describe a teacher that effectively delivered a lesson through a direct instructional approach that was strong and succinct. This vignette, derived from our RTOP observation data, is provided as an example of a typical day in a science classroom of DLMHS.
As we enter the classroom, we notice that the classroom is filled with humorous, informational science posters decorating the four walls around classroom. At the front of the classroom sits the teacher’s desk and the student desks were arranged in groups of four throughout the classroom. We took our seats and shortly after, the teacher walks into the classroom to start class. He begins today’s lesson by dimming the lights and directing the students’ attention to the PowerPoint slides that are projected onto a screen at the front of the room. The teacher introduces the topics of today’s lesson, which include a review of the anatomy of the urinary system from the last class and an introduction of a new topic, water balance. To start, he goes over some “fun facts” of water balance in the urinary system. During this time, the students and teacher joke back and forth as he goes over these “fun facts” and it seems as if these jokes were purposefully inserted into today’s lesson to ease the students into the beginning of class.

As the lesson continues, the teacher begins the new topic for the day of water balance and he starts this lesson by comparing the skeletal system of human babies and adults and the differences in water balance due to this difference in the skeletal system. Students are taking notes on notebook paper and asking questions without waiting to be called upon. The atmosphere in this classroom seemed academic and rigorous yet at the same time very casual. As the teacher flipped to the next slide in today’s lecture, he displays a figure on fluid compartments inside and outside the cell. For this slide, he is introducing the concept of electrolytes and is referencing previous class topics on water and solutes to build on this foundational knowledge. The teacher then asks the students for examples of electrolytes and students respond by calling out answers.

After introducing the concept of electrolytes, the teacher relates sodium and potassium (electrolytes) to sodium and potassium pumps, concepts the students had learned earlier in the year. This process of calling upon previous science knowledge (whether through his class or a previous Biology class) was a tactic he uses as he introduces each topic in today’s lecture. In concluding his lesson, the teacher tells “three stories” relating to water balance to summarize and bring relevance to today’s topics.

This vignette of a Human Anatomy & Physiology class captures the science instruction in one class, but in discussing science instruction with the other science teachers during a focus group, it seems many of the other science teachers follow a similar model of direct instruction that is then followed by laboratory activities. This second vignette focuses on science laboratory instruction follows a Biology teacher as he and his student teacher carry out a laboratory activity:

The layout of this classroom includes a demo desk at the front of the room and student desks grouped into fours throughout the classroom. In today’s Biology class, the students are applying their knowledge of human body organ systems through a dissection of preserved rats. At the start of class, the teacher goes over the directions for the rat dissection. These directions include lab safety, obtaining materials, and how the students should record observations during the dissection. These observations require all students to write down their observations about the muscular, respiratory, and circulatory systems. While explaining the requirements, the teacher passes out packets that give a visual procedure for students to follow in proceeding with the lab dissection. After these initial instructions, the excited students asked questions about the rat:
“How does it die?” “Is it the same rats from earlier in the year when we did nutrition?” “Do they [rats] smell?” “How does it [the chemical] preserve rats?” After the teacher answers these questions, the students pick up their materials and begin the lab.

The teacher and student teacher walk around helping individual groups and ask them about the observations they have made about their rat. Because this lab is to be completed in one day, the students are looking at a variety of features on the rat, including the torso, abdomen, legs, and head. Once the students open the rat, they use the dissection guides to help identify major organs within the rat. As the lab continued, the teacher is reminding groups that the purpose of the lab is to record observations, as he notices that some groups had made more developed observations than other groups.

In one group, a student has just taken out the heart and the teacher asks, “great you found a heart, what do you see? What observations could you make?” The student teacher walks around helping as well. She moves from group to group and helps the students identify some of the different organs in the rat and ask questions about the organs to the students. Near the end of class, the teacher is checking with students to make sure that they had made observations before they begin cleaning up for the day.

Mathematics Instruction.
A unique feature of STEM-related instruction was the teaching design used for mathematics. Mathematics instruction was a challenge district-wide as both the DLMHS and the district performed below statewide averages on the set of mathematics assessments (see the section on Student Outcomes). In regard to mathematics instruction at DLMHS, the principal said:

We have a number of kids that really struggle in Algebra. Math is the biggest problem in this district over all. We get kids that come to us very unprepared to even be successful in Algebra and there is a lot of work being done in the district to try to improve that.

Within this context, the mathematics teachers at Dozier-Libbey had taken an innovative approach to their courses, which as the principal said, has “shown some really great results.” The school leader related in an interview, “our math teachers actually took the Algebra curriculum and they broke it into concepts.” As the teachers presented the concepts, they regularly tested the students. “A student will be tested on every concept five times, so that if they haven’t got it in the beginning and they start getting it, they can pass.” Teachers rotated the concepts, so that

“On a concept quiz there would be four or five concepts. For example, one quiz would cover concepts one through four. The next week will cover concepts two through five, followed by another quiz on concepts three through six, and then four through seven. So, they’re tested on those repeatedly and then they can go back in, get more help, and take them over. So, we just keep trying until they’ve got it and that’s really helped.”

These concepts were evaluated using a progression scale and once a student mastered a concept, they were exempt from being tested on it for future tests. Figure 2 lists the major mathematic concepts that students were taught throughout the year in Algebra 1 and Figure 3 displays two example mathematics problems from an Algebra 1 concept assessment.
Using this method of instruction and assessment, after a student scored a 4 (the highest score on this progression scale) twice on a mathematic concept, a teacher would record that the student mastered the concept. In addition, a student would receive a stamp in their mathematics notebook indicating that they mastered the concept. This process allowed students to track their own progress during the course of the year. In subsequent assessment cycles, teachers would include new concepts, as well as old concepts from previous assessments. If a student had mastered the concept, they were allowed to skip those problems. The mathematics teachers at DLMHS found this approach to be a way of personalizing mathematics instruction and assessment for all learners in a class while also preventing teachers from making several versions of single tests for different levels of learners.

A mathematics teacher explained that students had the opportunity to meet with their mathematics teachers to revisit and master the Algebra concepts during their advisory period (also discussed in the section Supports for Underrepresented Students). When the school first started, students spent advisory periods with an advisory instructor. Over the school’s five years, the advisory period evolved such that students may use this period to receive extra support from teachers by signing out of their advisory room, and going to the room of any teacher with whom they would like more instructional time.
DLMHS uses a mastery based instructional approach in mathematics through the identification of concepts and their systematic assessment. Students are expected to master all 36 concepts on this checklist by the end of the year. Source: “Algebra 1 Concept Checklist.” Document collected on DLMHS site visit.

Two Example Algebra 1 Concept Problems from a Larger Assessment

24) Rules of Exponents
Simplify. Write with positive exponents.

\[ a) (3y)^3 \]

\[ b) (-7x^2y)(-5x^3y^3) \]

\[ c) -\frac{20a^d}{10a^d} \]

\[ d) \left( \frac{r^2}{3x^3} \right)^2 \]

25) Polynomial Operations
Simplify.

\[(7x^2 - 5x + 8) - (2x^2 - 7x + 5)\]

In this assessment, the two problems shown are testing Concept 24 (Rules of Exponents) and Concept 25 (Polynomial Operations).

Source: “Algebra 1 Concept Problems.” Document collected on DLMHS site visit.
**Bringing in Professionals.** Business partnerships are discussed briefly here in terms of the business partner’s relationship with the instructional practice at DLMHS, however please see the section *Real-World STEM Partnerships* for more information.

A strength of DLMHS was the common ability of teachers to bring in and connect students with professionals in their community. This focus is especially strong during the ninth grade year when introducing students to health careers. One of the duties of the work based learning coordinator at DLMHS was to help to bring in STEM professionals to the classrooms at DLMHS. In relation to the linked learning pathways, an Antioch district administrator said in an interview that his goal with guest speakers was to create meaningful relationships and to develop partnerships that move beyond the role of a traditional guest speaker. He elaborated,

*I don’t want you to come in and be a guest speaker. I want you to come in and be engaged and be a partner with my pathway and be engaged with what’s meaningful to you. Maybe come in twice a year, because I know you’re going to come back more and next time you have two more people that are with you.*

The types of interactions with guest speakers at DLMHS tended to focus on bringing people into DLMHS rather than taking the students out to the community. In addition to the professionals that visited the school to speak to students, the sophomores participated in e-mentoring in which they were required to research a profession and correspond via email with someone that has that job.

**Career Readiness Instruction**

An important product of the health and medical instruction at Dozier-Libbey was the emphasis placed on student career preparation. A student explained:

*The main project you do as a freshman, you pick a career that you might want to go into – as a freshman you are looking into what you want to do in the future. What other school asks you to look into that? It’s an incredible resource.*

When asked about their future plans, many students had ambitious career goals in medical fields, including pediatrics, diagnostic radiology, and surgery. It is not a requirement, however, that this career exploration result in health related ambitions for every student. As one advisor said,

*What is really great is that all the students come in thinking they want to be in the healthcare field, and through [the program] they find they may not like it and that is fine. Because here, they are more college ready than they would be in any other district school.*

Whether students aim for health related careers or not, the principal agreed: “Our goal is that when they graduate from here, they know what they want to do, they know how to get there in the most expedient way and successfully complete that program.” She added, that way “they have not wasted two years in college figuring out that they didn’t want to do that and start over. That is what we sell to parents.”
3.2.4. Summary.
DLMHS was a school that employed a thoughtful and deliberate integration of its medical theme into nearly all aspects of the school’s curriculum. Each grade level had been assigned a health theme and the school used large, integrated grade level projects to drive instruction around these themes. Despite the multiple interdisciplinary projects, DLMHS struggled to fully integrate mathematics into these integrated grade level projects due to student placement in mathematic courses by ability level rather than grade level. One way the medical theme was been actualized in instruction was through bringing in community health professionals and connecting students with these professionals through projects and guest lectures. DLMHS looked to improve their practices and they continued to build in more innovative, project-based instructional practices into their classes that fostered more collaboration between teachers in each grade level.

3.3. Integrated Innovative Technology Use (CC3)

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.

3.3.2. Design.
DLMHS’ design for technology use primarily focused on obtaining and distributing multiple types of technologies that administrators, teachers, and students could integrate into their daily activities. At the time of the visit, an administrator stated in a focus group that the school had the technology to do the things required of its current work, but also that it had no back up when technology fails or changes over time. With this concern in mind, administrators at DLMHS said they were pushing the district to adopt a technology plan, as they currently did not have one.

In an interview, Principal Nancie Castro indicated that innovative and integrated technology use was critical to a well-functioning school. For this reason, she included interview questions on the use of technology when meeting with prospective teachers. Specifically, she looked for teachers that “like to use technology, want to integrate [technology] not just as a teaching tool, but also to allow students to use technology.” While some prospective teachers “get really intimidated with the technology,” her perspective was that if a teacher was intimidated by technology, then that was acceptable as long as they were open to using it. She said, “The kids know [how to use the technology], they’ll figure it out.” In hiring, she was looking for teachers that “offer [students] opportunities” because a teacher could always, “use the kids to teach other kids.” Thus, while the school did not always hire teachers that were technology experts, it did exclude those not willing to learn or use technology in their instruction.

DLMHS did not offer courses for students to learn about technology. In addition, there were few professional development opportunities dedicated to technology for teachers and staff members as well. Instead, DLMHS focused its efforts on developing technology competence through its ubiquity.

3.3.3. Implementation.
DMHS’ implementation of technology use was thoroughly aligned with its design. Technology use was ubiquitous throughout the school, and could be seen in the hands of students, teachers, administrators, and parents. The primary uses for technology focused on communication and instruction.

**Communication.** The primary way in which communication technology was integrated throughout the school was through a system called School Loop, an online portal for communication among members of the DLMHS community. Using School Loop, students could access files remotely (e.g., slideshows from classrooms), view class-specific calendars with assignment due dates, email teachers, and complete schoolwork through the site. Parents could register on the website, as well, to view their child’s grades and progress in his or her courses. Teachers could also use School Loop to contact students enrolled in their classes or their parents.

