Gary and Jerri-Ann Jacobs High Tech High: A Case Study of an Inclusive STEM-Focused High School in San Diego, California

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1. **INTRODUCTION**

This case study describes the Gary and Jerri-Ann Jacobs High Tech High School (GJJ-HTH) in San Diego, CA. Driven by the singular vision of its founder, Larry Rosenstock, this public charter high school was the first school in a thriving network of schools spanning grades K-12 that resulted from expansion of the charter. The network of schools, a public charter school network known as High Tech High, attracted students from across the San Diego metropolitan area with its unique approach to learning focused on student production of knowledge and academic work products. An example is shown in Figure 1.

Figure 1. Excerpts from *Calculicious*, a Cross-Disciplinary Work Product Produced by Students of the Gary and Jerri-Ann Jacobs High Tech High School.

Under its charter with the state of California, GJJ-HTH’s educational mission included serving students from groups under-represented in science, technology, engineering and mathematics (STEM) college majors and careers. As a high school focused on preparing all of their students for college with a rigorous college preparatory curriculum, GJJ-HTH is an example of a successful inclusive STEM-focused high school (ISHS). This new type of high school is the subject of much interest because some, such as GJJ-HTH are showing impressive results with students from groups under-represented in STEM college majors and careers, including graduation and college acceptance rates approaching 100%. In 2008, Means, Confrey, House, and Bhanot published a report detailing characteristics of STEM-focused high schools across the
U. S. Funded by the Bill and Melinda Gates Foundation, this survey-based study found that ISHSs had grown rapidly in the early 2000’s and numbered in the hundreds, including schools-within-schools and magnet schools. Their study found that the mission of STEM schools opened after 2000 had shifted significantly from a prior focus on serving the gifted and talented to a new focus on serving students from groups under-represented in STEM college majors and careers. Of the 99 STEM schools responding to the survey, that opened between 2004 and 2007, 73% reported having such a mission, only 6% reported having a mission focused on educating the gifted and talented, and the remainder reported a dual mission.

ISHSs were featured in a National Research Council report on successful STEM schooling (2011), but there has been no systematic study of this new phenomenon. This case study of GJJ-HTH is one of a set of case studies conducted under a research project funded by the National Science Foundation: Opportunity Structures for Preparation and Inspiration (OSPrI). The goal of the OSPrI project is to use multiple instrumental case studies to systematically examine ISHSs in different contexts to develop a theory of action for scaling up such schools, in line with recommendations of the President’s Council of Advisors on Science and Technology (2010) to increase the number of ISHSs.

GJJ-HTH is a unique case study because it explores the context of an exemplary ISHS founded under a public school charter than replicated its unique learning approach as it expanded into a network of schools spanning grades K-12. As a result, approximately two-thirds of GJJ-HTH’s ninth graders came from HTH middle schools fulfilling the same charter obligation to purposefully include students from diverse backgrounds without regard to prior academic achievement. Although the focus of this case study is on GJJ-HTH, the high school, the context of being embedded within the HTH Network of schools (HTHN), that included its own Graduate School of Education, is intricately interwoven.

In the remaining sections of this Introduction, the research questions are presented and the selection of GJJ-HTH for inclusion in the OSPrI study is explained. There is a brief summary of the research design, including the specific data collection activities that occurred before and during a site visit to GJJ-HTH.

1.1 FRAMING THE STUDY

This case study asks:

- Is there evidence for each of the candidate critical components (listed in Table 1, to be explained later) found at GJJ-HTH?
- How are the critical components implemented at GJJ-HTH? Do other components emerge from the data collected on-site that are critical to the school’s character and success?
- What are the contextual affordances and constraints that influence GJJ-HTH’s design, implementation and student outcomes?
- How do GJJ-HTH 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 ten candidate critical components defined in Table 1.
Additionally, the study was designed to capture themes that emerged from the data. Note that the order of the candidate critical components in Table 1 is not intended to indicate relative importance. Each case study reports on the prominence of particular components based on the findings.

Table 1

Definitions of Candidate Critical Components

<table>
<thead>
<tr>
<th>1. <strong>STEM-Focused Curriculum.</strong> Strong courses in all 4 STEM areas, or, engineering and technology are explicitly, intentionally integrated into STEM subjects and non-STEM subjects.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. <strong>Reform Instructional Strategies and Project-Based Learning.</strong> STEM classes emphasize active, immersive, and authentic instructional practices/strategies informed by research. Opportunities for project-based learning and student production. Performance-based assessment practices that have an authentic fit with STEM disciplines.</td>
</tr>
<tr>
<td>3. <strong>Integrated, Innovative Technology Use.</strong> Technology connects students with information systems, models, databases, STEM research; teachers; mentors; social networking resources for STEM ideas, during and outside the school day.</td>
</tr>
<tr>
<td>4. <strong>Blended Formal/Informal Learning beyond the Typical School Day, Week, or Year.</strong> 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.</td>
</tr>
<tr>
<td>5. <strong>Real-World STEM Partnerships.</strong> Students connect to business/industry/world of work via mentorships, internships, or projects that occur within or outside the normal school day/year.</td>
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<tr>
<td>6. <strong>Early College-Level Coursework.</strong> School schedule is flexible, and designed to provide opportunities for students to take classes at institutions of higher education or online.</td>
</tr>
<tr>
<td>7. <strong>Well-Prepared STEM Teaching Staff.</strong> Teachers are qualified and have advanced STEM content knowledge and/or practical experience in STEM careers.</td>
</tr>
<tr>
<td>8. <strong>Inclusive STEM Mission.</strong> The school’s stated goals are to prepare students for STEM, with emphasis on recruiting students from underrepresented groups.</td>
</tr>
<tr>
<td>9. <strong>Administrative Structure.</strong> 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.</td>
</tr>
<tr>
<td>10. <strong>Supports for Underrepresented Students.</strong> 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.</td>
</tr>
</tbody>
</table>


For full treatment of the research design, including the conceptual framework and research literature underlying the ten critical components, the reader is referred to the publication cited in Table 1; for a detailed description of the data collection and data analysis methods, the reader is referred to the Research Framework for Case Studies document. Both are available on the OSPri website (ospri.research.gwu.edu). Following the section on selection of the Gary and Jerri-Ann

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1 Herein after referred to simply as critical components with the understanding that they are theorized to be critical.
Jacobs High Tech High for inclusion in our study, there is a brief section on data collection activities.

1.2 SELECTION OF GARY AND JERRI-ANN JACOBS HIGH TECH HIGH SCHOOL

The goal of the OSPrI study is to characterize a set of exemplar inclusive STEM-focused high schools and conduct a cross-case analysis to develop a theory of action for scaling up such schools. By exemplar, we mean that the school has a reputation for success, including some unusual successes with its student population in comparison to school district or state averages, given the demographically appropriate comparison groups. In addition, the school should be well established within the school district or state, based on thoughtful planning with community support. By inclusive, we mean that the school admits a range of academically average students, i.e., the school’s admissions criteria do not limit applicants to students who demonstrate that they are gifted and talented in STEM or are very high achievers. By STEM-focused, we mean that the school requires more, or more rigorous, mathematics and science courses to graduate than district and state requirements; or that its science, technology, engineering and mathematics classes are more integrated than traditional schools. We were primarily interested in STEM-focused high schools that required all their students to complete college preparatory courses including at least four years of mathematics with the fourth year being Pre-calculus or Calculus; and at least four years of science including core courses in Biology, Chemistry, and Physics. The school may or may not also require technology or engineering courses.

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

The Gary and Jerri-Ann Jacobs High Tech High School in San Diego, California was recommended by education experts in the field. After verifying through examination of the HTH website and publicly available data that the school met our selection criteria of exemplar outcomes, inclusive admissions, and STEM-focus, we approached the HTH director of external relations with a summary of our intended study. She coordinated approval of the research project at the network and school level. She also arranged for a site coordinator, a science teacher at GJJ-HTH, whose role it was to coordinate with OSPrI project personnel to arrange the schedule for the data collection visit. The research approval encompassed both the school and network level, allowing us to interview administrators at both levels.

1.3 DATA COLLECTION

Data collection began before the site visit to the school, by using publicly available data and documents found on the school and district websites, to begin to understand the school’s design and context, and to collect demographic and outcome data. Also, two online questionnaires were
completed prior to the visit: a school description questionnaire completed by the HTH director of external relations, and a survey completed by the school’s teachers. Phone interviews were conducted with the director of external relations to follow up on the school description questionnaire responses. To understand implementation, the OSPrI study team, comprised of six researchers whose expertise in STEM education and educational research spanned science, mathematics, technology, and engineering, visited the school for one week in December 2012. Data collection on site involved focus groups with teachers, students, and parents; classroom observations; and interviews with key staff and community members. In teams of two, researchers collected data using observation instruments and focus group and interview protocols. The data collection activities during the visit are shown in Table 2. Data was then analyzed in the context of the school to answer our research questions.

Table 2

**OSPri Data Collection Activities at Gary and Jerri-Ann Jacobs High Tech High School**

<table>
<thead>
<tr>
<th>Classroom Observations</th>
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</thead>
<tbody>
<tr>
<td><strong>STEM Classes</strong></td>
</tr>
<tr>
<td>Biology</td>
</tr>
<tr>
<td>Biotechnology</td>
</tr>
<tr>
<td>9th Grade Physics</td>
</tr>
<tr>
<td>11th Grade Engineering</td>
</tr>
<tr>
<td>12th Grade Multimedia and Science</td>
</tr>
<tr>
<td>9th Grade Mathematics</td>
</tr>
<tr>
<td>11th Grade Mathematics</td>
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<tr>
<td>12th Grade Mathematics</td>
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<tr>
<th>Focus Groups</th>
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</thead>
<tbody>
<tr>
<td><strong>Teachers</strong></td>
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<tr>
<td>Teachers of Engineering</td>
</tr>
<tr>
<td>Teachers of Science</td>
</tr>
<tr>
<td>Teachers of Mathematics</td>
</tr>
<tr>
<td>Teachers on Informal Learning</td>
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<tr>
<td>Teachers on Use of Technology</td>
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<tr>
<th>Interviews</th>
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</thead>
<tbody>
<tr>
<td>GJJ-HTH Director Peterson</td>
</tr>
<tr>
<td>GJJ-HTH College Counseling Director</td>
</tr>
<tr>
<td>GJJ-HTH Education Specialist</td>
</tr>
<tr>
<td>Alumnus</td>
</tr>
<tr>
<td>Science Museum Director (Business Partner)</td>
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<table>
<thead>
<tr>
<th>Other Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>School Day</strong></td>
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<tr>
<td>Advisory</td>
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<tr>
<td>Morning Meeting</td>
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<tr>
<td>School Tour</td>
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</tbody>
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<tr>
<th>Researcher Activities</th>
</tr>
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<tbody>
<tr>
<td>Team Debrief – Day 1</td>
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<tr>
<td>Team Debrief – Day 2</td>
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</tbody>
</table>


2. CONTEXT

This section situates the case in terms of its public charter network and locale, and then provides background information on the school history and initial design, its admissions policies and student demographics. Findings are then presented in two major sections, Exploring the Design and Implementation Dimensions, and Exploring the Outcomes Dimension.

2.1 THE CHARTER NETWORK AND LOCALE

GJJ-HTH is a public charter high school (grades 9-12) in a public charter school network located in San Diego, California. It was the first school established in the High Tech High Network and shared a common set of design principles with other schools in the Network.

At the time of this study, the HTH Network was operating eleven schools in San Diego County: two elementary schools, four middle schools, and five high schools. It functioned like an independent school district but the 4,500 students it served came from all over the metropolitan area. GJJ-HTH was located near an office park and small shopping center not far from downtown San Diego. Navy facilities, government contractors, and high tech industries were also located in this region of the San Diego metropolitan area.

2.2 SCHOOL HISTORY AND DESIGN

From 1996-1998, industry leaders in San Diego, assembled by the Economic Development Corporation and Business Roundtable, met to discuss the challenge of finding qualified individuals for the high-tech workforce. These firms were struggling to find qualified candidates for high-tech positions, and as a result, had large expenditures for training their new employees. For example, Irwin Jacobs, founder of Qualcomm, was struggling to hire 800 engineers a year, and had to spend thousands of dollars per person teaching new employees basic skills (Murphy, 2004). In particular, these industry leaders were concerned about the “digital divide” that resulted in low numbers of women and members of ethnic minority groups entering the fields of mathematics, science, and engineering (High Tech High, 2013).

Faced with a shortage of workers, in 1998 the group voted to start a charter school in San Diego to address these needs. The goal was to create a school where students would be passionate about learning and would acquire the basic skills of work and citizenship. To lead this effort, the group selected Larry Rosenstock, then president of Price Charities in San Diego, as the founding principal of the school (High Tech High, 2013). Rosenstock located a site, prepared the charter application, hired staff, and oversaw the development of the program, while Gary Jacobs, director of education programs at Qualcomm and other members of the business community took the lead in addressing issues of financing and facilities development (High Tech High, 2013). The design principles Rosenstock implemented at this new public charter high school named after Gary and Jeri-Ann Jacobs--personalization, adult world connection, common intellectual mission, and teacher as designer—were intended to accomplish the goal laid out by the industry working group.
The creation of GJJ-HTH was related to two global goals: addressing the economic and national need for an increased supply of well-educated scientists and engineers, qualified and ready to work in demanding jobs that require higher order science and mathematics skills; and addressing persistent inequities in the distribution of educational opportunities and the resulting lack of opportunity structures for students from groups under-represented in STEM fields. Rosenstock stated, “I learned that housing segregation causes school segregation. So, we look at every single zip code in the city [when recruiting students].” The School Director echoed this theme, describing GJJ-HTH as “an example of social class integration. You have a middle class student and an impoverished student working together on projects in a safe and supportive environment.”

Rosenstock’s vision for GJJ-HTH was based on the premise of “production not consumption.” Under this philosophy, students were taught to think critically and to learn through producing. “They [students] need to alter conditions in order to find out and understand them,” said Rosenstock. “If kids are making things, using various technologies, they’re also consuming those technologies.” This act of production was one of the foundations of the academic program and learning environment at GJJ-HTH.

An unstated but equally important goal of GJJ-HTH as it existed at the time of our visit was to act as an ambassador for the vision and design principles stated above; that is, to function as a showcase and participate in outreach and dissemination efforts. In this respect, GJJ-HTH was not a consumer of educational philosophy, but a producer of it, mirroring, at a meta-level, their educational focus on production.

2.3 STUDENT ADMISSIONS AND LOTTERY DESCRIPTION

The student body of GJJ-HTH reflected the demographic diversity of greater San Diego. It did not have restrictive admissions requirements such as prior academic achievement, but students and parents from outside the HTH network of schools needed to submit applications prior to a published deadline. Students who were enrolled in GJJ middle schools did not have to reapply between schools, and about two-thirds of GJJ-HTH’s ninth grade slots were filled by HTH middle schoolers. For the remaining slots, GJJ-HTH used a computerized lottery program based on ZIP-code weighting to form a student body that reflected the demographics of the San Diego region. It should be noted that HTH middle schools were also open-admission and their student bodies formed to reflect the demographic diversity of greater San Diego. In order to increase representation from low income students, HTH undertook extensive efforts to recruit students from low income neighborhoods and offered statistical advantages in lotteries to students receiving free or reduced price meals through the National School Lunch Program (High Tech High Charter School, 2009).

2.4 STUDENT DEMOGRAPHICS

The makeup of the student body at GJJ-HTH mirrored that of San Diego County, with some minor variations. GJJ-HTH drew approximately 85% of its students from within the boundaries of the San Diego Unified School District. Table 3 presents the grades 9 to 12 demographic data from the 2012-2013 school year for GJJ-HTH, the High Tech High network, San Diego Unified, San Diego County, and the state of California. GJJ-HTH had a lower proportion of students
classified as Hispanic/Latino, Limited English Proficient, and Socioeconomically Disadvantaged than the district, county, and state, three student groups that are under-represented in STEM majors and careers. A one-sample chi-square test was conducted to assess whether the proportions for these three student groups were statistically significantly lower in GJJ-HTH than in the surrounding district, county, and state. The results across all groups and comparisons indicated that GJJ-HTH’s proportions were in fact significantly lower than in all three comparables ($p < .05$). Aside from these three student groups, GJJ-HTH’s demographics were comparable to the surrounding district, county, and state, most notably with African American and Special Education groups.

Table 3

| 2012-2013 Demographics Comparing GJJ-HTH, HTHN, District, County, and State |
|-----------------------------------|--------|--------|-----------|-----------|---------|
|                                    | GJJ-HTH | HTHN   | San Diego | San Diego | California |
| Students Served (Grades 9-12)      | 578     | 2,566  | 39,133    | 159,900   | 1,964,759 |
| Females                           | 46.0%   | 48.4%  | 49.0%     | 48.5%     | 48.7%    |
| Males                             | 54.0%   | 51.6%  | 51.0%     | 51.5%     | 51.3%    |
| Hispanic/Latino*                  | 41.3%   | 46.2%  | 45.9%     | 46.7%     | 50.7%    |
| American Indian or Alaska Native  | 1.0%    | 0.9%   | 0.4%      | 0.6%      | 0.7%     |
| Asian                             | 7.4%    | 5.0%   | 8.8%      | 5.5%      | 8.7%     |
| Pacific Islander                  | 0.5%    | 0.8%   | 0.7%      | 0.7%      | 0.6%     |
| Filipino                          | 5.9%    | 5.9%   | 6.6%      | 4.5%      | 2.8%     |
| African American                  | 10.6%   | 8.0%   | 10.5%     | 5.9%      | 6.8%     |
| White                             | 33.0%   | 32.7%  | 23.1%     | 32.6%     | 26.9%    |
| Two or More Races                 | 0.2%    | 0.4%   | 3.0%      | 3.0%      | 2.0%     |
| Limited English Proficient*       | 11.8%   | 14.4%  | 27.5%     | 27.5%     | 26.4%    |
| Special Education Students        | 10.2%   | 11.7%  | 12.9%     | 11.0%     | 10.0%    |
| Socioeconomically Disadvantaged*  | 43.9%   | 44.8%  | 66.1%     | 50.4%     | 55.9%    |

Note. Data retrieved from California Department of Education website (http://dq.cde.ca.gov/) on August 13, 2013. HTHN compiles the enrollment data for all five HTH high schools: Gary and Jerri-Ann Jacobs, Chula Vista, North County, International, and Media Arts. *Differences reported are statistically significant where noted above.

2.5 PHYSICAL SPACE

The school’s physical space was designed to be open and transparent, a theme that was present in the school’s mission and that carried over into the curriculum and instruction as well as interpersonal relationships. The building was a repurposed hangar, and featured glass-walled classrooms and several large, open spaces, as shown in Figure 2.

Figure 2. Interior view of Gary and Jerri-Ann Jacobs High Tech High School.
The school received thousands of visitors each year, which was evident in the way our research team was welcomed; our host was organized, efficient, and open with us in a way that suggested lots of experience with teams of visitors. A 12th grade student, part of the Student Ambassadors group, guided us on a tour of the school in a professional manner, highlighting the science labs, open collaboration spaces, and ninth-grade “fishbowl,” a large open classroom. The tour guide walked freely into classes that were in session, addressing the teachers by their first names and interacting with the teacher and students. This was not disruptive to the class because the structure was so fluid that it could accommodate the newcomers without interrupting learning. The school receives visitors every day of the year, and according to the tour guide, they are quite used to being observed. The research team sensed that students and teachers felt that they were an integral part of what made GJJ-HTH successful and played active roles in explaining and demonstrating why the educational approach at the school worked so well.

3. EXPLORING THE DESIGN AND IMPLEMENTATION DIMENSIONS

As explained in the Introduction, this study explores design, implementation, and outcome dimensions of GJJ-HTH focusing on ten critical components defined in Table 1. Additionally, the study was designed to capture themes that emerged from the data. This section of the case explores these ten components first, followed by discussion of emergent themes. For each component, we first present the design dimension—what the school had built into its plans. This is followed by a discussion of the implementation dimension—what we observed on the visit. The section on the outcome dimension follows these findings.

3.1 STEM-FOCUSED CURRICULUM

3.1.1 Design

The graduation requirements for GJJ-HTH are shown in Table 4 compared to those of the state of California. As shown, GJJ-HTH requirements exceeded the State of California graduation requirements in all STEM subjects.

Table 4

Graduation Requirements for the State of California and the Gary and Jerri-Ann Jacobs High Tech High School

<table>
<thead>
<tr>
<th>Subject Area</th>
<th>State of California</th>
<th>GJJ-HTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science</td>
<td>2 years including biological and physical science</td>
<td>4 years</td>
</tr>
<tr>
<td>Technology</td>
<td>N/A</td>
<td>2 Years</td>
</tr>
<tr>
<td>Engineering</td>
<td>N/A</td>
<td>1 Year</td>
</tr>
<tr>
<td>Mathematics</td>
<td>2 years including Algebra 1</td>
<td>4 Years</td>
</tr>
</tbody>
</table>

All students were enrolled in the same sequence of core classes; the typical sequence is shown in Table 5. This was purposeful, aligned with the school’s common intellectual mission design principle that “all students pursue a rigorous curriculum that provides the foundation for entry and success at the University of California and elsewhere, as well as success in the world of
work. (HTH website).” Students seeking greater academic challenge could elect to take any academic course for honors credit. The honors designation was indicated on the students’ transcripts with the completion of additional coursework pre-defined in signed contracts between each student and the teacher. This feature was added so that students could differentiate themselves and demonstrate to colleges that they were challenging themselves within their coursework. Advanced Placement (AP) courses were not offered because HTH followed an educational model that was not compatible with AP requirements (see the section on Early College-Level Coursework for more detail). There were very few electives offered to GJJ-HTH students.