One student claimed in a focus group, “School Loop is the new Facebook. You know you’re a Dozier kid when you’re on there more than Facebook. I’m on there all the time. I check my grades constantly.” Another student in the focus group gave this example as to how School Loop is used in one class:

*You can email teachers, email other students; if you have an assignment, you can put it in Dropbox. My medical ethics teacher uses it a lot. You can check the calendar, future assignments. All your work is saved on the app. Teachers can text you without having your [phone] number. It gets sent to the whole class. The teacher can text everyone to say, “Bring your econ book.” They have a lot of lectures and slides. Some teachers have references. They put the PowerPoints up there and you can go back up there and read them or PDFs. They have records up there.*

Students also used social media to help communicate with one another. Students in a focus group indicated that they “use a lot of Facebook groups” and that:

*A lot of people on Facebook go on and talk about their projects. People last year talked about how to make the project better. If you forget your homework, you can go on the group and ask about the homework. Social media is a great way to communicate if you don’t have someone’s phone number or you don’t know where they live.*

School Loop was also used to communicate information to students that might not be specific to a single class. For example, an administrator notified us that DLMHS had recently added a new section to the School Loop site that allowed users to post news tailored to specific audiences. Teachers and administrators discussed using this feature to notify students of upcoming standardized exams (e.g., SAT days) and events like college admissions and financial aid information sessions.

Teachers indicated that they believed that some students did not have access to technology at home. These students were given access to computers and other technology during their advisory period. All students had an advisory class, but during this time, students could work on their computer related work at school or other class assignments.
DLMHS also used its School Loop site and other technologies to improve the efficiency and reach of its administrative procedures. For example, an administrator indicated in an interview that DLMHS conducted an automated grade check every Monday for its students. If students had a grade lower than a certain cut off, they were notified and required to attend advisory class to work with the teacher who taught the course.

Given that technology was a constant presence at DLMHS, teachers and administrators needed to be competent at using these technologies. Technology professional development was not formal but instead centered on having staff members teach one another; Veteran teachers showed new teachers how to use School Loop, for example. Teachers in focus groups indicated that they also often shared new kinds of technology or uses for technology in their teaching.

**Instruction.** Technology in the classroom was common, although not necessarily universal. At the time of our visit, DLMHS had projectors, laptop carts, graphing calculators and clickers. Many classes used clickers to assess student understanding as the class was proceeding. Students reported that they enjoy their use and claimed that the anonymity provided by clickers encouraged them to participate more in classes. While some students claimed that clicker use has declined over the years, our research team noted their use in several classes that we visited.

Innovative technology use was more common in the classes that fit the school’s science and health theme. These classes used specific technological tools based on the course’s content. For example, a health class used a “robotic” baby to teach the students about childcare. Science teachers also discussed teaching laboratory classes and using tools like Vernier handheld probes, thermometers, and pH strips. Some teachers also discussed using external resources like Ed One Stop (a service where teachers can access lesson plans, videos, research, and other materials), the Kahn Academy, BrainPop, and Standard Deviance.

Teachers recognized that nearly every single student had a cell phone with them in school daily. While cell phone use was not openly tolerated, some teachers and students in focus groups claimed that students often used cell phones as calculators or for other purposes if the lesson called for it. One teacher suggested that he thought that cell phone use was beneficial to the classroom, but that it could be improved. At the time of our visit, students were unable to connect to the Internet through their phones. Some teachers had tried to get the district to open the server to let students use the Internet.

Other teachers saw the negative side of cell phone use for instruction. One teacher explained in an interview:

*I have been pulling my hair out with the cell phone problems. The kids that were using the cell phones today, they weren’t fooling around – they look at their grades, they take pictures of documents, and pulling up the vitals. I think that’s fabulous. It’s when I’m lecturing and they’re texting. It’s a nightmare. Within a day, we have a blocked schedule and the next day – someone has taken a picture of test and put it on Facebook...Kids want to listen to their music, some were looking up information and five or six were texting. It’s hard to differentiate. It’s not a battle that I’m fighting anymore, as long as it’s not there during the quiz or a test.*
The issue of technology-enhanced cheating and academic dishonesty issues came up multiple times in our discussions with teachers. One teacher discussed how they had fought for the school to subscribe to the service *Turnitin.com*, which can be used to identify potential cases of plagiarism. The teacher clarified that she believed this was not an issue of students trying to cheat, but rather that students “just think it’s okay to copy and paste. They don’t understand how it can affect them.”

**Cyber High School.** DLMHS offered a credit recovery program titled Cyber High. Cyber High was an electronic high school curriculum that integrated educational curriculum and technology using Internet resources. The Cyber High curriculum was fully accredited through the Fresno Unified School District and was aligned with California State Content Standards and Frameworks. Selected courses also met the University of California’s A-G requirements. The benefit of Cyber High was that it was a free program offered for students to make-up credit deficiencies for high school graduation while providing an individualized self-paced learning experience for students in an alternative learning environment. The Cyber High Courses available at DLMHS can be found in Table 5.

**Table 5. Cyber High Courses**

<table>
<thead>
<tr>
<th>Mathematics</th>
<th>Language Arts</th>
<th>Social Science</th>
<th>Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algebra I</td>
<td>English 1</td>
<td>American</td>
<td>Health Education</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Government</td>
<td></td>
</tr>
<tr>
<td>Algebra II</td>
<td>English 2</td>
<td>Economics</td>
<td></td>
</tr>
<tr>
<td>Basic Math</td>
<td>English 3</td>
<td>U.S. History</td>
<td></td>
</tr>
<tr>
<td>Geometry</td>
<td>English 4</td>
<td>World History</td>
<td></td>
</tr>
</tbody>
</table>

Source: “Cyber High School @ Dozier-Libbey Medical High School.” Document collected on DLMHS site visit.

3.3.4. **Summary.**

Technology played an important role in connecting students, teachers, administrators, and parents to each other. The School Loop system acted as an integrated and connected system that linked almost every aspect of DLMHS to one another. Most members of the DLMHS community had Internet access, and the school provided some resources for those who did not. Technology use for instructional practice was less ubiquitous and novel, however the school did use technologies like PowerPoint, calculators, and clickers for instruction and had resources for tools in laboratory classes.

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

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.
3.4.2. Design.
DLMHS considered informal learning activities that went beyond the typical school day or school schedule. Even at the earliest stages, before the school was even built, the school leaders met with business partners to include activities with them into the concept and design of the school. The primary focus of these informal learning activities was to extend the medical focus of the school beyond mere integration of a medical theme into all classes. The school’s focus on informal learning helped to develop relationships with other organizations (discussed further in the section CC5, Real-World STEM Partnerships). These relationships included the development of an internship program and a broad variety of after school offerings, like clubs, for students to participate in.

3.4.3. Implementation.
Most of DLMHS’ informal learning activities were aligned with the school’s medical focus, whereas other activities were oriented around creating a feeling of community in the school. Students participated in a wide range of extracurricular activities that included sports, clubs, job shadows and internships. While there was a variety of informal learning opportunities, students and parents also identified several areas where the school could go further in its offerings.

Clubs. DLMHS had several clubs at their school. These clubs included a Rotary Club, Amnesty International, anime, and their biggest club, Health Occupation Students of America (HOSA). The purpose of the HOSA organization was to develop leadership and health skill competencies through a program of motivation, awareness and recognition, which was an integral part of the health science education instructional program. This student organization put on several events throughout the school year. In one recent event, HOSA coordinated with the Medical Reserve Corps to visit the school for three days and set up tents and CPR manikins, intended to have every student and staff member to learn hands-only CPR. While participants were not able to obtain an official certification, the purpose was to show students how to do chest compressions. In addition, HOSA Students attended a state leadership conference to participate in different competitive healthcare related events. When students were asked to discuss HOSA, they gave the impression that while many students were members of HOSA, fewer were very active members. In a focus group, one student claimed, “A lot of people are just in it but they don’t participate. Only a certain amount of members are really active.”

While the school offered several clubs, some parents and students were still disappointed in the number of available. In a focus group, one parent claimed that:

Many of the students don’t feel comfortable, because they want more activities, sports, diversity, so they choose to go to the other schools. It weeds the students out who want more social things. It’s such a small school; you might not see some other clubs that you would at the other schools.

Another parent mentioned that students have tried to start additional clubs, but that they have not succeeded because of a lack of involvement from other members of the DLMHS community:

I know the kids in the first year tried a gay straight club, but the teachers didn’t have time to be a moderator for these clubs. They start out and the kids propose these things, like computer, chess, anime, drama, but they fall by the wayside because they don’t have the teacher support. We’ve
asked for volleyball, tennis, and soccer; there are quite a few things that would bring about more diversity in that area and wouldn’t have to go off campus to go to clubs and sports.

The issue of sports was particularly salient in the DLMHS community. DLMHS did not have the facilities for high school sports. It was built using an elementary school design due to the amount of hardship funds available from the state of California to build the small school. Since its inception, students and parents were told DLMHS would have not have sports facilities and if they wanted to compete in sports, they would do so at their home high school. As a result, students were able to participate on the sports teams of other nearby schools—primarily Deer Valley High School. There was agreement among nearly everyone that we spoke to on our site visit that this lack of on-site sports contributed to a noticeable lack of community at the school.

**Internships and Job Shadowing.** DLMHS did not have a formal internship program for its students, however some students participated in internships and job shadows that were coordinated through the school. The school’s work-based learning coordinator developed relationships with many healthcare organizations in the area with the intent of connecting interested students with potential career opportunities. These internships and job shadows were originally designed to be opportunities for seniors, but the school found that many seniors already knew what they wanted to do or were too busy to participate in an additional internship. Consequently, the school began to encourage juniors to job shadow or participate in these internships and job shadows.

At the time of our visit, internships were offered through Sutter Delta Medical Center and John Muir Health. In an interview, the work-based learning coordinator said, “It is usually around 10 internships [each year]. Sutter is about twenty job shadows and about 10 internships [each year].” When asked whether the Kaiser Hospital across the street from DLMHS had student internships, she responded, “[They] won’t do it for us. They had a HIPAA issue with another school” and so do not allow student internships.

The school does not offer its students any form of credit for these internships and job shadows, and instead wants students to do them for the experience. The work-based learning coordinator claimed, “It is like getting ready for a job. But there is no extra credit.” When asked to describe a typical medical internship, the work-based learning coordinator emphasized that while all of the internships were different,

It is usually two periods a week for a couple hours where they actually go and observe at first and then they do clerical work. They can do filing. They learn what the support structure of the facility is in contributing to operations. Even though they may do filing, when they are gone, someone else is doing it and it is a very important part that leads to patient care. So they are spending time in departments for 8 weeks and the job shadow is where they come and watch a professional for 4 hours.

The students also receive regular evaluations from their internship organizations. The work-based learning coordinator said, “Muir and Sutter do an evaluation of the student because they are there for quite a few weeks. It’s like a job. They have to know if they are doing well or not.” Afterwards, students complete a “reflection report” in which they list what they learned, what
they saw and what they heard. The administrator continued, “They all love it. They all say that’s so much better than learning in the classroom.”

The number of students who participated in these internships was relatively small compared to the population of the whole school. The work-based learning coordinator suggested that this was potentially because it required students to be extremely motivated and that the application process is typically rigorous:

*The reasons the job shadows and internships are different is because the kids have to be motivated. They have to provide their own transportation because we don’t. The advisory committee also sets the standards for job shadows and internships, so there is a grade requirement just like they have for a job. They have to keep a 2.0 GPA and no more than one ‘F,’ which is the same to get a work permit. They have to have all of their shots, have to have two negative TB tests, HIPAA training, and they have to acquire scrubs, although they can borrow those from us. There are more requirements for students, so it’s pretty rigorous. It’s more like they are applying for a job. If someone has a less than 2.0 or more than one ‘F,’ they can appeal to a panel. There’s a 10-page application. Some of those are district documents and some are healthcare provider documents. It’s pretty rigorous. That’s why they are more limited. They also cannot have any bad behavior referrals, which means no drugs or alcohol. In all, it’s pretty rigorous.*

The work-based learning coordinator also conveyed that students who put the time and effort into the internships and volunteering could find the experience very rewarding:

*One student volunteered 1,500 hours. Now, she’s in a radiology technology program...There’s another student at Santa Cruz. She earned her CNA on her own in the summer and did an internship at John Muir Health. She’s going into nursing...One of our students did every Saturday at the John Muir Health mobile clinic because she speaks fluent Spanish. She was one of our special education students and she did great.... Another was going to San Francisco State but he couldn’t afford it so he went to a two-year college and got a phlebotomy job at Kaiser.*

When asked to elaborate on the relative scarcity of internships, the work-based learning coordinator explained, “It’s a small number that get the job shadow and internships, but we are trying to grow that. But they all get all the other work-based learning experiences: guest speakers, e-mentors, HR interviews, career fair, field trips to health care organizations, the college trips.” Even if students were not able to participate in the most in-depth opportunities, members of the DLMHS administration have tried to bring other career-related informal learning opportunities to the rest of DLMHS’ students.