Table 5

<table>
<thead>
<tr>
<th>Grade</th>
<th>Science</th>
<th>Mathematics</th>
<th>Engineering</th>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>9th</td>
<td>Physics</td>
<td>Integrated Mathematics I</td>
<td></td>
<td>Multimedia Production</td>
</tr>
<tr>
<td>10th</td>
<td>Chemistry</td>
<td>Integrated Mathematics II</td>
<td>Principles of Engineering</td>
<td></td>
</tr>
<tr>
<td>11th</td>
<td>Biology</td>
<td>Integrated Mathematics III</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12th</td>
<td>Environmental Science</td>
<td>Integrated Mathematics IV (Calculus)</td>
<td></td>
<td>Multimedia Production</td>
</tr>
</tbody>
</table>

HTH was committed to an integrated model of instruction in which content was covered in depth rather than in breadth. Most courses fully integrated two subject areas with the exception of mathematics. Mathematics courses were taught independently and designed with smaller projects in order to have a more organic presentation of mathematics concepts. Students, teachers, and parents at HTH felt that when mathematics was integrated into other courses, the topics in the other course would take priority and mathematics was used only superficially. In prior years, the decision of which subjects were integrated with each other was made by an administrator, but the teachers asked that they have the opportunity to choose how the subjects were integrated except mathematics, which was not integrated with the other subjects. The current classroom structure reflected that change with pairs of teachers who worked together on integrated courses, linked as teaching partners (See the section on the Teaching Staff for a description of this collaboration). This was aligned with the HTH design principle that “High Tech High teachers are program and curriculum designers. They work in interdisciplinary teams to design the courses they teach (HTH website).” HTH did not use textbooks, and preferred that students obtain their information from reliable, online sources. Also, the curriculum and integration of topics could change slightly from year to year because the curriculum design began with the teachers’ passions and explored new course combinations and themes. However, the teachers maintained a mindfulness of the California standards as they planned their curricula, knowing that students were still responsible for passing the California state tests.

Thus, the projects and units of emphasis used to teach the content varied from year to year depending on teacher expertise, but all students left HTH with four credits in mathematics at the Algebra 1 level and above, four credits in science, one credit in engineering, and two credits in technology coursework focused on multimedia production. Mathematics courses were organized as an integrated mathematics sequence, beginning with Integrated Mathematics I that combined content from Algebra 1 and Geometry, then progressing through more rigorous content including
study of quadratic, exponential, logarithmic, and trigonometric functions, as well as probability and statistics. Integrated Mathematics IV covered Calculus content.

3.1.2 Implementation
This discussion of the implementation of GJJ-HTH’s STEM curriculum is organized to: first present findings on the implementation of its curricular design, including the use of integrated STEM coursework; and then explore the implementation of its rigorous STEM curriculum.

3.1.2.1 STEM Focus
HTH was known as a STEM-focused high school, and both students and parents in focus groups reported that they chose HTH because of this focus. The integrated curriculum supported the high level of science offered at HTH, and science content was also present in the humanities and in mathematics classes. The ideas of design and problem solving were pervasive through the curriculum at HTH. All students took the same sequence of courses, which presented an environment where all students participate in STEM courses. One alumnus stated:

_I really chose HTH because it was a STEM-focused high school. I wanted an environment where those were focused on. My college is considered the best school for women who want to go into science, and I want to pursue geology in graduate school because of what I learned here at HTH. I wanted to go to a college that had a good STEM program, and if I wasn’t at HTH, I wouldn’t have been pushed to look at those kinds of school. I would have been pushed to just stay with political science._

According to the Development Officer, the STEM-focus of HTH was:

_Extremely, extremely strong. One of the most compelling things for me is when you look at college students, what majors they are choosing, and STEM majors represent, oh about 17% nationally and our kids are choosing it at a rate of 34%, twice the national level. And if you count in other fringe STEM disciplines like economics or accounting, it is higher. So that is indicative of what we are doing here. And when you get to know that every 9th grader takes physics, it’s not a choice, everybody does it boy, girl you are taking physics. And with team teaching, everything is so melded._

Within this STEM-focused curriculum offered a HTH, a depth of knowledge was valued over the breadth of knowledge. The college advisor at HTH said, “It’s about the context of what our school offers, the depth of learning rather than breadth of knowledge.” This is one of the reasons an AP curriculum is not offered at HTH because it did not fit within the HTH philosophy of learning subjects in depth. The college advisor said:

_The tension is that AP would argue ‘an inch deep and a mile long’ where we go with ‘a mile deep and an inch wide.’ We go for depth not breadth. And when our parents hear that, our philosophy, they say, ‘oh that makes sense’. And then obviously our teachers are more engaged when they can do that depth and not breadth._

3.1.2.2 Integrated subject matter
HTH focused on covering topics in depth rather than offering shallow survey courses and used the vehicle of integration to accomplish this goal. For example, the engineering and biology
teachers decided to integrate their classes. They taught their sections independently, but worked together to plan classes that integrated biology and engineering. While some days these courses were taught separately, other days students would attend two class periods of an integrated version of this course on the same day. Another pairing was a humanities teacher with a biology teacher. These two teachers structured their courses around the human experience in the natural world. While visiting, our research team observed one unit where the teachers were integrating biological concepts into writing typically taught in a humanities course. When discussing their integrated science and humanities course, the biology teacher, describing an upcoming unit titled “Sound Mind, Sound Body,” explained how his students explored topics in depth: “Each student will become a specialist in a particular system.” he said. “The student will understand in depth the physiology of that system, and as a project, students will study a malady with respect to that system.” The project the teacher referred to was an in-depth study of the relationship between human anatomy, holistic health, and prevention and rehabilitation of body systems. In addition to this classwork, the entire class planned to take a weekly hike in San Diego that got progressively longer each week as students got into better shape. During these hikes, the humanities teacher would cover naturalist writing, and students would learn about authors such as Henry David Thoreau who encourage or write about a connection with nature. Afterwards, as a final project, students would create a 5-foot woodcut depicting a hiking student that served as an informational display. The woodcuts would be labeled with QR codes (a type of barcode) created by the students, which, when scanned, could provide information about various organ systems. There were many examples of artwork displayed across the entire campus. The striking theme across all of the artwork projects were their focus on integrated STEM topics such as poems written on science themes and artwork based on physics principles.

As mentioned previously, mathematics was the only exception in the integration model of content at GJJ-HTH. The Chief Academic Officer (CAO) felt strongly that the mathematics curriculum was diminished by forcing it to be integrated with other subjects. Though it was integrated at one time, the school made the decision to separate it based on past poor performance in mathematics. A GJJ-HTH mathematics teacher explained the rationale:

“We were having a lot of kids go to college, and their biggest piece of feedback was that they weren’t ready for their calculus class at college. And so, based on that feedback, we have switched up our curriculum and we’ve beefed up the math program and now the feedback we’re getting is that they’re doing well on college calculus.

Parent feedback during focus groups corroborated this: “I think it’s that way [mathematics not integrated] because they [the students] weren’t learning the math before. And a lot of parents were turned off by HTH because they weren’t learning the math, so I appreciate what they did.” Students in focus groups also agreed that it was a good idea to separate out the mathematics from the integration. One 11th grader commented: “What I think has been found is that math is really difficult to integrate into a project and cover all of the standard topics that you need to know for a test.”

Although mathematics was no longer integrated into the subject matter, it was still project-based (see CC2). Teachers found that shorter projects in mathematics led to more learning. Two 11th graders shared their experiences with projects in mathematics:

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The way I’ve seen some teachers tackle is that instead of having a two-week project, they squish it down to one. And so they can keep the pace up.... So for example, one thing we were covering was graphs and statistics, and we were making info graphics. And so our teacher said “Alright, I just taught you this this this and this, and next Wednesday the info graphic is due.” That’s it, and for those days, we’d have little lessons, but the rest of the time in class was dedicated to finishing the info graphic.

I know for our math class, since our teacher used to be a student here, he knows how the system works, and he knows the good parts and how to make it work for us and how we’re going to learn the best. And we’ve only dedicated 5% of the semester to a project. We’ve only done one project for one week, that’s it. We’ve been learning other math, like logarithms, trig, algebra 2, pre-calc. We’ve been dedicating it to that because he knows that we need to prepare for the SATs, because he went through the same thing.

As mentioned previously, GJJ-HTH did not use textbooks and preferred that students obtained their information from online sources. Since teachers did not have a central set of resources and the assignments required a vast array of information, the source of the curriculum used by the teachers was complex to articulate. Teachers drew ideas about how and what to teach from their professional background and expertise, which was extensive, and as a result, students were presented with unique projects requiring that they seek information outside of the traditional textbooks. This had the potential to create a challenge when students graduated from GJJ-HTH and went on to traditionally-taught courses in college, but alumni reported that the communication skills and work ethic they learned at GJJ-HTH were more than adequate to help them scaffold to this new format. One alumnus stated:

I think I still struggle with it [learning from textbooks], to be honest, but I think, also because of [GJJ-]HTH, I always felt comfortable talking to professors and teachers, and so if I don’t get something, I’ll ignore the textbook and go talk to the professor. Being able to communicate is the huge part.

The curriculum design began with the teachers’ passions and the topics changed over the course of time. One teacher stated when asked about the curriculum scope and sequence:

It depends on who you pitched your interest to and who you are paired up with, so it is the two teachers working together to develop what their interest and curriculum is and planning backwards from that and you create this thing at the end.

Another teacher explained the sources for the curriculum and the role of individual choice and teacher autonomy in selecting topics:

That’s kind of the point too--that you teach to your passion, you teach to your personality. There is no pressure to say, ‘Hey, this pacing guide, we’re all on December 12 on this; ’ it’s very different. And it’s not that there is one right way. There's one right way for me to do it based on my strengths and where I’m coming at from this, which is great because then students get different experiences throughout the years and in different classes. It’s very much ’no matter
what classes you go into, you’re going to see a different experience,’ and there’s no one saying ‘You should be doing what they’re doing.’

The teachers were guided initially by California State Standards, but then made decisions about specific coverage based on their own interests. One GJJ-HTH teacher summed up this process:

*We do use the standards, we look at them and look at them as a reference, but we’re not married to them, we’d rather hit the ones that are most important. We have to be aware of what they [the students] are facing in the next year so they are prepared [referring to curriculum planning].*

Teachers at GJJ-HTH did not assign textbooks in their classes, and instead the learning centered on intricate, relevant, real-world problem solving that required students to seek reliable online resources.

3.1.2.4 Rigor
The teachers at GJJ-HTH were concerned about ensuring that students were ready for college, that there were honors possibilities that matched AP level of rigor, and that projects were intentionally challenging. The teachers we observed and interviewed seemed very mindful of the high rigor in their classes, and they designed projects that were connected to the real world in significant ways. During classroom sessions observed during the site visit, students were rarely off-task and transitioned from classwork to group projects seamlessly. Teachers facilitated the students’ learning of core subject matter through carefully-constructed projects, and then taught material that might not be covered in the projects in a more traditional way. One 11th grade student discussed work that they did at the end of the year last year. He said:

*We began on a really big project which is in partnership with the Science Center in Balboa Park. And that was both in engineering and biology. So that was something that was a goal that we set for the end of the semester.... Some people took on honors work as science fair, others work with the SAT textbook... then we’re learning extra topics, going more in depth in biology, like we did photosynthesis, DNA replication, it connects to labs that we do, and that’s sort of filling in the gaps when we’re not working on projects.*

Every public high school in California must submit courses for credit approval. The honors biology course at GJJ-HTH received an equivalent weight to the AP biology course at neighboring high schools, suggesting equivalent rigor. The projects, which focused on real-world issues, were high in rigor, which was apparent from classroom observations and conversations with students about their projects. At the time of the visit, the engineering/biology course was making displays about biological phenomena for the Reuben H. Fleet Science Center in San Diego, an interactive science museum for children of all ages in Balboa Park. For this project, students were required to make a working prototype of an interactive display that taught museum patrons about a biological phenomenon, such as how mold replicates. Students then took their prototypes to the museum committee and pitched their work for display in the museum. The committee agreed to include a limited number of the projects in the museum. An 11th grade student described the project:
We do a lab and then we break out into projects. The projects are all unique but at the same time, they all tie into the one same idea that we’re all aiming for with our projects and trying to find out. And so this year, what we’re trying to find out is invasive species – see how they invade, where they’re coming in from, how to prevent it. So for example, we are trying to prevent biofilm from developing on bottoms of boats; it’s invasive to San Diego and will spread to other areas. So we’ll have a lab every now and then, to learn how to do DNA barcoding and all of that, and when we’re not doing that, we are trying to find out what kind of bacteria is growing in the kit, what prevents life from growing on it, collecting data from the San Diego Bay. I used to go to the regular public school, and it’s very different from being in the textbook, where they tell you what to do, what the procedure is, this is your conclusion - here what you conclude is what you conclude. The errors are your own because you made your own procedures, your own methods, your own hypothesis. It’s diverse.