### 3.4.4. Summary

DLMHS offered a number of informal learning activities outside of the school day for its students. These primarily operated with the intent of exposing more of its students to the field of medicine. These opportunities included clubs, job shadows, and internships. Even though students indicated that they liked having the opportunities, they also believed the school could do more to expand its offerings. For example, students and parents wished that DLMHS had a
sports team. Additionally, only a small number of students were active in clubs and an even smaller number of students participated in the health-oriented internships and job shadows.

3.5. **Real-World STEM Partnerships (CC5)**

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.

3.5.2. **Design.**
DLMHS’ founders valued partnerships with external organizations from the very beginning. One district official claimed in a focus group “the CEOs from Sutter Delta and John Muir Health got together with the superintendent to say we want a medical pathway. There was that before the school even opened.” This intended pathway was one of several reasons why the school opened up next to the Kaiser Permanente Antioch Medical Center. Once the medical pathway program development had begun, the planning committee (including members from local medical and health organizations—see Context and Overview for more information on the committee), sought partnerships that could help with funding and program design. Principal Nancie Castro, who led the school planning team, explained:

> I spent a lot of time talking to community groups such as Rotary, Nurses Association, and Hospital Boards. I did everything I could think of to spread the word about what we were doing so we could start building strong industry partnerships.

It was through this process that Nancie Castro contacted ConnectEd: The California Center for College and Career. ConnectEd is an organization primarily funded by the James Irvine Foundation that supports linked learning pathways through funding and professional assistance. Principal Castro explained, “They had a project they were doing with 10 schools across the country. They were all healthcare academy types, either school within a school or stand-alone schools, and they were developing these integrated lessons.” As the DLMHS planning committee had already wanted to develop a medical high school, ConnectEd became a helpful partner in the design of the school. Principal Castro added that ConnectEd helped DLMHS partner with other organizations as time went on.

DLMHS administrators continued developing partnerships with nearby organizations. DLMHS’ work-based learning coordinator reflected on how she came to work at DLMHS:

> We had a consultant come in and said we need a single point of contact at the school to work with the healthcare partners. I have been involved with Sutter and Kaiser before because I had been the teacher of record for internships and I had like 30 internships from Deer Valley and lived here. I am pretty connected with the healthcare community and private practice because we had internships there. It is kind of networking and who you know.

Principal Castro and the school’s work-based learning coordinator suggested that these partnerships were built with the intention of providing DLMHS students with improved access to experiences with medical professions.
3.5.3. Implementation.
At the time of our visit, DLMHS maintained close working relationships with several of its partners. Despite these partnerships, the school faced some setbacks over the years that attenuated some of the positive effects of these relationships. Students participated in internships at external organizations and partnered with health organizations to develop clubs (see Blended Formal / Informal Learning Beyond the Typical School Day / Week / Year for more information on the students experiences in these internships). The school also received additional support for professional development from its partners.

Partnerships for Internships & Clubs. A small number of students from DLMHS participated in internships with partner organizations. At the time of our visit, internships were offered through Sutter Delta Medical Center. The work-based learning coordinator said usually around 10 internships and 20 job shadows were available for students each year. Other opportunities were organized by school staff members and included class field trips. In an interview, the school’s work-based learning coordinator explained:

All of our freshman walk to Kaiser on a field trip. John Muir Health also offers what they call “HOST tours” to the Walnut Creek Medical Center for our sophomores. We have an E-mentor program where they email healthcare professionals based on their career choice. Then they do a reflective report. We do practice interviews, although not this year.

As the school was located next to the Kaiser Permanente Antioch Medical Center, DLMHS administrators claimed that they had hoped to have a strong partnership with the hospital that would lead to internships for students. Unfortunately, the Kaiser Permanente internships were put on hold after an intern (from another school) violated HIPAA protocols. While DLMHS administrators hoped to resume internships in the future, this had not occurred at the time of our visit.

DLMHS had a close working relationship with John Muir Health. The hospital ran internships over the summer for students, mock interviews for students, and has matched funds to help students participate in the student group Health Occupation Students of America (HOSA), which has a strong presence at the school. At the time of our visit, DLMHS was in its last year of a “Health Science Capacity Building Grant,” which was a state-level grant that has helped the school to fund and develop their HOSA chapter. One of the requirements of the grant was that the school had to create a HOSA chapter and much of the grant money has gone towards helping students attend leadership conferences.

Quarterly Meeting with Business Partners. Quarterly, the work-based learning coordinator, lead health science teacher, and the principal met with business partners from the surrounding community to discuss how the school can partner with these various organizations. These business partners included representatives from nearby hospitals, universities, county education officials, and businesses in Antioch. These meetings have been ongoing since the inception of the school and the businesses partners have helped the school in developing its health science curriculum and finding community partners to volunteer for school-wide events like senior
defense day. When we asked the business partners about how they considered their role in the advisory board process, one representative responded:

*I think as an attendee at these meetings, I am getting informed of what is going on here. What their needs are. What they see upcoming that I can get involved in at whatever level of commitment that I can make. Like senior defense day and sitting on the panel. For all of us that attend, it is very exciting to see what is going on here.*

3.5.4. Summary.
Industry representatives have been a part of the school from its planning and inception. Some joined the school’s advisory team after the principal started hiring staff. Specifically, health care representatives helped to develop the health science curriculum for the students and have played a major role in providing internships and job shadowing opportunities for students. Unfortunately, the school has faced some difficulties in leveraging these partnerships for students, either due to a lack of available opportunities (e.g. few internship openings) or due to unforeseen circumstances (e.g. Kaiser terminating its internship program).

3.6. Early College Level Coursework (CC6)

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.

3.6.2. Design.
DLMHS administrators explained that the primary goal of the pathways program was for students to be equipped with work ready skills by the end of high school. A district administrator said in an interview, “I’m not so keen on having them be technically trained at the end of the four years to go into the medical field. I want them to have work ready skills.” The district administrator defined these work ready skills as, “the technical skills to bring relevance to what they’re learning.” To that end, the intent was to offer a rigorous program of high school science and mathematics courses while providing relevance through the medical-themed curriculum (see STEM-Focused Curriculum, CC1) and collaborative projects (see Reform Instructional Strategies and Project-Based Learning, CC2). In addition, DLMHS provided options for early college coursework in the form of Advanced Placement courses, community college opportunities, and a dual enrollment course.

**Advanced Placement.** Dozier-Libbey Medical High School used Advanced Placement (AP) courses to give all students the opportunity to experience college level rigor in a high school setting. These AP courses were not required programs and students could decide if they wanted to take the courses or enroll in a general course. DLMHS offered seven classes for AP credit: Biology, Psychology, World History, U.S. History, Literature, Calculus, and Statistics. If students decided to take an AP exam, they were required to pay the entire cost of the exam, $89 per test. Students who were either enrolled or eligible to participate in the Federal Free or Reduced Price Lunch Program qualified for the College Board fee reduction on all AP Exams that they took in a given year.
Los Medanos College. Students at DLMHS could take college courses at Los Medanos College, the local community college. If students enrolled through DLMHS, the cost was $1.00 per credit, plus the cost of the textbooks. Preference for enrollment in these courses at the community college was given to college students; students from DLMHS could enroll if space was still available.

Medical Terminology. In addition to AP courses, DLMHS offered a Medical Terminology class articulated with Los Medanos College. This course was given on the DLMHS campus and required of all 9th graders. Students who earned a grade of A or B in this course were eligible for three units of college credit.

3.6.3. Implementation.
DLMHS was known by students, parents, and the community as a rigorous school. Awards such as being recognized as a “California Distinguished State School” have furthered this perception and culture of a rigorous school. One parent in a focus group said, “Dozier-Libbey seriously prepares the students for college.” And in fact, 97% of all students from the 2013 graduating class at DLMHS attended a four or two year college or university after high school, with 48% of all graduating students choosing a four year university and 49% choosing a two year university.

The opportunities for students at DLMHS to take early-college coursework have fueled this rigorous college-going culture. A team of two researchers observed an AP Calculus class where students were reviewing for the upcoming AP Calculus test. The teacher said she had received her AP training from a Summer Institute offered by the College Board. When we asked how many of the students would take the upcoming AP test, we found that many students would not be taking it due to the high price tag, while other students had the opinion that taking this test could be a waste of money.

One of the challenges that DLMHS encountered being smaller schools was how to offer a wide array of courses given the small enrollment. For upper level math courses, DLMHS only offered one section of AP Calculus or AP Statistics each year, and the class offered was contingent on the number of students that signed up for each course. If more students signed up for AP Calculus than AP Statistics, then AP Calculus would be offered the following year. Students have identified these restricted course offerings as a challenge in accessing early college courses at DLMHS. They could not always get the course that they wanted.

3.6.4. Summary.
Many students at DLMHS took the AP classes for the challenge. One student said in a focus group, “We choose AP classes, and they expect a lot more from us.” Moreover, for many students, there was an attitude that these rigorous AP courses would prepare them for their future careers. Students at DLMHS were very articulate about their future career goals and aspirations. One student discussed his career goals in relation to pursuing the rigorous Dozier-Libbey certificate in a focus group:

There is something called the Dozier-Libbey certificate. You get it if you have really good grades and do volunteer service, do extra credit, and do all of the Dozier classes. At the end of high school, I want the Dozier-Libbey certificate. After high school, I want to go to a college in
Florida and get two years and then go to nursing school for four years. I want to be a pediatric nurse.

Students chose to come to DLMHS to prepare themselves for a career, and for many, they chose this particular school because it was a pathway to explore and learn more about the medical field, a field of interest to many students. Students knew when attending DLMHS that the coursework would be rigorous and many embraced the challenge of early college coursework in preparing them for their future careers.

3.7. Well-prepared Teaching Staff (CC7)

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

3.7.2. Design.
The teaching staff at DLMHS was intentionally and thoughtfully hired. Successful candidates typically had strong content knowledge in their discipline, a passion for teaching, and experience in a collaborative and cooperative environment. The principal of DLMHS stated that she looked for candidates that had, “the expertise in their subject areas” and “the excitement and the passion to want to be part of something great.” The principal believed that this combination of expertise in a content area, experience in collaborative teaching, and a tough work ethic were the necessary attributes in developing a high caliber teaching staff.

3.7.3. Implementation.
When DLMHS first opened, the principal was able to select her teachers, rather than having teachers assigned by the district. The principal hired two-thirds of the current teaching staff from within the Antioch school district and one-third from outside the school district. During interviews, she said she looked for content expertise, experience in collaborative teaching, and a hard work ethic. She explained, “I would really explicitly say this is a Super Bowl team. So, you know, it’s hard work when you’re on a Super Bowl team and that’s what you should expect, because we don’t want anything less than that.”

Even though DLMHS was a medical-themed pathway high school, experience in health careers was not a hiring requirement for new teachers. This was mainly due to the difficulty of finding teachers with that experience. The principal said in an interview that if a teacher had experience in the medical field that it “was definitely a plus, but there’s just not a lot of that out there.” Moreover, while most DLMHS were not required to have industry experience, there was one small group of teachers at DLMHS where this was a requirement. The Career Technical Education/Regional Occupation Program (CTE/ROP) teachers who were hired by Contra Costa County Office of Education were required to have teaching credentials and recent, relevant, full-time industry experience. Due to these necessary credentials, a Contra Costa County administrator said, “it’s sometimes really hard to find a good teacher to teach these classes.”

Who are the teachers? Twenty-five teachers responded to the Teacher Survey administered before the researchers began the site visit, including 17 females and six males, 96% of whom
identify as White, and 4% as Asian. With an age range from 25 to over 55, the majority of respondents were in the 35-49 year range, had been working as a teacher for an average of 18 years, a median of 18, and a range from 2 to 36 years. The teachers mainly held degrees from colleges and universities within the state of California or nearby states, with few holding degrees from outside that region. Most had bachelor’s degrees and teaching certifications in the subject areas they were teaching. These teachers sought out DLMHS because of its STEM focus, medical theme, and collaborative format. Some had been on the planning committee for the school.

**Teacher responsibilities.** The teachers at DLMHS had a variety of responsibilities that went well beyond classroom instruction. Teachers met two hours each week, alternating grade level and department groups. One teacher expressed in a focus group, “We all fit together like a puzzle really, really well and we like to work together. We want to do more. When we have grade level time, it’s not enough.” Some teachers lamented that due to the small campus, they often had to take on many responsibilities. Another teacher said, “It’s tough with a small campus, because it’s hard to get prep time together. We wear a lot of hats, but our principal is very supportive.” It is this grade level planning time that many teachers said aided the development of many of the collaborative and grade level projects that students work on across classes.

**Teacher confidence.** Teachers were generally confident in their ability to engage students in reform-based practices and encourage interest and participation in the STEM fields (Table 6). Teachers felt the most confident in their ability to recognize and respond to student diversity and helping students to take responsibility for their own learning.

**Table 6**

*STEM Teacher data for Pedagogical Strategies*

<table>
<thead>
<tr>
<th>Question - I am confident in my ability to:</th>
<th>Scale 1-5*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead a class of students using investigative strategies</td>
<td>3.9</td>
</tr>
<tr>
<td>Manage a class of students engaged in hands-on/project-based work</td>
<td>4.3</td>
</tr>
<tr>
<td>Help students take responsibility for their own learning</td>
<td>4.4</td>
</tr>
<tr>
<td>Recognize and respond to student diversity</td>
<td>4.4</td>
</tr>
<tr>
<td>Encourage students’ interest in science</td>
<td>3.8</td>
</tr>
<tr>
<td>Use strategies that specifically encourage participation of females and minorities in STEM</td>
<td>3.8</td>
</tr>
<tr>
<td>Involve parents in the STEM education of their students</td>
<td>3.2</td>
</tr>
</tbody>
</table>

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

**Teacher Collaboration.** The teaching environment at DLMHS was designed to be collaborative. The principal intentionally hired teachers that had experience in collaboration. Collaboration primarily occurred in grade level teams, with the exception of mathematics (due to mixed grade levels of students in mathemath classes). The teachers then met during grade level planning periods to implement these grade level projects and to reflect on what to do differently the following year. In describing the grade level projects, one teacher in a focus group said, “We create everything at the grade level meetings.” Another teacher said, “The focus for us is what all 12th grade kids are doing and where can we put that stuff so it is being reaffirmed in this class, its being read and written in that class.” Another teacher said in an observation debriefing, “We
have all sorts of sticky notes that say next year to do this, next time say this”. Based on the
teacher survey and follow up conversations at DLMHS, teachers at DLMHS genuinely enjoyed
collaborating and sought more release time to continue to create and execute the integrated units.

**Teacher professional development and support.** Teachers at DLMHS described most of their
professional development as occurring in-house, due to a lack of funds for external professional
development. Teachers described having access to professional development primarily through
the district office and ConnectEd. On occasion, some teachers had attended AP workshops,
College Board summer institutes, or specialized workshops in project based learning and small
learning communities.

The majority of the teachers claimed that their recent professional development experiences
confirmed what they were already doing. Many teachers also stated that professional
development caused them to change their practices with respect to research based practices when
it was related to practices such as problem-based and project-based learning,
инquiry/investigation-oriented teaching strategies, and the use of engineering or design concepts
and activities. For teachers who taught AP courses, the AP workshops attended seemed to be
greatly appreciated.

Based on the Teacher Survey and subsequent discussions with teachers at DLMHS, the teachers
generally sought more professional development in practical applications in the medical field
that connect with the material being taught in the individual courses. This included both
professional development and curriculum materials on incorporating themes from healthcare and
the medical field into their curriculum. They also sought knowledge about research and practices
in education outside of DLMHS, feeling that reform based instruction such as inquiry teaching,
project-based learning, and writing instruction within content areas would be useful.

The above statements are reflected in data from the Teacher Survey in Tables 7 and 8, 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 was sufficient to support their instruction. They were slightly
less positive about the time they had for professional development, but felt that the limited time
that they had was effective in enhancing their instruction.

**Table 7**

**Time for Collaboration**

<table>
<thead>
<tr>
<th>Question – Rate your access to the following resources:</th>
<th>Scale 1-3*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time available for teachers to plan and prepare lessons</td>
<td>2.6</td>
</tr>
<tr>
<td>Time available for teachers to work with other teachers</td>
<td>2.6</td>
</tr>
<tr>
<td>Time available for teacher professional development</td>
<td>2.5</td>
</tr>
</tbody>
</table>

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

**Table 8**

**Value of Collaboration**

<table>
<thead>
<tr>
<th>Question – Rate the effect of your access to the following on your STEM instruction</th>
<th>Scale 1-5*</th>
</tr>
</thead>
</table>


Time available for teachers to plan and prepare lessons 4.7
Time available for teachers to work with other teachers 4.8
Time available for teacher professional development 4.5
*1 = inhibits effective instruction, 2 = somewhat inhibits effective instruction, 3 = neutral or mixed, 4 = somewhat facilitates effective instruction, 5 = encourages or enables effective instruction

3.7.4. Summary.
Carefully selected teachers, philosophically aligned with the collaborative model of DLMHS, worked with passion and diligence to carry out the school Mission and Vision that were operationalized through the schools VITAL Signs. The teachers arrived at DLMHS with solid content area backgrounds and prior teaching experience. Overall, teachers felt they had adequate time to plan but felt that additional time in their grade level teams to plan and implement grade level interdisciplinary projects would be beneficial. Teachers were supported in continuing their education through professional development offerings by the district and ConnectEd, but felt more professional development on reformed based teaching practices and incorporating themes from healthcare and the medical field would be useful.

3.8. Inclusive STEM Mission (CC8)

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

3.8.2. Design.
The stated goals of the school’s inclusive STEM Mission at DLMHS were found in three documents: the school’s mission statement, vision statement, and admissions procedures.

The mission statement published on the DLMHS’s website specifically identified preparing all students for success in health professions and college: “DLMHS exists to challenge students with exciting rigorous instruction that prepares them with the knowledge and experience to succeed in health science professions and college.”

DLMHS’s vision statement echoed that mission, focusing on rigor and preparing students to be successful citizens “Every student valued, every student challenged, every student prepared to succeed in a changing world.”

The admission procedures were decided by the Antioch Unified School District school board. The process was open and guided by four goals:
1. All students have equal access to the program.
2. The student body will reflect the demographics of our community.
3. The selection process is non-discriminatory and fair to all.
4. Selection is made early for planning purposes.

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

**Inclusiveness.** Two criteria must have been met for a student to enter the lottery for admission to DLMHS. First, a completed application packet was required to be turned in on time, and second, a parent/guardian and the student were required to attend one information meeting prior to submitting the application. Once applications were accepted, an external entity conducted the lottery process by randomly selecting students to attend the school. Because more females than males applied to DLMHS, more females were picked in the lottery, and subsequently more females attended DLMHS. In the 2012-2013 school year, 64% of the student body was female and 36% was male. The principal described that this disparity has increased over time due to the proliferation of the other pathways programs in the Antioch Unified School District. She explained that when the school first opened, DLMHS was only one of a few pathway programs so she was able to visit each of the middle schools in the county to do presentations. Now that there are “10 or 12 choices for students,” Principal Castro stated that she does not “get to go out to every middle school and make presentations to every eighth grader anymore.” It was her opinion that this could account for the increasing trend toward the gender imbalance at DLMHS. When she was presenting at the middle schools, she described how she would market the school to both males and females and emphasized professions that appealed to males and females, “I talked about fireman and EMT and all of the different things within healthcare that I thought would appeal to both. It’s not just doctors and nurses.” The principal thought that the gender imbalance was an issue of concern, noting, “That’s going to be something we definitely have to look at.”

The students at DLMHS drew from all of Antioch. One teacher said in a focus group, “We run the gamut of SES and home life. We have everybody.” On campus, the students were seen wearing medical scrubs as their school uniform. One student in a focus group commented on the equalizing effect of the school’s dress code by saying, “You can’t judge someone based on wealth if everyone is wearing the same clothes, like scrubs.” A PowerPoint presentation designed for parents that were considering enrolling their son or daughter at DLMHS said:

*Our dress code is very important to us. We are training students for success in an industry that demands a professional appearance. We know as a school community, the reputation of our students means everything – so we dress for success.*

Another student from the focus group commented on the school’s inclusive environment saying that it was an inviting and safe environment:

*I think it’s really inviting. It’s a really diverse campus and no one seems to have a problem with one race or group that I know of. It seems like a really good campus. I don’t think there have been any fights this year. It’s just a really happy place to be.*

In a focus group, one parent stated that the school was not as diverse as it could be. She believed the size of the school limited the number of sports and clubs and, as a result, may unintentionally weed out students looking for a more social atmosphere at school:
I don’t think it’s that diverse. My kids enjoy coming but don’t feel it’s diverse. When I see the population I don’t think it’s as diverse as it could be. The school does a good job going out to middle schools, but the parents that put in for the application, many of the students don’t feel comfortable, because they want more activities, sports, diversity, so they choose to go to the other schools. It weeds the student out who want more social things. It’s such a small school; you might not see some other clubs that you would at other schools.

**STEM Focus and Rigor.** DLMHS offered a rigorous college preparatory program to all students, as described in the section entitled *STEM-focused Curriculum*. Beyond the two years of laboratory science and three years of mathematics required for graduation by the state of California, DLMHS required four years of science, requiring physiology and a fourth year of science chosen from Physics, AP Biology, AP Chemistry or AP Physics. In mathematics, DLMHS required a fourth year of coursework beyond the three years required with the fourth year course content chosen from Pre-Calculus, AP Calculus, AP Statistics or Medical Math. The guidance counselor, who worked at DLMHS and another local high school, commented on the rigor of the STEM curriculum:

*I really like this program. I am at two high schools, so I can see the different in the students, in the rigor. Here they are mandated to take four years of science and math; it’s just part of the curriculum. Even our Special Ed students are taking the same courses just with support. Other high schools, the special Ed are not taking A-G classes, and I have seen great success.*

**3.8.4. Summary.**
DLMHS 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 medical and health related careers and workplaces.

**3.9. Administrative Structure (CC9)**

**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.

**3.9.2. Design.**
After serving as a middle school principal for six years, Principal Nancie Castro “jumped on” the chance to lead DLMHS, and led the research on other inclusive schools with a career pathway focus. She and the school planning committee developed a vision for the school, emphasizing the “opportunity to start fresh to really build a culture.” An advisory board with representatives from local hospitals, career tech colleges, Cal State University, and the local community college helped to shape the school. This board provided feedback on curriculum and program, helped to identify resources, guest speakers and field trips.
Principal Castro also spent the start-up years developing marketing materials and spreading the word about DLMHS. In an interview she said, “I spent a lot of time talking to Rotary, any kind of community group I could find.” She also talked with “nurses associations, hospitals. I talked to hospital boards. Just everything I could think of to get the word out of what we were doing to start building the partnerships.” Nancie also visited all the eighth grade students in each of the district middle schools to present DLMHS as a high school option and to talk about the program. When it came time to put out the applications, Nancie said she got “480 applications for 200 spots.”

DLMHS was accredited by Western Association of Schools and Colleges (WASC). This membership requires schools to articulate their Expected School Wide Learning Outcomes. “We call ours, VITAL Signs,” said Principal Castro, explaining that every student should have verbal, intellectual, technological, and academic and leadership skills. “This is what we want every graduate to be.” Every senior in 2013 was expected to collect “evidence from the projects they had done in their classrooms to show that they have met this and are prepared for the next step.” This evidence was then presented during a 20-minute senior defense.