The engineering instructors at GJJ-HTH reported that any of the students who take the engineering course could sit in a college freshman engineering class and understand the content. As one engineering teacher stated, “We develop good engineering brains here.”

GJJ-HTH teachers were well aware that doing projects had the potential to diminish the rigor of the content. One teacher described how they dealt with this challenge:

You can do PBL [project-based learning] poorly. In that case it would take away from the rigor. As a new teacher, I probably did some projects that weren’t so great. But we do a good job here of making sure the core concepts we want them [the students] to learn are at the forefront of the project, and the superficial parts of the project -- we don’t waste a lot of time cutting and gluing and doing things that take away from learning.

Mathematics teachers reported that their ultimate goal was to get their students ready for the real world. In a focus group, they stated that 10 years ago, the students going to college were giving the mathematics teachers feedback that they were not ready for their calculus class in college. Based on that feedback, the curriculum had changed and the alumni now reported that they were succeeding in college calculus. The mathematics teachers felt that the strength in the curriculum comes from teachers getting students to think deeper about concepts, to apply them and to have them see the connections to other disciplines. As a mathematics teacher stated:

We don’t just emphasize “here are the steps” but rather “what does this mean?” and get them to express in many ways their understanding of what the math concepts mean and how you connect them to other concepts in the real world.

3.1.3 Summary
GJJ-HTH offered a STEM-focused curriculum where students were required to take more, and more rigorous, STEM coursework than required by the state of California, and covered subjects in depth rather than in breadth. To achieve this aim, GJJ-HTH offered only a few electives and had an intentionally designed course sequence taken by all its students, aligned to its common intellectual purpose design principle. GJJ-HTH did not offer AP courses because the survey curriculum of AP did not fit in with the GJJ-HTH philosophy of depth in teaching; rather students had the option to take particular courses as honors courses with additional coursework.
Coursework at GJJ-HTH was implemented through an integrated model of instruction that integrated two content areas, with the exception of mathematics. This instruction was carried out by two partnering teachers who planned and designed their themed units together, then worked together in planning and implementing the curriculum they designed across an entire semester. Mathematics was intentionally not integrated into this model to better focus on the rigor needed for college preparation. GJJ-HTH’s commitment to rigorous coursework was carried out by engaging students in real world challenges that emphasized the learning and production of knowledge rather than the memorization and consumption of knowledge.

3.2 REFORM INSTRUCTIONAL STRATEGIES AND PROJECT-BASED LEARNING

3.2.1 Design

There were two HTH design principles related to instructional strategies:

*Through projects, students pursue their passions and continually reflect on their learning and growth. Students with special needs are supported through a full inclusion model.*

*Assessment is performance-based: all students develop projects, solve problems, and present findings to community panels. All students are required to complete an academic internship, a substantial senior project, and a personal digital portfolio. Teachers employ a variety of approaches to accommodate diverse learners, and recognize the value of having students from different backgrounds working together (HTH website).*

Projects were a primary focus of the instructional strategy in most classes at GJJ-HTH. Students pursued personal interests through projects, and they compiled and presented their best work in personal digital portfolios. The digital portfolios provided a comprehensive look at each student’s work and learning. Each digital portfolio included a personal statement, resume, and work samples. The work samples included information about the students’ learning goals, projects and internships. Students updated their digital portfolios each semester, documenting their learning over time.

Facilities were tailored to support both individual and small-group learning, including GJJ-HTH-provided networked wireless laptops, project rooms for hands-on activities, and exhibition spaces for individual work. Assessment was performance-based: all students developed projects, solved problems, and presented findings to community panels. Most classes had periodic assessments of student work in the form of check-ins or deliverables, but most classes worked towards a major school-wide presentation, called Exhibition, where students presented their major classroom projects to the community.

Project-based learning was a required instructional strategy at GJJ-HTH. Teachers described their instruction as being loosely based on California state standards, but taking significant advantage of each teacher’s personal strengths and interests. While there was no uniform or required curriculum at GJJ-HTH, the GJJ-HTHN Director of External Relations said that teachers were guided by works such as *Understanding by Design* (2005) and Patton’s (2012) book, *Work That Matters: The Teacher’s Guide to Project-Based Learning.* Coursework was
integrated across both STEM and non-STEM classes, and the pairings of courses were decided by the teachers.

### 3.2.2 Implementation

This section begins with findings on implementation of project-based learning at GJJ-HTH, followed by class vignettes that exemplify the key elements.

#### 3.2.2.1 Project-Based Learning

All teachers at GJJ-HTH adopted a project-based learning instructional style; this was the primary instructional strategy for all courses except mathematics. Mathematics teachers limited the number and length of projects, employing more traditional direct instruction and group practice. Teachers spoke about an awareness of the potential of projects to dilute or divert content learning. They dealt with this challenge by developing a strong background in the implementation of project-based learning and carefully selecting the topics of the projects to maximize content knowledge. Two teachers reported in post-observation interviews that, in order to avoid gaps in content knowledge, they found time to insert content that might not be addressed in the projects. This inserted content could be a mini-lecture, or a more traditional structured lab, perhaps combined with independent research.

The hierarchy of knowledge, teachers, and students appeared to become flattened through project-based learning at GJJ-HTH. An 11th grade student explained:

*One of the things about our class right now is that I feel like our teachers aren’t really teachers just standing in front of the class, but for science fair especially, they are more like mentors, rather than just standing there teaching us something. I don’t really think of it like resorting to teachers as last resort – she’s really helping us through the process, she is like a mentor, almost like a partner in the project, not someone to grade you.*

As expected, freshman projects required more teacher facilitation than did senior projects. Teachers provided a great deal of guidance in freshman year but gradually gave responsibility for all aspects of the project to the students. A mathematics teacher explained her strategies for giving students responsibility for learning:

*I use a lot of questions, rarely give kids answers. When they ask questions, I answer with a question so that they have to figure it out. My response to their question would be, ‘Well what do you know, how can we get there, what tools do we have?’ The critical thinking – that’s my main goal.*

Students, teachers, and administrators at GJJ-HTH strongly emphasized that *production* of a meaningful product was a key component of the school’s vision and philosophy, and this was reflected in the nature of the projects. Another component of effective project-based learning was the application of the projects in the community, and this occurred frequently at GJJ-HTH with the help of community partners. One parent explained:

*For example, my two kids were a team in a project, a very difficult project, to build from ground up, and it was exhibited in a museum, and they had to stand there and explain it. It was so*
technical, but the teamwork was great. They had to present it for two days, answering complex questions, and in the end it was chosen to stay at the San Diego museum in Balboa Park.

GJJ-HTH frequently invited scientists, engineers, and other STEM professionals to attend panels, give students feedback, or provide pre-project advice on design. Most of these relationships were cultivated by teachers and administrators who had relationships in the community. This real-world connection was also factored into the assessment of projects, where often the community members acted as judges (see CC5, Partnerships, for more detail regarding real-world STEM partners). One teacher described:

I’m having my students do a project right now, and one of the rubric points is that it has to be visually appealing, and we were kind of joking about how that’s subjective, but that’s okay because we try to emulate the real world – and in the real world, with your boss and a project, if the boss says they want it red, then it has to be.

The sense of accomplishment that students felt as a result of the project-based instruction was notable. An alumnus of GJJ-HTH stated:

That’s huge – that pride in work here. You don’t get that in college. Most of my work in college was essays that teacher would grade and then throw away, or tests that they’d grade and throw away. At GJJ-HTH, you got a sense that work had purpose; you could do things that would influence people.

Even students who struggled with the projects stated that they accomplished important work:

There was one thing I liked a lot in GJJ-HTH--the projects I wasn’t any good at like math were some of the best because they taught me to improvise a skill set I didn’t have and had to develop on the fly. That helped me a lot and I realized that wasn’t a skill everyone had when I was editor-in-chief of a newspaper: we got some new kid who had to do a layout and he freaked out when he couldn’t use a program and how to figure it out. I had to walk them through the steps of working it out.

Students not only felt a sense of accomplishment with the projects, but they also felt the projects prepared them for college and beyond. One student stated:

GJJ-HTH made it easy. I was used to having the freedom to choose courses because of the projects. A little shocked that everything was on my will to [decide whether to] go to classes, but GJJ-HTH helped because it gave us [more] freedom to work on projects and accomplish our assignments than the average student would [have had].

One drawback of mainly focusing on projects was that students were not prepared for the use of textbooks in a traditional college classroom:

We knew how to handle the freedom, but the shock for me came with textbooks – because I didn’t use textbooks at high school. Everything was researched on the computer, and so when they
were like ‘here’s a textbook and you need to make sure you’ve read this whole chapter,’ I was like ‘wait, why, can’t I go on the Internet to find the answers? Can’t I find a different method to do it than what the textbook is giving me?’ That’s where I struggled the most.

However, because of the student-centered instruction that the students experienced at GJJ-HTH, with the associated responsibility for learning, this student was able to adapt quickly to a new learning environment. Another alumnus of GJJ-HTH similarly commented on the class structure and how it affected him in college:

I felt like the transition went well – I also found it hard to work with textbooks, and in general college was hard. By my third and fourth years, I was starting to get good grades and feeling ‘with it,’ instead of always having to climb out of a hole with my studies. [GJJ]-HTH helped with freedom-- making my own schedule, going to class, paying attention, and using the professor resources such as office hours is super important. A lot of my smart friends in college never did go to office hours, and they missed out on connecting with the coolest minds out there, especially the UCSD [University of California at San Diego] teachers.

Projects that were described or observed during our visit to GJJ-HTH ranged from a podcast inspired by science fiction, to interactive museum exhibits that were constructed around biological phenomena’ a Mystery of Life Exhibition where students carried out a research project and presented their findings to experts in the field (similar to a science fair); a collaboration between humanities and physics where students constructed a physical manifestation of a social theory; documentary films, writing poetry or narratives and publishing them through self-publication websites such as Lulu or Blurb; multimedia presentations; and scientific research with community partners. An example of a work product was shown in Figure 1 and another is shown in Figure 2 that follows. Students and parents reported that the depths of the projects inspired them to pursue more knowledge. A parent characterized student inspiration when she stated:

Getting the core basics, getting to apply it for the next level, so that the children who want to be challenged more have the environment where they can. I don’t want them in a classroom where they are taught to the lowest denominator. More than just the basic requirements, more advanced, inspire them to take it to the next level, with the teacher supporting them. I really want him to be doing projects where he wants to do more. Instead of just coasting.