3.9.3. Implementation.

Teaching Staff. Principal Castro was able to select the school teaching staff, interviewing those from within and outside the district. Because of the difficulty of finding qualified teachers with prior experience in health careers, she focused on finding staff experienced in collaborating on curriculum development and excited about the work involved in a start-up school. As one teacher said in a focus group, “Most of us fought for this job and worked hard for this job. We wanted it.” The teacher continued, “We knew it was a lot of extra work. We all came from different schools where we knew people wouldn’t change. … From the start, we got to set up the rules and establish the goals and beliefs of the school. We were able to say what we wanted the kids to believe rather than having someone tell us that.”

Principal and Administration. The school staff of Dozier-Libbey was lean, including 25 teachers, 1 principal, and a part-time vice-principal. Leadership decisions were made by the principal alone, or by a leadership team comprised of the principal and a team of teachers that represented different grade levels and disciplines. Many of the teachers who began with the school remained there in 2013, and newer teachers gave both the principal and their colleagues high praise. One teacher said in an interview, “I think she is a teacher’s principal. She is really supportive of what works well in your classroom.” When asked about the ability of the school to survive if the principal were to move on, a teacher in a focus group responded, “We are a very strong staff. We know what our mission and vision are. If we got a new principal, they would have to accept a strong culture.”

One important role at the school was the work-based learning coordinator. This role was designed to provide a single point of contact to work with the healthcare partners. Initially this role was supported through grant funding and was filled by a teacher who had, in the past, worked in the local healthcare industry. Her role involved setting up field trips, guest speakers, and internships. The principal said in an interview, “With funding running out, she has less time to set up these opportunities.” At the time of our visit, the work-based learning coordinator was also teaching classes in health sciences and medical terminology. A halftime clerical person had
taken over some of the responsibilities for arranging the speakers and fieldtrips. The work-based learning coordinator claimed “you really need that person with industry experience and knowledge of the curriculum to integrate all these activities of what students are learning.” Consequently, the school continued to seek funding for this role, but it appeared that it would likely continue to be staffed by a clerical person with no medical experience or connections, making the work more challenging.

Another change in staffing over the first five years of DLMHS’s operation was the role of the guidance counselor. In 2011-12, the district decided to split counselors among the high schools and not having them based at schools, but rotating among schools. Different counselors staffed DLMHS on different days of the week, so staff and students both reported having little connection or continuity with counselors.

A guidance counselor acknowledged in an interview that by being at the school only one day a week, she had not been able to meet with every parent. She added that they had only had time to track the courses students were taking because:

>We have a set schedule for them every year, so we know what classes they are going into next year. We pay attention to credit recovery. I help them with that and I am keeping track of their academic records.

If students had a need for a counselor on a day a counselor was not on campus, the principal handled the situation and a counselor would be asked to follow up when next on campus.

3.9.4. Summary.
In 2013, Dozier-Libbey was in its fifth year of operation and preparing to launch its second set of graduates into the world of college and health care careers. It began as a part of a large-scale effort by the district to provide students with career-focused or small learning community experiences. It has successfully launched virtually all of its first graduating class into higher education. The school enjoys strong partnerships with local health care providers who helped the school planning committee to design the school curriculum and program, identify resources, and serve as guest speakers and facilitators of field trips to medical sites.

Over its years of operation, there have been struggles as well. As the funding associated with the initial startup and design runs out, there are cuts in staffing that seem quite important to its mission. The school has been led by a strong, supportive principal who often used a leadership team comprised of teachers who represented different grade levels and disciplines. The teachers at the school reported that they felt empowered by the school mission and vision, and worked with the leadership to achieve school-wide goals.

3.10. Supports for Underrepresented Students (CC10)

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.

3.10.2. Design.
DLMHS was designed to be a small school with a focus on career and technical education (CTE), providing students the opportunity to explore medical careers through a rigorous college preparation curriculum. The concentration of medical facilities and corporations in the geographic area suggested that a medical theme would be effective in attracting and retaining students, and providing valued college and career preparation. For the academic year of 2012-2013, DLMHS saw 97% of their graduating seniors graduate with plans to attend a two or four year college (Dozier Libby Medical High School website, 2013). In addition to its medical themed CTE curriculum and its small school size, DLMHS used an array of supports from (a) socio-emotional, (b) academic, and (c) college preparation to best serve the needs of its student population that included large proportions of groups of students traditionally under-represented in STEM.

3.10.3. Implementation.
Small School. DLMHS was designed to be a “small school” that would house about 600 students, its approximate population size in 2012-13.

The principal noted in an interview that the size of the school seemed to account for some of its success in supporting students: “I think just being a small school we’re able to kind of really provide more support for the students, because we really know them and they feel connected to the teachers as someone to go to if they have a problem.” This is especially important for students who have not had family members in higher education or working in medically related industries. In a focus group, the Workforce Development Coordinator of John Muir Health said:

Most of the students do not have parents or family members that are in the medical arena so they are coming to this school really looking for opportunity. What they are getting exposed at this school…all the guest speakers, all the job shadowing, learning about (medical) jobs during interviews. There are so many different things to do in the medical arena, but most kids think it’s doctors and nurses. They don’t have family members influencing them. These (medical) people are influencing them and exposing them to opportunity for a better life. And it is really pretty exciting. I would say most of their parents have not gone to college in this community, so I just think it is very cool.

Ninth graders in a focus group noted that because of the small school size, teachers noticed if a student’s grade dips and would reach out to offer support. Teachers in a focus group reported that the size of the school allowed them to know the students well and helped teachers work together to support students. If a student was having a problem, it could often be solved quickly by speaking to other teachers and asking them to help.

Several teachers said that the supports for students with disabilities were among the best that they had experienced, due to the small school size and frequent communication among staff. The special education teacher at DLMHS said in an interview:
My strength is based on the fact that the teachers on this campus make an effort to work me. They come to me and collaborate and that’s easier for the kids. It boosts their self-esteem because it’s an everyday thing and everyone is pulling for the same thing.

In addition, students with disabilities were mainstreamed more and offered supports for the demanding courses. If these students were at a larger school, some would be placed in more restrictive inclusion classes. The teachers thought that DLMHS, while making more demands on students with disabilities, was also helping them to be more successful and on the path to better opportunities after graduation.

Advisories. According the principal, the advisory period was one of the main ways for students to get help from a teacher every day. The advisory period was scheduled 5 days a week for 30 minutes, right before lunch. No other classes were offered at that time. The advisory was initially conceived as a time for students who were having difficulties to find help, but it has been expanded to include all students. As one parent said in a focus group, “Kids take it upon themselves to get help”. Students reported that their teachers used the advisory period to check their grades and provide advice for improvement. The help might be as simple as one-on-one explanation of some concept or assignment that was giving a student difficulty, or it could involve matching a student with a tutor. In addition, college and career counseling occurred during the advisory period. Although the advisory was a relatively simple support and not unusual in U.S. schools, in a small school with set aside time for communication and help, it served as a kind of glue to join the various support systems that were available to students. Students, teachers, and administrators all knew that there is time built into the school day for personal attention and support.

Tutoring. In an 11th grade focus group, students reported that many students at DLMHS have tutors. In addition, teachers are willing to work with students one-on-one, so a private tutor is not always necessary. According to the principal, one of the biggest challenges for incoming 9th grade students and all of the teachers at DLMHS was the low level of student preparation in mathematics. The mathematics deficiencies influenced instruction in mathematics courses, but also influenced the school’s ability to find and retain Chemistry teachers.

Mastery Learning Systems. DLMHS instituted a mastery learning system (also discussed in relation to mathematics in CC1, STEM-focused Curriculum and CC2, Reformed Based Instructional Strategies and Project Based Learning) that allowed students to retake tests and key assignments until they reached the criterion level of demonstrated proficiency. The mastery learning system seemed to help students through close monitoring and by not allowing them to fail. However, it also required more work of both students and teachers. Unlike other schools where a poor assessment result might be glossed over with hopes for better performance in the future, the mastery system required students to be able to demonstrate their facility with concepts on a test. A 9th grade student in a focus group pointed out:

This school is really about giving you chances, letting you have the ability to retake, and just get better at it instead of just saying you didn’t do well on the first time, so you’re done. This school wants you to actually learn the concept. We don’t want you to fail.
**School Loop.** The School Loop system (also described in the section on *Integrated Innovative Technology Use, CC3*) played an important role in providing student support. Through this system, both parents and teachers had quick access to a student’s grades. For parents this was important. One parent reported that seeing her child’s low grades on School Loop, allowed her to act on the problem. Follow-up with willing helpful teachers often was a successful and necessary strategy. A student reported that teachers used School Loop to check on students, and students could use it to contact individual teachers for special help or tutoring. Teachers sometimes made their presentations or study guides available on the School Loop. The principal said in an interview that students could use School Loop to, “turn things in electronically. They have lockers. The teachers put stuff in their locker that the kids can access”. Evening financial aid and college preparation sessions were also advertised to parents and students via School Loop. The school guidance counselor said in an interview, “we promote it through School Loop and parents who are registered through School Loop receive that information.”

Schools often have communications systems, but at DLMHS, the communication connected students to tutorial services and one-on-one sessions with teachers during advisories, allowing immediate progress to be made. It helped build confidence that the challenging environment could be handled. In addition, students, advisors, teachers and parents all had access to the same information about a student, so the School Loop helped to prevent problems from falling through the cracks. Instead, it often provided a means for their resolution.

**College and Career Guidance.** Students at DLMHS had access to all of the support services discussed above in grades 9 through 12. However, junior and senior years are typically the years when support services are stepped up for college and career readiness activities and for college counseling. Yet due to recent state school funding cuts, the school had not had not figured out a way to fill in the gaps left by the defunding of positions like high school guidance counselors.

In previous years, DLMHS had a full-time guidance counselor, but the load had been reduced to part-time counselors who rotated into the school a few days per week. The one counselor that we interviewed was only at DLMHS once a week, on Fridays. In our interview with the guidance counselor we discussed how teachers at DLMHS took much of the college preparation burden from the guidance counselors. She reported, “They [teachers] are great with that [college support] and that is why I have been able to keep up with the academic [support] because there is a lot of support in the classrooms.” In order to prepare students for college, teachers start with 9th graders. In the beginning of their freshman year, students in their health science classes create 4-year plans to graduate from high school. In addition, the counselor said that teachers give students their transcripts every year, make sure students are achieving academically, give college application reminders, and during the senior year, teachers give presentations on SATs. The school district sent out announcements about college counseling events held in groups in the evenings. As staff and students told us, this made it difficult for part-time counselors to get to know students well, or to develop counseling programs designed specifically for the DLMHS students’ specialized college planning needs. One student noted in a focus group:

*You just go in there and ask them (counselors) questions. Last year counselor was here all the time. They are only here on alternating days. And it’s like there are two and sometimes there is*
three and we share them with all the other students, so it’s like you can’t really see them, it’s really hard. There are people in the career center, they will help you too.

The science teachers in a focus group had a similar take on the need for a full-time guidance counselor:

...last year there was a full time counselor. Having her on campus was great. She built relationships. With the way our district is restructuring, there are many days now that we go without a counselor. It’s hard for students to be able to talk to someone who is trained in counseling and academics or personal issues. That is an area we can definitely grow and work on. Last year the counselor knew everyone. This year it’s a revolving door.

One of the guidance and career counselors assigned to DLMHS remarked in an interview, “I think it is important to have someone here 5 days a week and there is someone stable and who the students know--this is the person I go to. I am here Friday and another person is here on Monday. You have a middle of the week where they don’t know who to go to for questions.”

Because of the loss of a full-time, on-site guidance counselor, teachers worked to pick up some of the counseling duties. Students and parents in focus groups expressed appreciation for their efforts and credited the teachers with their skills and knowledge about the college application process. One teacher in a focus group remarked:

*We don’t do anything special. We hold the bar high for everyone. We constantly tell those kids we hold it high because “I know you can do it and I am here if you need anything.” I constantly have kids in my room; kids come and eat lunch in my room if nothing else just to talk. In terms of preparing them for college, we haven’t done such a good job of it, but we pounded it into their heads. They all go on campus tours. We require it of our students, we tell them go visit a campus. When we rotated counselors this year, teachers had to pick up the slack; one of our teachers is doing a really great job of that. She makes writing colleges essays as part of their class.*

**Students with Disabilities.** In addition to the serving the needs of all DLMHS students in helping them prepare for college, the school or school system also provided a strong special education program for about 30 of their 650 students identified as having disabilities. There was a full-time special education teacher on staff, as well as a special education aide. The special education teacher team taught a mathematics class with a mathematics teacher, saw students individually and in groups, and consulted with teachers about how to meet the needs of these students. Each student could have one-on-one help of 225 minutes / week with the special education teacher. She reported in an interview that the students with disabilities at DLMHS were getting a challenging, but strong, education. She liked her role in the school and remarked:

*My strength is based on the fact that the teachers on this campus make an effort to work with me. They come to me and collaborate and that’s easier for the kids. It boosts their self-esteem because it’s an everyday thing and everyone is pulling for the same thing. I have a big group of kids from middle school who wouldn’t tell me they were SPED and they didn’t want anyone to know they were affiliated with me. Here, however, they seek me out. I have a room full of kids every lunch.*
In the remarks by staff on supports for students at DLMHS, a strong theme was the need for supports to build a college-going culture for the specialized medical mission of the school in addition to STEM education. Students from DLMHS did not always have family members who have attended college, nor did they have immediate links to medical careers. Nonetheless, it was reported by the assistant superintendent that medicine was one of the strongest growth industries in the region. Thus, it made sense to build a school with a medical theme. However, the lack of a full-time college counselor and the lack of interaction with Kaiser Permanente Hospital directly across the road were directly felt by DLMHS staff and students.

3.10.4. Summary.
DLMHS is a specialized medically themed school that attracts a large population of students who aim for college, success in STEM, and a strong preparation for medically related jobs and careers. The school held high expectations for students, and as a consequence, found the need and the means to provide supports to its students. So far, the record of student success has been strong. The advisories, tutoring programs and communication system provided a means for the students, parents and teachers to support students. In the last graduating class, nearly all of the students reported that they were headed for two or four year colleges. The financial cutbacks in the State of California required difficult cuts in services. The commitment and collaboration of school staff have made it possible for the school to provide solutions – though improvised and not always ideal - to these challenges.

4. EMERGENT THEMES

The research team initially set out to examine how and to what extent the 10 hypothesized critical components instrumental to this case study were evidenced at DLMHS. However, we also looked for additional themes that were part of the DLMHS program. We identified the following emergent themes that further helped to explain how DLMHS functioned.

4.1. Emergent Theme: Focus on Career Readiness & Identity

DLMHS’ focus on student preparation for health-related careers extended beyond the curriculum taught in science classes. It was apparent that the school’s design team understood that classroom preparation in STEM courses was only one aspect of a school program required to affect student career interests and preparation. Students also would need to feel a personal connection to their potential career options if they were to actively work towards career goals (e.g., Diekman, Clark, Johnston, Brown, & Steinberg, 2011; Wrzesniewski & Dutton, 2001). There was a broad variety of evidence that showed the DLMHS community sought to influence its students by changing their personal relationship with health and health fields. That is, DLMHS purposely, and often successfully, attempted to prepare students for health careers and to make students identify with healthcare as a career option. This focus also extended to using healthcare careers to help the Antioch community.

4.1.1. Exposure to Health Careers & Health Identity.
One of the many career-related pieces of learning that happens at DLMHS was student exposure to the entire field of healthcare. Principal Castro initially noticed “When the kids come to us as
freshman, they really don’t know what they want to do. A lot think, ‘I want to be a pediatrician or a veterinarian.’ They don’t know all the careers in the health field.” DLMHS made a concerted effort to show students that healthcare jobs exist outside of the most familiar ones. Several students found this aspect of the school helpful, and suggested that they learned just as much about what they didn’t want to do for a career. One student recalled, “I wanted to be a sports physician. When I first came here and saw how much work it was and the sleepless nights. Then, even when you get the job, there’s pressure. So I realized the job might not be for me.” Another student said, “I wanted to be a psychiatrist at first, but now I realized I don’t want to do that. I want to teach instead.” When asked to discuss how the student body felt about medical careers, another student suggested, “Most people when they come here wanted to be in medicine, and then changed their mind. For me, it made me want to be in the medical field.”

Parents also agreed that this was a successful and integral component of DLMHS. One parent suggested in a focus group that this was one of the primary reasons that her daughter went to DLMHS:

*She decided to go to DLMHS because she wasn’t sure of her career choice and she wanted to kind of determine whether the medical field would be interesting for her. It turned out she ruled it out after four years, which saved her time in college.*

Another parent was very happy that:

*Students start to learn about the medical field and can make an informed decision before college. [DLMHS] prepares them to succeed. They give them the tools. If the kids choose not to follow, it’s really up to them. The school itself really provides the nurturing for them to succeed in higher education.*

Principal Castro was extremely proud of the exposure students had to various careers. She believed that it helped students think about careers in a meaningful way that solidified their interests. Principal Castro claimed in an interview, “Last year’s graduating class, when we did exit interviews, I think every single student was able to articulate a career that they were going for.” When asked how many students were interested in healthcare-related careers, Principal Castro added:

*A lot of students said they were going to go into health care, about 70%. Some students choose areas other than health care, but they were still able to share a specific career they wanted to pursue like business, law, or theater. They had an idea and understood the need to have a career goal. That really validated for me that what we were doing was really working because the kids could understand that they needed a goal and a plan to get there. It also made me realize that all the exploring they do in their 4 years here is so meaningful because there are so many different careers within health care to choose from that are so specific, and they didn’t realize they existed before they came to Dozier.*

DLMHS had a strong culture emphasizing medical occupations and health. One parent claimed in a focus group that the major difference between DLMHS and other schools was “the fact that all the projects, professional dress, how they have to go out and act like they’re in the medical
field.” As discussed in the section *Inclusive STEM Mission*, students all wore medical scrubs as a school uniform. Students claimed that this made them feel “like professionals” and sometimes even led to other members of the community mistaking them for doctors or nurses. The culture of healthcare even spilled outside of the school day and affected student’s food choices. One parent claimed “I know my daughters are much more health conscious, like food, and medicine they take. They’re very savvy as to medical terminology and medical things.”

4.1.2. Community Focus.
Several founding and current administrators and business partners referenced the importance of DLMHS students eventually entering the healthcare workforce, especially as it related to the city of Antioch. One healthcare business partner claimed in a focus group “these students are going to be our employees in the future and we need good employees.” Another added, “We are hoping…that they will become part of our professional network in the future.” These business partners’ hoped that students would stay in the community. This seemed to be occurring since county officials reported that many students chose to attend nearby universities. One county official claimed, “In this community they come back. They don’t go very far and then they come back.”

The county official and other healthcare representatives present in the focus group were ambivalent about student immobility. While they were happy that Antioch (and nearby areas) would benefit from the improved education of its population, they also noticed students might be giving up better opportunities to stay nearby.

*I have even noticed it with college acceptances in the Antioch/Pittsburg area. If they get accepted at UCLA and they get accepted to a school here. UCLA being the better school perhaps, they stay close home. They stay as close as they can. Often times it’s financial. They don’t have the means to pay for the trips home. They live at home and commute (locally).*

However, administrators said that students who left California tended to not return:

*I have also noticed that students that went away to college out of California don’t necessarily think they have to come back. I don’t know if they have gained extra confidence or seen another world. But that tends to be typical too.*

While the DLMHS community did not entirely agree as to whether or not this community focus was overall positive for the students and for the Antioch community, the career-related community focus was a strong theme at the school.

5. STUDENT OUTCOMES

Having explored the design and implementation dimensions in the above sections, the study now examines the student outcomes for DLMHS. There is overall agreement that ISHs 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). To capture student outcome information for DLMHS, OSPRI compiled publically available near-term outcome data such as student scores on
state assessments, student demographic data, and average SAT and ACT scores from the California Department of Education database. The study also gathered information on longer-term outcomes such as high school cohort graduation rates and postsecondary-related outcomes from DLMHS.

It is worth emphasizing, however, that this OSPri study does not present student outcome data as causal evidence that DLMHS’s design and implementation have led directly to any particular positive student outcomes. These data do not allow such inferences because the comparisons rely 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 success.

5.1. Inclusive Demographics: Who are the students that DLMHS is serving?

Table 9 presents demographic data for grades 9 to 12 from the 2012-2013 school year for DLMHS, the nearby comprehensive Deer Valley High School, the surrounding district, and the state. Deer Valley was selected as a comparison school because it is one of the high schools located closest geographically to DLMHS. Additionally, Deer Valley offered several pathways as part of the pathway initiative at Antioch Unified District, as is DLMHS.

DLMHS’s student body reflected a relatively high level of ethnic/racial and economic diversity, with substantial proportions of socioeconomically disadvantaged, Hispanic/Latino, African American, Asian, or Filipino students. Generally, these proportions at DLMHS matched the demographics of Antioch Unified District, although it is interesting to note the high percentage of female students at DLMHS.

<table>
<thead>
<tr>
<th>Demographic Category</th>
<th>DLMHS</th>
<th>Deer Valley</th>
<th>Antioch Unified District</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students Served (Grades 9-12)</td>
<td>639</td>
<td>2,711</td>
<td>6,132</td>
<td>1,964,759</td>
</tr>
<tr>
<td>Females</td>
<td>64.3%</td>
<td>50.5%</td>
<td>49.4%</td>
<td>48.7%</td>
</tr>
<tr>
<td>Males</td>
<td>35.7%</td>
<td>49.5%</td>
<td>50.6%</td>
<td>51.3%</td>
</tr>
<tr>
<td>Hispanic/Latino</td>
<td>37.9%</td>
<td>25.3%</td>
<td>34.3%</td>
<td>50.7%</td>
</tr>
<tr>
<td>American Indian or Alaska</td>
<td>0.5%</td>
<td>0.4%</td>
<td>0.9%</td>
<td>0.7%</td>
</tr>
<tr>
<td>Native</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>9.7%</td>
<td>6.3%</td>
<td>4.9%</td>
<td>8.7%</td>
</tr>
<tr>
<td>Pacific Islander</td>
<td>0.5%</td>
<td>1.1%</td>
<td>1.1%</td>
<td>0.6%</td>
</tr>
<tr>
<td>Filipino</td>
<td>8.8%</td>
<td>7.3%</td>
<td>5.4%</td>
<td>2.8%</td>
</tr>
<tr>
<td>African American</td>
<td>16.4%</td>
<td>32.2%</td>
<td>25.9%</td>
<td>6.8%</td>
</tr>
<tr>
<td>White</td>
<td>22.4%</td>
<td>20.8%</td>
<td>22.8%</td>
<td>26.9%</td>
</tr>
<tr>
<td>Two or More Races</td>
<td>3.8%</td>
<td>6.5%</td>
<td>4.7%</td>
<td>2.0%</td>
</tr>
</tbody>
</table>
5.2. Assessment Scores: How are DLMHS Students Progressing and Achieving Academically?

The overarching California Standardized Testing and Reporting (STAR) Program was originally authorized by the California governor in October 1997. As described on the California Department of Education website, throughout the history of the STAR Program, the State Board of Education developed and selected a number of different tests to serve as the program’s mandated norm-referenced assessments.

For the 2012-2013 school year, STAR included four components: the California Standards Tests (CSTs); the California Modified Assessment, for eligible students with Individualized Education Programs (IEP); the California Alternate Performance Assessment, for students with significant cognitive disabilities; and, the Standards-based Tests in Spanish, for eligible Spanish-speaking English learners. The CSTs were a major component of California's accountability system for schools and school districts, used for calculating each school’s Academic Performance Index. California’s Department of Education (2010) described:

The CSTs for English–language arts (ELA), mathematics, science, and history–social science are administered only to students in California public schools. Except for a writing component that is administered as part of the grades four and seven ELA tests, all questions are multiple-choice. These tests were developed specifically to assess students' knowledge of the California content standards. The State Board of Education adopted these standards, which specify what all children in California are expected to know and be able to do in each grade or course.