Figure 2. Images from the San Diego Bay Project, a Long-term Project at GJJ-HTH.
The project-based instruction drove a great deal of the variety of skills that students reported learning at GJJ-HTH. An 11th grade student stated:

Class is different every day – it’s never boring. A lot of the time, especially with science fair, we’ll do a lesson ...then after we’re done with our notes or lab, we go straight to working on science fair while other people are working on their projects. So, [right] now we are doing individual streaking of bacteria for science fair.

An 11th grade student explained her perception that working with groups on projects was intended to promote learning new skills or knowledge from peers:

All of the group work helps; we can be doing a group project and we can learn from someone else in a group. One of the main focuses of this school is learning from each other. We are all on the same level and help each other out.

Students reported that they learned a great deal from other students during their work on projects and that when they struggled they often went to a group member for further instruction. This structure built self-reliance. One student noted in a focus group, “There is a lot of self-teaching and using the resources that we have, like the Internet or ask[ing] another student.” Teachers also modeled help-seeking by virtue of working with their colleagues. Engineering and physics teachers in a focus group reported that the strength of their classes came in part from teachers working collaboratively and sharing skills and knowledge. One teacher said in an interview that students get to know the teachers’ different strengths and would go to these teachers for guidance on projects for other classes. This supported further flattening of the hierarchy of knowledge, students, and teachers.

Time management was a prominent skill that students learned through the project-based instruction at GJJ-HTH. For some students, especially during freshman or sophomore year, it was difficult to stay on task without the teacher prompting action. However, the teachers and students reported that students developed time management skills over time. They learned that the projects were complex and that they could not do quality work in a short period of time.
Students learned how to regulate their work so that they could accomplish the goals that the teachers set for them and by learning to set goals for themselves.

3.2.2.2 Classroom Vignettes
The following section includes a pair of classroom vignettes, presented to paint a more detailed picture of a student’s classroom experience. Vignettes from an integrated Engineering/Biology course and an integrated Physics/Humanities course are presented.

Integrated Engineering/Biology Class: Design and implementation of an interactive biology museum exhibit prototype

As soon as students enter the classroom, they all get in their groups and get to work on their projects. The classroom has a very large "garage door" that can open so that students can work on constructing their projects outside. There are several computers placed throughout the classroom (see Figure 3). It looks to be about one computer for every two students. The classroom is also used to store the students' projects.

Figure 3. Integrated Engineering/Biology Classroom

As students are constructing their exhibits for the showcase next week, the teacher is walking around and assisting students as they need help. Some of the students need extra materials, so the teacher will be making a trip to a wood supply store to buy more supplies later today.

Students are working on their exhibition project in conjunction with their biology class. Students first began this project in their biology class where they picked a topic they wanted to explore (e.g., genetic engineering). Once the students picked their topics, students were put into groups with other students with similar topics. In biology class they learned about the science of their topic while in their engineering class they created a physical representation of their topic. It seems that the students know what they need to complete for their showcase next week, and the teacher is assisting students as they have questions. The displays are mostly complete and resemble the caliber of what you might see at a public museum, high quality. One student created a display with black and white light to show bioluminescent bacteria. Two of the students walk
to their Biology teacher’s classroom to get a brighter black light to make their bacteria glow brighter. They initiate a discussion with their teacher about some specific materials they need for their project. They had already researched these materials ahead of time online, but were worried about the cost. Their teacher is willing to buy it for them, but she is afraid it won't arrive in time for the showcase next week. The students decide to order the equipment with the help of a teacher from another classroom and return to the engineering class to continue with the display construction of their luminescent bacteria. The class ends with a student discussion of what has been accomplished and what still needs to be done to complete the projects.

**Integrated Physics/Humanities Class:**  
*Constructing a social theory*

As the students walk into their 9th grade physics class, they notice that today the classroom divider is open meaning they will be working with their classmates in the adjoining humanities class. This is a large classroom with a giant gear in the middle of the classroom, foundational to the current project that the students are working towards completing. There was excitement in the air. The exhibition day is only two weeks away and the students are working diligently to finish their projects in time. This project has students creating a social theory about the rise and fall of civilizations, and then designing a literal representation of this theory as a gear-driven moving model using principles learned in their physics class.

**Figure 4. Giant Gear for Cross-Disciplinary Project to Produce a Gear-driven Model of a Student-generated Social theory about the Rise and Fall of Civilizations.**

Today, however, students are not focused on the construction of their projects and have instead brought with them their social theory essays written for their humanities class. As the students sit down in their project groups, they are joined by students from an 11th grade humanities class. They are here today to help the 9th graders peer-edit their essays. As the 11th graders read over the essays, it is readily apparent the students are comfortable and well versed in giving and receiving constructive feedback. This skill was taught at GJJ-HTH as a common step in the design process in project-based learning.
Along the sides of the room, student constructions from their project are lined up at different levels of completion. Each student has a different role in the project: machinist, physicist, artist, or journalist. While each person in the project is ultimately responsible for certain parts, all students in each group are responsible for understanding and being able to explain the underlying physics knowledge necessary to complete the project.

While working on the physics project, a student asks the teacher whether he can do a re-test. He arranges a time with the student and then the student returns to his group and continues working. The teacher has designed his own grading system based on the California physics standards where students must master specific standards throughout the year to pass his class. This grading system, created by the teacher in GoogleDocs is different from all the other teachers at the school. He has also set up an automated emailing system that sends daily emails at 8:00 am to all students with deficiencies, meaning the student either did not turn in a deliverable assignment or did not pass an assessment on a particular standard. This email alerted students to the particular standards they needed to re-learn and re-test. As class progresses and students finish editing their essays, the room begins to buzz as students move to continue work on their projects. The students stay on task and apparently know what they need to complete. The teacher spends his time going to groups and checking on their individual progress. Periodically students ask to borrow certain tools or for certain materials to facilitate the projects’ completion.

3.2.3 Summary
Projects that tapped into real-world applications appeared to create the foundation of the instructional strategy at GJJ-HTH. Reform teaching practices, including project-based learning, small group work, and performance-based assessment, were evident throughout the school and in all but mathematics classrooms. Mathematics classes observed used more direct instruction but were still student-centered and provided opportunities for work among students. Projects had a strong production focus and typically integrated at least two subject areas. Self-learning, self-reliance, and continuous learning were modeled by teachers and administrators, and were strongly evident in students.

3.3 INTEGRATED INNOVATIVE TECHNOLOGY USE

3.3.1 Design
In general, technology was considered by GJJ-HTH administration and teachers when planning facilities and curriculum. Facilities appeared to be tailored with individual and small-group learning in mind. Each classroom had at least a few computers and laptops for students to use. There was a multimedia classroom equipped with a class set of Apple desktops.

The school had numerous unusual and innovative technological resources. For example, students and teachers had access to a laser cutter, which was used in a number of courses and for a variety of projects. Many projects required the use of animation, modeling, or other (e.g., Photoshop) software.

Each student developed a public online digital portfolio used in every class, and while not part of any class or graduation requirement, their portfolios provided a comprehensive look at their work.
products and the learning processes that took place. Each digital portfolio included a personal statement, resume, and work samples. Students updated their digital learning portfolios each semester, documenting their learning over time.

3.3.2 Implementation
The findings on how technology was implemented in innovative ways begin with a description of the technology infrastructure followed by discussion of innovative uses and the impact on student learning.

3.3.2.1 Technology Infrastructure
The school appeared to have adequate funding and infrastructure to support innovative technology use. There were several network-level and school-level administrative staff, and the school was thoughtful about technology planning. Teachers brought requests to the school level and decisions were made through discussion. A teacher explained:

*Sometimes when I am designing a project I find software I need; I can request it from IT. We’ve done that with math, engineering, chemistry. It’s teacher-driven. Some of it is school-wide though. Five years ago, they were talking about getting rid of MS office, moving to open office. When that issue came up, it was school-wide; we did the cost-benefit analysis as a school.*

Funding, while adequate, was not so plentiful that the school was wasteful with technology funds. They were also resourceful. A teacher said:

*We are pretty good at finding free things; we can Google around to find stuff. But we also get a fair number of grants both individually and as a school. We get the money and we can get what we need, e.g., half a million dollars from Qualcomm to buy fabrication equipment. We also make do, make it cheap; we use the 2001 version of adobe CS.*

There were multiple teachers who could act as technology resources. One teacher explained:

*Scott is the go-to guy for the laser cutter -- he’s the engineering teacher for the school -- and there are really different teachers you go to for certain IT help. There are two Multimedia teachers you can go to, a senior one and a freshman one. Anything engineering or robotics related is good to go to the robotics teacher.*

3.3.2.2 Integration into curriculum
Technology was integrated into all courses, and students were required to take a Multimedia technology course their first year. Other STEM courses could include a small focus on the software needed for a particular project, for example spreadsheet or geometry software for a mathematics class. An administrator described technology as “ubiquitous” at the school. Most projects involved some technology component, whether in the collection of data, production of the work, or the presentation phase.

3.3.2.3 Flattening of hierarchies
Communication technology seemed to contribute to a sense of a flattened hierarchy among teachers, students, and knowledge that arose from the instructional strategies that focused on
student production of knowledge with teachers as mentors. Students were able to email, text, and
electronically chat with teachers at any time, including teachers they were not currently in class
with. Students were also able to communicate seamlessly with each other. One tenth grade
student said:

Yes, we use Google Docs, to share documents so we don't even need to be together in the same
room. School-wide, everyone has their own school email account, Gmail--GJJ-HTH is part of
Gmail. If something is saved on your Google drive you don't have to be on the school drive.
Teachers also email right away. We email them all the time. I feel like I can get a lot of work
done over a weekend or on a break because teachers will get right back to you. It's amazingly
easy. [We] rarely have to exchange numbers because all emails come up when you type the
name in. Even teachers you don't have as a teacher.

Technology access outside of school did not appear to be a challenge for GJJ-HTH students,
most of who lived in the urban area surrounding GJJ-HTH. The area provided numerous points
of access to Wi-Fi locations, libraries, and other resources for students who did not have home
Internet service. Many students also used phones in lieu of computers to access the Internet. One
student said:

Almost everyone has Internet at home. They do accommodate if you don't have Internet at home.
I have a library nearby my house. There is a resource room at school that is open until 5, and in
the mornings they are here. You can hand-write work and hand it in later typed up. Also teachers
are super accommodating for FRL students who don't have laptops. There have been at least 6
or 7 instances where they have given student laptops on-loan from school. I used one my whole
freshman year. I could take it home and get my work done. Could get Internet.

Students were also permitted to use phones during class time, depending on the class and the
purpose of the assignment.

Technology was used to connect students with real-world mentors and scientists, both for the
purposes of learning about their subject area and for two-way discussions about research topics
of interest. The biotechnology teacher, for example, used Skype to connect his class with an
internationally known researcher to discuss a project they were all working on together.