The CSTs were administered to students who were enrolled in the grades and courses detailed in Table 10 at the time of testing or who had completed the courses during the 2012-13 school year. The majority of the tests listed below were administered as End-of-Course (EOC) assessments, meaning that they were not tied to a specific grade level that was consistent across all schools, but rather they were administered to students when they completed the relevant course during that school year, regardless of which grade those students were in at the time. DLMHS students did not take courses that corresponded with every EOC subject listed in the table; those assessments that were administered to DLMHS students are presented in boldface, with results that will be examined in subsequent tables and figures. DLMHS students did not take the Physics EOC assessment because they took Physics in their 12th grade year.

<table>
<thead>
<tr>
<th>English Language Learner</th>
<th>3.6%</th>
<th>5.2%</th>
<th>16.8%</th>
<th>21.6%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Socioeconomically Disadvantaged</td>
<td>49.0%</td>
<td>48.0%</td>
<td>54.9%</td>
<td>55.9%</td>
</tr>
</tbody>
</table>

Note. Data retrieved from California Department of Education website (http://dq.cde.ca.gov/dataquest/) on November 18, 2013.

Table 10
2012-2013 CSTs Administered to California High School Students

<table>
<thead>
<tr>
<th>English-Language Arts</th>
<th>Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>All students in grades 2 through 11</td>
<td>Students in grades 8 through 11, for the below subjects:</td>
</tr>
</tbody>
</table>
Students in grades 5, 8, and 10, with the grade 10 Life Science assessment covering middle school Life Science and high school Biology content standards. Additionally, students in grades 9 through 11 who completed a standards-based science course took one of the following CSTs:

- Biology
- Chemistry
- Earth Science
- Physics
- Integrated/Coordinated Science 1, 2, 3, 4
- Students in grade 10 who completed a standards-based science course took one of the tests listed above in addition to taking the CST for Life Science.

Students in grades 8 and 11, with the grade 11 assessment covering U.S. History. Additionally, students in grades 9 through 11 who completed a standards-based world history course took the following test:

- World History

Note. The bolded assessment subjects are those that were administered to DLMHS students during the 2012-2013 school year.

California uses five performance levels to report student achievement on the CSTs, according to their Department of Education website: Advanced, Proficient, Basic, Below Basic, and Far Below Basic. “Advanced” and “Proficient” are defined as:

**Advanced:** This level represents a superior performance. Students demonstrate a comprehensive and complex understanding of the knowledge and skills measured by this assessment, at this grade, in this content area.

**Proficient:** This level represents a solid performance. Students demonstrate a competent and adequate understanding of the knowledge and skills measured by this assessment, at this grade, in this content area.

DLMHS has access to a state-run longitudinal student database that allowed them to track each of the school’s cohort outcomes on the CST in ELA as those students progressed through the elementary and secondary grades. Through these data, DLMHS could see how their incoming 9th graders performed on the 8th grade and earlier administrations of the ELA CST, compared to the scores for Antioch Unified School District overall. Table 11 displays the outcomes for the class of 2014 cohort for DLMHS on the ELA CST in grades 8 through 11, compared to those of the
district. DLMHS students came to the school as 9th graders having outperformed the district, on average, on the 8th grade ELA CST. This provides some indication that the incoming students at DLMHS may have been slightly higher achieving relative to the overall student population of the district. However, it is noteworthy that the difference between the DLMHS outcomes and the district outcomes on the ELA assessment as that cohort progressed through the high school grades: DLMHS’s cohort increasingly outperformed the district as a whole. Similar data on student outcomes on the Mathematics CST were not available through the state database, unfortunately.

### Table 11

**ELA 8th through 11th Grade CST (California Standards Tests) Results for DLMHS and District, for the Class of 2014 (Percent at Proficient or Advanced)**

<table>
<thead>
<tr>
<th>Grade</th>
<th>DLMHS</th>
<th>District</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>8th</td>
<td>64.1%</td>
<td>50.8%</td>
<td>13.3%</td>
</tr>
<tr>
<td>9th</td>
<td>75.8%</td>
<td>57.8%</td>
<td>18.0%</td>
</tr>
<tr>
<td>10th</td>
<td>73.8%</td>
<td>50.0%</td>
<td>23.8%</td>
</tr>
<tr>
<td>11th</td>
<td>70.6%</td>
<td>42.9%</td>
<td>27.7%</td>
</tr>
</tbody>
</table>

*Note. Data provided by DLMHS on January 8, 2014.*

Regarding DLMHS’s outcomes on the CSTs, Figures 4, 5, 6 and 7 present the percentages of DLMHS students who have achieved at or above the “proficient” level on the CSTs, broken out into the science, mathematics, and humanities. Additionally, these figures compare DLMHS’s results to the outcomes from the nearby Deer Valley High School and the surrounding district and state. For the Life Science and Biology assessments, DLMHS compared favorably to Deer Valley, the district, and the state; this is consistent with DLMHS’s medical focus. Notably, however, DLMHS struggled with the Chemistry assessment, with only 14% of their students attaining at least a “proficient” rating, a statistic that lagged behind the outcomes for the state overall. This result may be partially affected by the reported high turnover in the Chemistry teaching position at DLMHS; during the site visit, the position was filled by a long term substitute teacher. DLMHS similarly appeared to struggle with the set of mathematics assessments, with generally equal or fewer percentages of its students achieving at the “proficient” level on those tests.

### Figure 4

**Spring 2013 Science CST (California Standards Tests) Results for DLMHS, Comprehensive High School, District, and State (Percent at Proficient or Advanced, for all grades tested)**
Note. Cumulative percentages reflect test score results only for students in grades 9-12. Data retrieved from the California Department of Education website (http://dq.cde.ca.gov/dataquest/) on November 18, 2013.

Figure 5
Spring 2013 Mathematics CST (California Standards Tests) Results for DLMHS, Comprehensive High School, District, and State (Percent at Proficient or Advanced, for all grades tested)

Note. Cumulative percentages reflect test score results only for students in grades 9-12. Data retrieved from the California Department of Education website (http://dq.cde.ca.gov/dataquest/) on November 18, 2013.

Figure 6
Spring 2013 Humanities CST (California Standards Tests) Results for DLMHS, Comprehensive High School, District, and State (Percent at Proficient or Advanced, for all grades tested)
Note. Cumulative percentages reflect test score results only for students in grades 9-12. Data retrieved from the California Department of Education website (http://dq.cde.ca.gov/dataquest/) on November 18, 2013.

**Figure 7**
Class of 2014 English Language Arts CST (California Standards Tests) Results for DLMHS and District (Percent at Proficient or Advanced, for all grades tested)

Some may argue that “academic excellence” reflects more than achieving at “proficient” levels, instead defining such excellence as performing at an “advanced” level, as described by the California Department of Education. Figures 8, 9, and 10 address this distinction, presenting the percentages of students achieving at the “Advanced” level on the CSTs across the disciplines. Again, DLMHS compared favorably to the comprehensive high school, district, and state on the Life Science and Biology assessments, but struggled with Chemistry. Similarly, DLMHS did not have a high proportion of their students achieve at the “advanced” level on the set of mathematics assessments.

**Figure 8**
Spring 2013 Science CST (California Standards Tests) Results for DLMHS, Comprehensive High School, District, and State (Percent Advanced only, for all grades tested)

Note. Cumulative percentages reflect test score results only for students in grades 9-12. Data retrieved from the California Department of Education website (http://dq.cde.ca.gov/dataquest/) on November 18, 2013.

Figure 9
Spring 2013 Mathematics CST (California Standards Tests) Results for DLMHS, Comprehensive High School, District, and State (Percent Advanced only, for all grades tested)

Note. Cumulative percentages reflect test score results only for students in grades 9-12. Data retrieved from the California Department of Education website (http://dq.cde.ca.gov/dataquest/) on November 18, 2013.

Figure 10
Spring 2013 Humanities CST (California Standards Tests) Results for DLMHS, Comprehensive High School, District, and State (Percent Advanced only, for all grades tested)
Figures 11, 12, 13, and 14 present CST outcomes for the science and mathematics assessments, disaggregated for four student groups that are traditionally underrepresented in STEM fields, as described in the Inclusive STEM-focused Mission critical component narrative. These groups include: economically disadvantaged students, African American students, Hispanic students, and female students. The four graphs below reveal similar patterns as described with the data for the whole student body at the school: DLMHS compared favorably in the Life Science and Biology assessments but appeared to struggle with the Chemistry and Mathematics assessments.

**Figure 11**
2012-2013 CST (California Standards Tests) Science and Mathematics Results for DLMHS, Comprehensive High School, District, and State (Percent Proficient or Advanced, for all grades tested, disaggregated for Economically Disadvantaged students)

Note. Data retrieved from California Department of Education website (http://dq.cde.ca.gov/dataquest/) on November 18, 2013.
Note. Data retrieved from California Department of Education website (http://dq.cde.ca.gov/dataquest/) on November 18, 2013. DLMHS did not have enough students in this group with outcomes for the Summative High School Mathematics assessment and thus data were not reported for that assessment.

Figure 13
2012-2013 CST (California Standards Tests) Science and Mathematics Results for DLMHS, Comprehensive High School, District, and State (Percent Proficient or Advanced, for all grades tested, disaggregated for Hispanic students)

Note. Data retrieved from California Department of Education website (http://dq.cde.ca.gov/dataquest/) on November 18, 2013.

Figure 14
2012-2013 CST (California Standards Tests) Science and Mathematics Results for DLMHS, Comprehensive High School, District, and State (Percent Proficient or Advanced, for all grades tested, disaggregated for Female students)

Note. Data retrieved from California Department of Education website (http://dq.cde.ca.gov/dataquest/) on November 18, 2013.

SAT and ACT Outcomes. Table 12 provides SAT and ACT outcomes for the most recent available data—the 2011-2012 school year. The average SAT scores for DLMHS students matched or fell slightly below those of the comprehensive school, district, and state, and slightly fewer percentages of DLMHS students scored above 1,500 overall than for the comparables. DLMHS did compare more favorably on the ACT results, with similar or slightly higher percentages of their students scoring higher than a 21 total on the ACT assessment.

Table 12
2011-2012 SAT and ACT Outcomes, for DLMHS, Comprehensive High School, District, and State.

<table>
<thead>
<tr>
<th></th>
<th>DLMHS</th>
<th>Deer Valley</th>
<th>Antioch Unified District</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td># Students taking SAT</td>
<td>98</td>
<td>242</td>
<td>447</td>
<td>194,191</td>
</tr>
<tr>
<td>SAT Critical Reading Average</td>
<td>491</td>
<td>494</td>
<td>486</td>
<td>491</td>
</tr>
<tr>
<td>SAT Math Average</td>
<td>485</td>
<td>497</td>
<td>485</td>
<td>510</td>
</tr>
<tr>
<td>SAT Writing Average</td>
<td>484</td>
<td>479</td>
<td>474</td>
<td>491</td>
</tr>
<tr>
<td>% Scoring Higher than 1,500 Total</td>
<td>38.8%</td>
<td>44.6%</td>
<td>40.7%</td>
<td>46.7%</td>
</tr>
<tr>
<td># Students taking ACT</td>
<td>51</td>
<td>67</td>
<td>170</td>
<td>87,016</td>
</tr>
<tr>
<td>ACT Average Score</td>
<td>21.8</td>
<td>21.8</td>
<td>21.4</td>
<td>21.8</td>
</tr>
<tr>
<td>% Scoring Higher than 21 Total</td>
<td>56.9%</td>
<td>55.2%</td>
<td>51.8%</td>
<td>57.7%</td>
</tr>
</tbody>
</table>
Note. SAT scores are on scale of 200-800, with a combined SAT score on a scale of 600-2400. ACT scores are on scale of 1-36. Data retrieved from the California Department of Education website (http://dq.cde.ca.gov/dataquest/) on November 18, 2013.

Longer-Term Outcomes: Cohort Graduation Rates and Postsecondary Outcomes.

Table 13 compares DLMHS’s 4-year high school graduation rate with those rates of the comprehensive high school, district, and state. Both for their overall graduation rates and for the rates of each particular student group, DLMHS had very high graduation rates that exceeded those of the comparable entities.

<table>
<thead>
<tr>
<th>Table 13</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-Year Adjusted Cohort High School Graduation Rate for Class of 2011-2012, for DLMHS, Comprehensive High School, District, and State</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Destination</th>
<th>DLMHS</th>
<th>Deer Valley</th>
<th>Antioch Unified District</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Cohort Graduation Rate</td>
<td>97.0%</td>
<td>91.3%</td>
<td>75.0%</td>
<td>78.5%</td>
</tr>
<tr>
<td>Females</td>
<td>97.4%</td>
<td>94.1%</td>
<td>78.1%</td>
<td>82.7%</td>
</tr>
<tr>
<td>Males</td>
<td>96.4%</td>
<td>88.5%</td>
<td>71.9%</td>
<td>74.5%</td>
</tr>
<tr>
<td>Hispanic or Latino of Any Race</td>
<td>97.9%</td>
<td>90.9%</td>
<td>75.2%</td>
<td>73.2%</td>
</tr>
<tr>
<td>Asian</td>
<td>100%</td>
<td>94.6%</td>
<td>85.3%</td>
<td>91.0%</td>
</tr>
<tr>
<td>Pacific Islander</td>
<td>100%</td>
<td>75.0%</td>
<td>60.9%</td>
<td>76.8%</td>
</tr>
<tr>
<td>Filipino</td>
<td>100%</td>
<td>91.1%</td>
<td>90.7%</td>
<td>90.6%</td>
</tr>
<tr>
<td>African American</td>
<td>95.0%</td>
<td>88.6%</td>
<td>66.6%</td>
<td>65.7%</td>
</tr>
<tr>
<td>White</td>
<td>94.9%</td>
<td>95.1%</td>
<td>79.2%</td>
<td>86.4%</td>
</tr>
<tr>
<td>Two or More Races</td>
<td>100%</td>
<td>93.3%</td>
<td>72.3%</td>
<td>84.3%</td>
</tr>
<tr>
<td>English Learners *</td>
<td>100%</td>
<td>80.0%</td>
<td>59.9%</td>
<td>61.6%</td>
</tr>
<tr>
<td>Special Education Students *</td>
<td>100%</td>
<td>84.8%</td>
<td>62.7%</td>
<td>60.8%</td>
</tr>
<tr>
<td>Socioeconomically Disadvantaged</td>
<td>96.8%</td>
<td>90.1%</td>
<td>70.2%</td>
<td>72.7%</td>
</tr>
</tbody>
</table>

Note. Data retrieved from the California Department of Education website (http://dq.cde.ca.gov/dataquest/) on November 18, 2013.
* DLMHS enrolled fewer than 10 students who classified as “English Learners” or “Special Education” students in their 2011-2012 cohort.

Table 14 presents graduation rates and postsecondary plans for the seniors from DLMHS’s class of 2013. These were data provided by the school in advance of official reporting on the California Department of Education website. Of the 130 students classified as 12th graders for the 2012-2013 school year on the state website, 128 graduated according to DLMHS, with nearly half of the graduates enrolling in four-year colleges. The other half of the graduates were intending to enroll in two-year colleges, with a handful going on to the military or a career/technical program (Antioch Unified School District, 2013c).

<table>
<thead>
<tr>
<th>Table 14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postsecondary Plans for Class of 2013 for DLMHS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Destination</th>
<th>Number of Students</th>
<th>Percentage of Students of</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total Number of 12th Graders 130 100%
Total Graduates 128 98.5%
Total 4-Year Colleges 61 46.9%
University of California System 18 13.8%
California State University System 29 22.3%
Private/Out of State 4-Year Colleges 14 10.8%
Total 2-Year Colleges 63 48.4%
Other (Career/Tech Programs or Military) 4 3.1%

*Note.* Data obtained from DLMHS on September 11, 2013, and retrieved from the California Department of Education website (http://dq.cde.ca.gov/dataquest/) on November 18, 2013.

5.2.1. Summary.

With a diverse student body that included substantial numbers of students from traditionally underrepresented student groups in STEM, including socioeconomically disadvantaged, Hispanic/Latino, limited English proficient, and female students, DLMHS generally compared favorably to a comparison school, the district, and the state on the state-administered assessments. However, while the school overall outperformed the comparison entities in the Life Science and Biology assessments, DLMHS appeared to struggle on the Chemistry and the set of mathematics state assessments, lagging behind the district and state in those subjects. DLMHS also scored slightly lower on the SAT than the comparable school, district, and state, but they did outperform those comparables on the ACT assessment. One area where DLMHS clearly outperformed the district and state, however, was in the longer term outcomes related to high school graduation rates.

6. CONCLUSION AND IMPLICATIONS

This case study of Dozier-Libbey Medical High School is the seventh of a set of cases on inclusive STEM-focused high schools. The data collected and analyzed support the presence of each of the 10 critical components initially proposed by the researchers and supported by education literature (see Table 1). Of the 10 components examined in this study, findings suggest that the STEM-focused Curriculum, Well-Prepared Teaching Staff, and Inclusive STEM Mission played dominant roles in characterizing the school. The school’s Reform Instructional Strategies and Project-based Learning and Integrated, Innovative Technology Use, along with its Real-World STEM Partnerships and Administrative Structure were also highly relevant at the school. Less often in evidence in our data was the critical components of Blended Formal/Informal Learning Beyond the Typical School Day, Week or Year, Early College Level Coursework, and Supports for Underrepresented Students.

The theme that emerged from the data that was not covered within the 10 critical components focused on the development of Career Readiness and Identity of students through the high expectations, structure and support of the linked-learning medical pathway.

While the DLMHS program and performance was the result of many factors, the school purposively emphasized these areas to guide its actions. When examining the school across our 10 critical components and emergent theme, DLMHS’s most prominent features were the emphasis the school placed on its: STEM-focused curriculum and career development supports.
As a career pathway program, Dozier-Libbey offered students an academic program focused on medicine and health, with a significant focus on student career development. At DLMHS, we found a broad array of evidence that showed the DLMHS community sought to influence its students by changing their personal relationship with health and healthcare professions through the curriculum. DLMHS worked to prepare its students for health careers and to identify healthcare as a career option. This focus also extended to using healthcare careers to help the Antioch community by inspiring students to develop a relationship with potential careers such that they would potentially consider entering the healthcare workforce in Antioch.

The Antioch Unified School District created a high school at DLMHS that offered their students the opportunity and support to master a strong STEM-focused medical themed curriculum that shaped each student’s relationship with their own personal career development. Through the linked learning pathways, DLMHS looked to nurture and develop the medical interest and talent of their students to prepare a medical workforce. While DLMHS did not put a significant emphasis on the completion of college-level classes during high school, it tried to ensure that all students were well prepared for college by instituting a system of mastery learning. Teachers at DLMHS came from a variety of backgrounds and were supported in their collaborative style of teaching. Classroom environments were fairly traditional in feel and facilitated the building of a content knowledge base, and students were supported in developing professional, and other non-cognitive skills through their collaborative projects. While DLMHS did not have a school design with an explicit emphasis on technology, technology was present in classrooms and teachers were hired that were open to the use of technology in the classroom. Programs like School Loop helped to facilitate communication between students, teachers, and parents. DLMHS also stressed the technological skills needed to succeed in college and modern work environments.

Informal learning opportunities did not seem to be particularly stressed at DLMHS. Even with a close proximity to other neighboring health organizations, the school has found it difficult to develop partnerships to facilitate unique informal learning opportunities for all students. While some such experiences did occur such as job shadows or internships, not all students availed themselves to them. Only a select few manage to obtain these unique learning experiences. Rather, the school chose to bring many of its business partners to campus for career days, email exchanges, and guest lectures for their students.

All of the work that DLMHS did to build its opportunity structures was with the intent of helping local Antioch students of all backgrounds succeed in college and beyond. The medical themed STEM curriculum was built to engage students of all backgrounds and develop strong career identities. This DLMHS program seemed successful in boosting high graduation rates and high rates of post-secondary plans in 2-4 year universities.

7. EPILOGUE

In the time following our research team’s visit to DLMHS, tensions between the high school and the school district reached a breaking point, according to media coverage. (Our research team was not in direct contact with the school after the visit except to get approval for the accuracy of this case study.) During the visit, our team collected data that alluded to the frustrations of some DLMHS staff about school district policies and resource constraints within the county. Some of
the issues were related to the intended rigor and vision of DLMHS. Teachers at DLMHS reported that the district’s vision for DLMHS no longer matched the vision of the teachers and students that attended the school. Tom Barnidge (2014a), a Contra Costa Times columnist reported this situation in an article on a petition from DLMHS teachers to the school district:

The petition, presented to the Antioch Unified School District cited grievances over part-time library hours, no vice principal, inadequate clerical staff and a need for more teachers, but those weren't the real reasons for revolt. The real disputes were over grading policy -- teachers advocate a "No D" policy, meaning if a student fails to score at least a "C," he or she fails -- and enrollment guidelines.

Antioch Unified Superintendent Donald Gill had criticized the “No D” policy, claiming it was a thinly veiled attempt to drive out low performing students within DLMHS to other schools within the county. Tom Barnidge (2014a) quoted Gill as saying:

Parents had it in their minds that their kids would start out as freshmen and have all the hopes and aspirations of graduating from this wonderful school, and find out because of this No D policy they didn't have enough credits and had to leave.

The DLMHS teachers organized to create an independent charter school. But on March 19, 2014, the conversion charter petition submitted by the teachers of DLMHS was rejected 5-0 by the Antioch school board, which instead approved a dependent charter petition (Barnidge, 2014b). The teacher-constructed conversion charter petition, had it been approved, would have converted DLMHS from a public high school to a public charter school, giving DLMHS autonomy from the district. The district’s dependent charter status, while giving the DLMHS its own funding stream, would nevertheless keep the school under district control for enrollment and grading policies (Barnidge, 2014c).

Following that decision, teachers at DLMHS submitted their petition to convert into a public charter school to the Contra Costa County Board of Education, a level above the school district. In response, Antioch Unified District officials filed their own charter petition in an attempt to thwart the teacher-led petition for independent charter status (Barnidge, 2014d). Shortly after, a Contra Costa County Superior Court judge halted the district-run charter school effort until a final determination was made about the teachers’ plans to convert DLMHS into an independent charter school free of district control (Burgarino, 2014a).

While dueling charter petitions submitted separately by the District and DLMHS teachers were being reviewed, Antioch Unified School District officials appointed Scott Bergerhouse as the dependent charter principal of DLMHS on April 9, 2014 (Burgarino, 2014b). Paul Burgarino (2014b) of Contra Costa Times reported that:

[District Officials had said that the current principal of DLMHS] Nancie Castro was not considered for the new principal position because she had indicated several weeks prior that she had decided to stand with her school and faculty on the issues raised, and intended to apply for the position of charter director.
Nancie Castro refuted the district’s claim that she wasn’t considered for the position of dependent Charter Principal. She said that she had expressed interest in the position of Charter Director before the District’s dependent charter was even proposed (Burgarino, 2014b). Furthermore, Nancie Castro reported that expressing interest in applying for the job of Charter Director should not have eliminated her from the opportunity to also apply for the position of dependent Charter Principal (Burgarino, 2014b).

Subsequently, Nancie Castro was informed by District officials in late June, 2014 that she would be reassigned to a teaching position at Deer Valley High School for the upcoming school year (Crowder, 2014). In August of 2014, Nancie Castro accepted a position as Director of Human Resources and Curriculum with Jefferson School District in Tracy, CA, ending her fourteen-year tenure with the Antioch Unified School District (Crowder, 2014).

Teachers at DLMHS continued to push for an independent charter status. On May 21, 2014, the Contra Costa County Board of Education voted 3-1 to deny the petition by DLMHS teachers to convert to a public charter school (Burgarino, 2014c). The majority of the Board agreed that the petition was unsound and did not satisfy the elements of the State Education Code that was required for a charter (Burgarino, 2014c). Undeterred, DLMHS teachers continued their efforts to convert to a charter school by filing a petition with the California State Board of Education in July of 2014 (Burgarino, 2014d). As of this writing, the teachers’ petition will go to the advisory commission on charter schools in October 2014 and then to the State Board of Education in November 2014 to determine the fate of dueling efforts to control Dozier-Libbey Medical High School (Burgarino, 2014d).
References