3.3.2.4 Technology self-learning
GJJ-HTH encouraged students and teachers to take initiative in improving their technology
skills. For example, students were expected learn from each other and from mentors about how
to use Adobe Illustrator, FinalCut, and other software to create projects. A 10th grade student
reported:

A lot of times you'll have a task, and it's something about this school, the teachers encourage us
to use technology that will enable a good product. We will have to learn how to use the
programs. They just have to set out to learn how to use a new program. All of the group work
helps, we can be doing a group project and we can learn from someone else in a group. One of
the main focuses of this school is learning from each other.
Another student explained:

*There is a lot of self-teaching and using the resources that we have, like the Internet, or ask another student... We can look around think of what you might want to use, can remember things you found other ways. It's a valuable resource. The Internet provides almost an infinite amount of information.*

A teacher supported this perspective as well, saying:

*Every assignment has a technology component, so they have to develop those skills. In 9th grade math we do Excel, Word, Sketchpad. I work in the resource room, special ed. Some of the 10th graders struggle with Adobe so I refer them to the media specialists or kids who are really knowledgeable. The kids start to stress so I find a kid who is really good so they can work together. We rarely teach them about technology, they learn from each other as they work together on projects.*

The teachers also followed the self-teaching model for themselves. When asked about how they sought technology help, one teacher responded:

*I am super comfortable with the basics, but Flash, forget it. We encourage the students to be proactive, just because the teacher can’t do it doesn’t mean the students can’t. I talked to [multimedia teacher] to help, his seniors make tutorials for my 9th graders as a project. I have 6 seniors in my classroom at all times to help. They were the experts so I didn’t have to be. We know who has what strength so we go to them. I always designate a couple experts since I can’t answer typically. We’re not scared to use tech even if we don’t know it, because we know the resources are around. I started Sketchpad with my students without even looking at it first, we all learned together. You don’t have to be an amazing expert.*

Students appeared quite savvy about appropriate Internet use. When asked, “How do you know that information on the Internet is trustworthy?” The students were immediate in their response. They offered decision rules such as, “Look at the credentials of the designer. If it comes from a .org, .gov, .edu it can be relied on better” and “Look, compare, and contrast with another website. You can judge it and see which one is better.”

It is worth noting, however, that the collaborative and open culture did not necessarily mean total freedom when it came to the Internet. Certain inappropriate or completely irrelevant web sites were blocked, for example. A teacher noted that there would always be students who misused the Internet. But the school made an effort to ensure that any site that might plausibly be used to gather information was available. Ad hoc requests for unblocking certain web sites were also honored quickly. For example, sometimes translator websites were blocked, but they could be unblocked if information was needed.

In all these ways, the technology was truly integrated into any given project that itself integrated multiple disciplines. For example, many students used a laser cutter in the building to create projects. This required using mathematics and physics to plan the cuts and computer programming to execute the cuts. The laser cutter, often mentioned by teachers as an example of
cutting-edge technology, was frequently borrowed by teachers from other departments who were inspired to use it for projects. Students were also often required to make podcasts to disseminate their research findings. They similarly learned how to use publication software in order to create a book that displayed their work.

3.3.2.5 Challenges
As in many schools, limited funding created a set of challenges when teacher aspirations went beyond what was possible financially. Teachers reported wanting more laptops, ideally a 1:1 ratio, and at the time of the visit, the school was not close to that. Current computers also lacked the memory to run more advanced applications, resulting in lost classroom time from crashes and workarounds. Other limitations related to broadband connectivity. The IT director explained, “We are maxed out with broadband basically all day. When everything is online and you have to wait 10 minutes for a video to load, it’s stupid.”

At the same time, teachers did not want technology purely for technology’s sake:

My dream would be that every class has a Smart Board. But a lot of teachers don’t use them. I like that teachers can push for what they really want instead of just putting it in every classroom, there’s no point in getting one for everyone. For some people a cheap document camera works much better than a Smart Board.

Lab spaces and equipment were also limited, in the teachers’ view. The lack of gas lines or other support for biology and chemistry labs required teachers to think creatively about workarounds. The resource shortage meant that teachers had to work together to share equipment and tools. A senior administrator provided another perspective to this challenge:

You can’t not give raises and then buy a bunch of computers. I have 6th graders going bonkers because they can’t load their computers for 6 minutes. The technology piece is slipping because of our finances.

Another challenge was that students who arrived from the GJJ-HTH middle school were a step ahead in terms of technology skills. According to one 9th grade teacher:

Some kids come from GJJ-HTH middle, so they know Google and Gmail; the other 9th graders, some of them know some things and some know nothing, based on where they come from. I just spent this morning talking to a student who came from another high school. He thought everything was really hard. The difference between the highest and lowest student is really hard. By the time they get to 10th grade they are all fine with Gmail, but there is variation in how they feel with other software, some can make web sites and some can’t.

3.3.3 Summary
One teacher summarized the use of technology well:

I could not imagine this school without technology; it would be a lot of paper Mache. It’s integrated, it’s a tool. We use what we need when we need it to do projects. You should talk to juniors who go on internships; they get a lot of tech during those 3 weeks. They have so many skills that they don’t even know they have. We use technology not just for technology’s sake; we
see the purpose. I see technology as just another learning tool. Our job is just to demystify it so they can use what they need to. They never take a technology class but they have to figure it out in English, math, etc.

In other words, there was no technology class at GJJ-HTH, because technology was ubiquitous and essential to every single thing they did, providing evidence of the full integration of technology into subjects at GJJ-HTH.

3.4 BLENDENED FORMAL / INFORMAL LEARNING BEYOND THE TYPICAL SCHOOL DAY / WEEK / YEAR

Informal learning opportunities, defined in Table 1, 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.” The focus in this section is on STEM learning opportunities outside a normal classroom setting and thus would include extra-curricular clubs or non-credit electives not required for graduation, as well as outside-the-classroom learning experiences required for graduation. Students engaged in the blending of formal and informal STEM learning experiences gained technical knowledge, academic knowledge, 21st century skills, and knowledge of potential career pathways that might inspire them to pursue a particular college major or career.

3.4.1 Design

A blending of informal and formal learning opportunities was central to the GJJ-HTH vision, as indicated by the attention focused on this component in the school’s design and the commitment of time and energy by teachers. It was aligned with the HTH design principle: “All high school students complete substantial internships in the world of work and service, where they develop projects that contribute to the workplace (HTH Website).” GJJ-HTH required all students to complete an annual intercession learning experience during a two-week block of time designed into the school year after winter break. During this time students could participate in a variety of activities of their own choosing, including an internship, a school project, college visits, or an overseas educational trip sponsored by GJJ-HTH. Another block of time for informal learning, known as X-block, was built into the weekly schedule. During this time, all teachers offered an elective course or activity in a subject of their choosing (e.g., sport, student yearbook). There were also clubs that met during lunch or afterschool, with teachers serving as club mentors. It should be noted that X-block courses and clubs varied in the degree to which STEM was integrated into their activities.

One of the GJJ-HTH graduation requirements was a month-long internship junior year. Preparation, such as resume writing and counseling, was built into the content of humanities classes starting in 9th grade and all 10th graders attended the junior post-internship presentations, as described in the section that follows on implementation. Although GJJ-HTH students were not required to fulfill 100 hours of volunteer service, this was strongly encouraged as a college application enhancement, and there were opportunities for informal learning related to STEM both within and outside of school through volunteer service.
3.4.2 Implementation
This section focuses on how informal learning opportunities for students, including internships, clubs, X-block, intersession, and volunteer work, were implemented at GJJ-HTH.

3.4.2.1 Month-long student internships
GJJ-HTH’s emphasis on college and career preparation, further discussed in the section on Supports for Students Under-represented in STEM, included a month-long student internship requirement. Internships were intended for students to engage in a real-world project that enabled them to learn while working on problems of interest and concern to the larger community. Over the years, the implementation of this internship process had evolved from a school-driven process to a student-driven process. When the internship requirement was first implemented, students in 11th grade were assigned by the GJJ-HTH internship coordinator to internships based on their interests, STEM or non-STEM. These students would then go to their internship sites two days a week, on Tuesdays and Thursdays. Alumni from the school described this process; they recalled meeting with an internship coordinator who asked them about their career interests in order to set up an internship for them. These alumni reported that for the most part they were assigned to a desirable internship that related to their interest, but even when this was not the case, they still felt like they benefitted from the experience. One alumnus stated: “One problem with that and why they changed it – we used to go Tuesdays and Thursdays, and have class the rest of the week - is that you don’t get immersed when you go twice a week over a whole semester, so it’s good now that they just condensed it into a whole month.”

Over time, GJJ-HTH moved to a more student-centered process where the student chose and implemented their internship independently. This shift occurred because administrators felt the students would be more invested in their internship if they were the ones to pick an organization and set it up. Students reported a range of methods of obtaining internships from cold-calling organizations of interest to setting up an internship through a family member or someone they knew. When asked what would happen to students if they couldn’t find an internship, every student cited the school’s many partnership connections and knew that they could fall back onto one of these school partnerships if their outreach to organizations of choice were unsuccessful.

Eleventh-grade students set up off-site full day academic internships at area companies, nonprofits, or public agencies. Some examples cited by students in a focus group included internships at a dental office, the Children’s nature center, and the U.S. Department of Commerce, and research assistantships at Qualcomm and the University of California at San Diego Medical School. Students were allowed to choose any internship they wanted to pursue and this could include STEM or non-STEM internships. Major government, education, and industry organizations participated in offering STEM-related internships to GJJ-HTH students, as detailed in the section on Partnerships.

The process of preparing for an internship began when students entered GJJ-HTH. 9th and 10th graders prepared for internships by creating resumes and cover letters in their humanities classes and participating in career panels held at the school. These career panels, organized by the college advisor, consisted of adults from the community who discussed their work lives and choices. In addition, all 10th graders were required to attend the presentations of learning that 11th graders delivered at the end of their internship. The presentation of learning, given to the entire student body, was a reflection of the students’ internship experiences and a discussion of
how these experiences enriched their lives. The presentations were graded by their teachers and were required for the internship credit. Teachers supported their students throughout the entire internship process. The resource specialist visited classrooms during their 9th and 10th grade years to teach students how to write a resume, and she communicated with students through email to inquire how their resumes were progressing. In the unusual circumstance that a student could not find an internship, students could ask a teacher to help place them through one of their many business connections. Ultimately, the school empowered the student to initiate these internship connections and to make it a meaningful experience. Some students discovered interests they didn’t know they had. One student in a focus group said: “The internship led me to environmental science, which made it more encouraging to go into that field in college.” Even a student who did not derive direct career interests from their internship still reported benefits: “It was good for personal development skills, but not for my major-related skills.”

3.4.2.2 Extra-curricular clubs
GJJ-HTH offered a variety of clubs that were generally started by students in consultation with a faculty advisor, but occasionally, clubs were organized by a teacher who had a particular passion and recruited interested students, such as with the newspaper club. According to a student focus group, all the clubs at GJJ-HTH were student-run with the exception of the robotics club which was run by a teacher. Clubs at GJJ-HTH included Model United Nations, Newspaper Club, Gay-Straight Alliance, Robotics, Darkroom Club, Sierra Club, and Roots and Shoots. Clubs met during or after the school day. Generally, students set the agenda for each club meeting. In instances where clubs met after school, teachers offered their room and volunteered to supervise meetings. Students had access to school technology and teachers as resources to accomplish their club activities.

Robotics Club was the most popular club at GJJ-HTH. This club was part of a national competition, centered on designing a robot for a challenge that began at the start of each calendar year. After the challenge was released, the students had six weeks to design and build a robot. After these six weeks, a few weeks were given to practice with the robot, and then in March, the robot was taken to compete in a local sports arena. Many teachers brought their classes out on a school day to watch the competition and cheer on the GJJ-HTH team. The robotics club was a big cultural piece of the school. Many students considered robotics their school’s sport; in fact, students in a focus group on informal learning joked that “robotics is the most attended sports event at GJJ-HTH.”

According to a teacher focus group on informal learning, they reported that transportation could sometimes be a barrier for after school clubs, but many opportunities for clubs did occur during school hours, such as lunch, or during other informal learning times like X-block (described in the next section). Overall, GJJ-HTH’s offering of clubs provided students with both formal and informal learning opportunities in a variety of subject areas.

3.4.2.3 X-block
As described in the design section, X-block was an elective course built into the school schedule in two 40-minute blocks. During this block of time, all teachers offered a course or activity in a subject of their choosing (e.g., sport, student yearbook), but according to teachers in one focus
group, it was an unwritten rule that the school offer two physical education X-block classes per year, because there were no formal physical education classes offered at GJJ-HTH. Seniors had priority in choice of X-block courses.

The implementation of these X-block courses aligned with the school’s twin philosophies of empowering teachers to teach to their passions, and nurturing the relationships between staff and students. Usually teachers created their own X-block course, but sometimes a particular student had an interest and requested that a teacher turn it into an X-block class. Teachers noted that in instances where these X-block courses were very popular with students, they could evolve over time into an extracurricular club.

### 3.4.2.4 Intersession

Intersession was an informal learning structure that was built into the school year as a two-week period directly after winter break. During this time students could participate in a variety of activities including a school science fair project, internships, or other school project. Some students used this time to visit colleges with their classmates, and other students used this time to extend their learning. The year we visited was the first year that students were able to sign up for the activity they wanted to participate in. One such extension during intersession was a school organized trip to the Galapagos Islands. Students fundraised for this trip, and for some students there was also scholarship money available. Every student was permitted to participate in one trip, and priority was given to seniors in awarding travel scholarships. Intersession was required, and while not all students travelled or participated in an internship during this time, students were expected to find an activity to do. The activities that students chose during intersession could be student or school organized.

### 3.4.2.5 Volunteer Work

Students were strongly encouraged to attain 100 community service hours before they graduated. It was not a formal graduation requirement, but the resource specialist said that colleges looked highly on community service for admission so it became a functional requirement within the school. Students could sign up for volunteer opportunities during intersession and there were also opportunities around the school for community service, such as volunteering to be a note taker in a particular class--taking notes for the entire class and then posting them online for students to download if they needed notes from class. Many students did outside volunteer work in the community as well. One student from a student focus group said that, after his required month long internship, he continued to volunteer at the science lab where he did his internship. Seniors also often volunteered during spring semester, devoted to working on their senior projects. During this semester, seniors attended a morning class, then were required to campus and either get a certain number of volunteer hours, or go to an internship.
3.4.3 Summary
GJJ-HTH supported blended informal and formal learning opportunities through its month-long internship, extracurricular clubs, X-block, intercession, and volunteer work. These activities exposed students to real-world problems and encouraged students to explore informal activities that were meaningful to the student. The school supported this interest through required and optional informal learning experiences. Through the informal learning experiences, and specifically within their academic internship, students built the types of skills that they would use in their future academic and professional lives, and had opportunities to explore possible career interests.

3.5 REAL-WORLD STEM PARTNERSHIPS

3.5.1 Design
Real-world STEM partnerships represented an important aspect to the design of GJJ-HTH’s instructional practices (see also CC4). For example, in order to graduate from GJJ-HTH, students were required to successfully complete an internship in a business or community organization during their junior year, demonstrating the importance GJJ-HTH placed on real-world adult work and productivity as a learning experience for their students. Prior to the start of the internship experience, GJJ-HTH prepared their students for the professional world through periodic classes providing support on issues such as writing resumes and cover letters and through constant conversations and mentoring around the process of contacting potential sites. These internship preparation classes took place during a student’s regularly scheduled class time and the conversations and mentoring took place during a student’s advisory period. Students had the opportunity to explore and reach out to potential internship sites themselves based on their interests, but GJJ-HTH had also developed a number of connections with business or industry partners that students could access to set up their internships. Several GJJ-HTH teachers also developed connections themselves through previous work experiences that could help students find internship placements. Once the internship was established, students were matched with individual professional mentors and worked at the internship site for 40 hours per week over a three-week period during the spring semester of their junior year.

Additionally, GJJ-HTH gave their teachers the flexibility and opportunity to incorporate partnerships and collaboration with business and industry partners into their project-based work in the classroom. These projects were accordingly designed to provide students with real-world applications to their assignments and exposure to professionals from STEM fields throughout the year.

3.5.2 Implementation

3.5.2.1 Internships and Mentorships with STEM Partners
GJJ-HTH students connected with real-world STEM partners primarily through their required month-long internship during their junior year. Originally, in previous school years, students worked at their internship sites twice per week over a full semester, but some students found that this partial schedule prevented them from being as immersed in the internship work as they would have liked, particularly if they were interested in participating in a longer-term project that required more sustained participation. As a result, to allow for a more comprehensive immersion
for the students’ internship experiences, GJJ-HTH switched to a 40 hour per week schedule over 3 full weeks during the spring semester of their junior year. This updated structure provided the stability that internship mentors needed to assign a full workload to the GJJ-HTH students while they were onsite.

One of GJJ-HTH’s more established STEM partners for internship placement was Solar Turbines, Incorporated; a subsidiary of Caterpillar, Incorporated headquartered in San Diego that manufactures industrial gas turbines. A student reporting in a focus group that he interned at Solar Turbines said that he worked on projects involving substantial use of CAD design software, received training on Pro-Engineer software to help design components that may be used in future turbine products, and was exposed to other logistical aspects of the industry. Other GJJ-HTH internship placements that were reported in a focus group included STEM organizations that included the San Diego Zoo; the Reuben H. Fleet Science Center in Balboa Park; an Alzheimer’s research center in San Diego; Qualcomm, a global wireless telecommunications company that is headquartered in San Diego; and the Battelle Memorial Institute, a global research and development organization. Students at these internship placements said they worked on designing and setting up children’s science museum exhibits, observed brain autopsies and scans, and worked on substantial biochemical or medical research projects on Alzheimer’s disease and heart disease, among other projects.

Several seniors and student alumni reported that the internship experience was one of their favourite aspects of their time at GJJ-HTH, and many of those who interned at STEM-related sites planned to or went on to pursue sciences in their post-secondary education and beyond. For example, one student who worked at the Battelle laboratories spent his internship working on advanced hands-on experiments with rats and worms as part of a larger research project on heart disease. His experience at the internship helped him confirm his interests in pursuing a career in biochemistry, and his plans included majoring in that subject in college. Another alumna served as a research intern at a laboratory at UCSD Medical School, a position that a GJJ-HTH biology teacher helped her to find and set up. Her enjoyment of that internship led her to obtain a subsequent internship after high school at a neuropathology laboratory and ultimately another research assistantship while enrolled at college. She also was initially a biology major at college, and even though she later switched to political science, her positive experiences on the internships led her to continue working the sciences into her political science studies and career aspirations. Even those students who eventually decided not to pursue the STEM field as a result of their internships stated that the experience was very helpful for exploring these interests.

Parents of GJJ-HTH students similarly reported that these internships with STEM organizations were influential in helping their children decide their future college and work interests. One daughter, for example, interned at a mechanical engineering site, leading to her interests in electrical engineering. Another son worked at an architectural firm for his internship, which inspired him to pursue the field in college; he currently had a job that he obtained through a connection he made while at GJJ-HTH.

### 3.5.2.2 Other STEM Partnerships that Support GJJ-HTH Instruction

GJJ-HTH’s partnerships with real-world STEM organizations were built into other aspects of the school’s classroom and project-based instruction. The Robotics Club at GJJ-HTH, for example,
had several professional sponsors, such as Qualcomm, Symantec, and SAIC, who provided both financial support for the club and mentors who came out to GJJ-HTH once a week to work with the club’s students around engineering and programming issues, public relations, social networking, and videography for communications.

GJJ-HTH also encouraged their teachers to incorporate these real-world STEM partnerships into their instruction, and the school director reported that there was a “natural partnership in almost every class.” Classes at GJJ-HTH often had a community component, where teachers contacted experts and other community members to come in to their classes to help out. As the school director described:

*I really think that the most successful school is one that doesn’t have walls. So we want to do as much as possible to get outside professionals into our schools. We really try to extend our arms wide open to bring these people into our school.*

As an example of the two-way connections GJJ-HTH has with industry partners, professionals from the Science Center in Balboa Park were invited to come to GJJ-HTH to critique student work, and teachers and students went to the Science Center for ideas and inspiration for their projects. In a focus group discussing community partnerships, a science teacher and school administrator said a natural partnership can be made in almost every class to bring in the community component. To do this, teachers contact experts and community members come in to help out. This decision-making process around incorporating STEM partners into their instruction was completely teacher-driven; the teachers were driving these partnerships. When financial support was needed, the teachers worked with the GJJ-HTH network foundation staff to write up grant applications, as needed.

A particularly structured example of GJJ-HTH’s partnership with a STEM organization was their work with the Reuben H. Fleet Science Center in Balboa Park. The Fleet Center is a science museum and planetarium that has operated for nearly 40 years in San Diego. The partnership between the Fleet Center and GJJ-HTH grew from a conversation between two GJJ-HTH teachers, one biology and the other humanities, and the director of Fleet’s Inquiry Institute, who manages their teacher training work. During this initial meeting GJJ-HTH teachers proposed a collaboration on a grant-funded project supporting teachers who were interested in taking inquiry pedagogy principles from museum exhibits for use in the classroom, and a partnership developed between Fleet and GJJ-HTH. The basic scope of the project involved Fleet Center staff teaching GJJ-HTH teachers how to build and develop museum exhibits, the GJJ-HTH teachers then teaching their students how to develop those exhibits, and then the students developing museum exhibits that would be displayed on the actual museum gallery floor.

Over the two years of the project, beginning in 2011, two Fleet Center staff members worked closely with the GJJ-HTH biology and humanities students on the design and implementation of posters and displays at the museum. This relationship grew from a conversation with two GJJ-HTH teachers and the director of the Fleet Center inquiry institute that does teacher training. The two GJJ-HTH teachers approached the Fleet Center asking if they would be interested in writing a grant for professional development in utilizing techniques in exhibit design and development for inquiry in the classroom. This project included training on design software,
principles behind the content, understandability, and durability of exhibits in the museum, and development of interactive museum displays. The students were assigned to projects where they took this training and developed actual exhibits to potentially be displayed at the Fleet Center. The Fleet staff provided critique and feedback to the students during their class time as they worked on these projects, and as the due date approached, there was constant communication via emails, phones, and meetings between the Fleet staff and the GJJ-HTH teachers and students. The culminating event was a showcase at the Fleet Center where the posters and displays developed by the students were installed and set up on the exhibit floor of the museum. The best ones were to be kept as part of the permanent exhibit at the Fleet Center.

The Fleet Center’s director of exhibits commented on the value he saw for the students from this project. As he described:

One of the things that [we] have emphasized is that what we are trying to teach you here is real world stuff.…. We are holding them to the same level, and I have told students, you guys are doing the caliber and the quality of work that we do at work. And I know we are asking a lot of you, but you are meeting that goal.

Another partnership that GJJ-HTH had cultivated was with a science lab located in the La Jolla neighborhood of San Diego, where students had the opportunity to participate in authentic lab work with professional researchers. While most GJJ-HTH students interned for three weeks, because that is the length of the month-long internship, at this lab, one 11th grade student had volunteered to intern for a whole year. Students in this internship participated in real lab work with the other researchers. One GJJ-HTH student in the lab said, “I put the band around the aorta - and the heart expanded.” When we asked him how GJJ-HTH prepared him for this experience, he said, “GJJ-HTH goes a bit more in depth and hands on - we have more labs than a public school.” This student described how his education at GJJ-HTH prepared him for the internship lab setting: “I have this [knowledge] and I am building off it because I have the hard basic stuff. When a researcher mentions glycolysis I understand it, and when I don't understand I write it down and look it up afterwards.”

GJJ-HTH has also partnered with world famous scientists such as sociobiologist E.O. Wilson and primatologist Jane Goodall. E.O. Wilson had participated in GJJ-HTH’s speaker series discussing how he became a scientist and Jane Goodall partnered with GJJ-HTH’s Roots and Shoots club and personally wrote the forwards for their yearly San Diego Bay publications. These two connections came from a teacher and the CEO of High Tech High. Larry Rosenstock serves on E.O. Wilson’s Biodiversity Foundation board, while a teacher had worked previously with Jane Goodall and knew her personally.

3.5.3 Summary
Real world STEM partnerships were an integral part of GJJ-HTH’s instructional practices. The required month-long student internship each spring was the cornerstone of the GJJ-HTH experience that emphasized the importance that GJJ-HTH placed on real-world adult work and productivity. The school encouraged and allowed teachers to collaborate with local businesses and the school gave the teachers the flexibility to
partner with businesses to bring relevance to student assignments. Students had found that their experiences at GJJ-HTH adequately prepared them for their month-long internships and aided in the development of their future career goals.

3.6 EARLY COLLEGE-LEVEL COURSEWORK

3.6.1 Design
The 2007-2008 academic year was the inaugural year of the concurrent enrolment program with GJJ-HTH and the University of San Diego (USD). Through a selective application process, 24 GJJ-HTH students were chosen each semester and given an opportunity to take one college class during their senior year at USD free of charge. In addition to taking college courses at USD, GJJ-HTH students could take community college courses through one of the many community colleges in the area.

3.6.2 Implementation
GJJ-HTH’s curriculum included honors options in 11th and 12th grade, but no AP courses. However, the state of California recognized GJJ-HTH’s honors options as having the same rigor as AP courses. Some students took AP exams, and there were provisions for students to work independently with GJJ-HTH teachers to prepare for the exams. For example, students in the honors calculus class were given supplemental materials if they expressed interest in taking the AP Calculus exam, and the teacher was a resource for their independent exam preparation.

Many GJJ-HTH students in the past took courses at local community colleges, but budget cuts in California severely impacted this option with the elimination of summer course offerings that GJJ-HTH students had frequently taken for dual credit. Students typically went to a GJJ-HTH college counselor to pursue this coursework independently. This early college coursework was taken outside of the regular school day, either during the summer or after school; students sometimes left early from GJJ-HTH to attend their college classes.

A limited number of students took college coursework through a program offered by USD, a private college that partnered with GJJ-HTH. Approximately 10 students took a USD course each semester (20 per school year); only introductory (100-level) courses were eligible. Students received dual credit for these courses at USD while only paying $25 per course. In their junior year, students could apply for a limited number of openings. Students who applied tended to be those who opted for honors-level coursework in junior year and were selected because they would represent themselves and the school well. GJJ-HTH was also one of 20 schools that piloted Purdue University’s Learn and Serve America course through the involvement of one of GJJ-HTH’s teachers in that project.

GJJ-HTH also had agreements with community colleges in the San Diego metropolitan area under the Regional Occupational Program (ROP). ROP is a county-wide program that offers occupational training programs free of charge for high school students to prepare them for specific occupations. These courses were designed for students to gain workplace and job acquisition skills so that students would be career and college ready. Students who took these ROP courses could choose to take a challenge exam to receive community college credits which would transfer to four-year institutions.
3.6.3 Summary
GJJ-HTH offered a college preparatory STEM-focused curriculum, which included opportunities to take honors level coursework in support of taking AP exams and earning college credit, with limited opportunities to take college coursework for credit. During the year of our visit, GJJ-HTH students had access to early college-level coursework through two avenues: a partnership with USD and partnerships with community colleges in association with California’s ROP certification program. The partnership with USD provided opportunities for approximately 20 GJJ-HTH upper level students, on an application basis, to enroll in 100-level courses to earn dual credit. The ROP certification program provided opportunities for any GJJ-HTH student to take challenge exams to earn transferable college credits. One ROP area GJJ-HTH focused on was the Biotechnology ROP. Interested students could take optional courses in this certification program or future college science coursework. Prior to the year of our visit, many more GJJ-HTH students had enrolled in community college courses, particularly summer courses, but these opportunities had been significantly curtailed by California education budget cuts.

3.7 WELL-PREPARED STEM TEACHING STAFF

3.7.1 Design
On its website, GJJ-HTH described the significance of a shared vision that must “evolve through the dynamic interaction of organization members and leaders” (http://hightechhigh.org/about). To that end, GJJ-HTH had the ability to select the teachers most able to carry out the school’s mission and vision and further develop their teaching skills and expertise through “many learning opportunities for practitioners, including teacher residencies and institutes at High Tech High, teacher ambassador programs, on-site technical assistance, and a graduate school of education offering Master’s degrees in teacher leadership and school leadership” (http://www.hightechhigh.org).

At the beginning of the school year, new GJJ-HTH teachers participated in an Odyssey program to train new teachers in the HTH culture and instructional style. During this Odyssey program, new teachers began to learn how to instruct students in the project-based learning style.

Time was scheduled into the school day, week, and year for teacher collaboration. The teaching staff at GJJ-HTH had regular meetings, forty-five minutes per day, without students, for collaboration and program development. In addition, there were three weekly student/faculty team meetings, weekly staff meetings, monthly department meetings, and several day-long professional development sessions throughout the year. During the year, teachers arrived at school an hour before the students each day to plan the program and discuss the status and future progress of students in teaching teams, academic departments, study groups, and the faculty as a whole.

One of the HTH design principles, previously discussed in the section on Curriculum, was Teacher as Designer: “High Tech High teachers are program and curriculum designers. They work in interdisciplinary teams to design the courses they teach.”
3.7.2 Implementation

3.7.2.1 Teachers’ STEM Content and Processes
GJJ-HTH worked with singular focus to create a team of teachers who are adult learners with common vision and goals. Speaking of his teaching staff, the CAO of GJJ-HTH stated, “that is our vision of having a wall-to-wall program – that all of the adults are learning.”

The average age for all teachers at GJJ-HTH who responded to the teacher survey (N=32) was mid-30s, with a range from under 25 to over 55, and they had been teaching for an average of 9 years with a range of 1-25 years. Of the STEM teachers, all had degrees in the content areas they were teaching, as well as active teaching credentials for the courses they were teaching, except those teachers who were working toward these credentials in the GJJ-HTH Graduate School of Education.

Teachers at GJJ-HTH demonstrated proficiency with content knowledge, and arrived at GJJ-HTH with strong backgrounds in STEM coursework. Most had college majors in the disciplines they were teaching. They were worldly in perspective, coming from a diversity of regions, and experienced in their fields of study, with many faculty members hailing from business, industry, research, or academia. As one student stated when asked what he thought made GJJ-HTH successful, “I think it’s the teachers; they’re not just teachers, but they are actually biologists, practicing scientists. They really know what they’re talking about; they’re not just there to teach it.”

Each teacher at GJJ-HTH that participated in our focus groups demonstrated that they were eager, willing, and able to be part of the larger collective learning vision of the school. Teachers were hired for their content knowledge and creative vision, and entered a system structured to support them as they grew toward project-based learning teaching excellence.

3.7.2.2 Staffing and Hiring at GJJ-HTH
When asked how he knew that his STEM program was strong, the school director commented, “I know because I hired everyone in the building. They are experts in the STEM field. I know the teachers know their ‘stuff.’” With about a 100:1 teacher applicant-to-position ratio, GJJ-HTH had the opportunity to be selective in hiring, and the selection process for new teachers at GJJ-HTH was very intentional and well thought through. As the Dean of the Graduate School at GJJ-HTH stated, “Hiring is the most important thing that directors do.” The process began at the network level, but ultimate decision-making was in the hands of the school directors. The school directors had the flexibility to select teachers, according to the school director, “the best teachers we can hire,” which about half the time resulted in selecting teachers who didn’t arrive with teaching credentials. The structure of GJJ-HTH with its in-house Graduate School of Education was perfectly situated to support and ultimately credential incoming staff.

During the hiring process, prospective teachers who made the initial cut came in for a day to observe other teachers, teach classes of students, and engage in group tasks and conversations. Of significant importance was their ability to collaborate and interact with all members of the community. Because of the cultural expectation of interdependence, described by an HTH
administrator as “we really rely on each other,” the incoming teachers needed to be able to model cooperative and collaborative behaviors for the students.

Of 50 teachers recently hired throughout the network, about half already possessed teaching credentials, and the other half planned to earn their teaching credentials through GJJ-HTH’s Graduate School of Education. These 25 people came to teaching from diverse backgrounds, including industry and academia. Other teachers came up through the ranks of the academic coaches in the school. About half of the teachers who responded to the teacher survey first had roles at GJJ-HTH as student teacher, tutor, or academic coach. The other half sought out the school for its project-based focus or otherwise had previous knowledge about the school. A small handful of teachers were recruited to teach at GJJ-HTH.

3.7.2.3 Teacher Training and Support
Teachers new to GJJ-HTH engaged in a two-week summer Odyssey Program, also known as “HTH Boot camp,” where teachers received an introduction to the HTH philosophy, acronyms, and lingo. In particular, new teachers were introduced to problem-based instruction and inducted into a staff culture that was open to ideas and development. Ultimately, each teacher was tasked with designing their own curriculum, which according to the school director was “very public, so it’s lived, unlike a traditional school where it’s a book and you don’t see their projects.”

As part of their contract, the teachers arrived an hour earlier than the students on most days, and twice a week, on Wednesdays and Fridays, teachers met with their team partners. About 90% of the teachers were in mentoring relationships, and there were weekly meetings between mentor and mentee. Collegial coaching was in place for those not in mentoring relationships. There were also group meetings throughout the day about teaching and learning, or advisory, community, culture, or college preparation, but not nuts and bolts; this time was well utilized, and valued.

According to the teacher survey, virtually every STEM teacher cited having had opportunities during the current academic year to watch other STEM teachers teach as part of their own professional development (PD), to meet with other teachers to discuss STEM teaching issues, and to collaborate with both STEM and non-STEM teachers with the purpose of integrating STEM course content. Between 75% and 80% of the teachers noted that the time available for their own curriculum planning and for collaboration with other teachers helped to facilitate effective instruction. In addition, most teachers responded that the professional development in which they had participated at least confirmed what they were already doing, but often caused them to change what they were doing in the classroom. (Table 6).

Table 6

<table>
<thead>
<tr>
<th>Question - Considering all your professional development, how would you rate the impact in each of the following areas? If your professional development experiences have not addressed the following areas, please check N/A.</th>
<th>Mean, Scale 1-3*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deepening my own S/T/E/M content knowledge</td>
<td>2.65</td>
</tr>
<tr>
<td>Understanding student thinking in S/T/E/M</td>
<td>2.47</td>
</tr>
<tr>
<td>Learning how to use inquiry/investigation-oriented teaching strategies</td>
<td>2.59</td>
</tr>
</tbody>
</table>
Learning how to implement problem-based or project-based learning 2.59
Learning how to integrate the different disciplines of S/T/E/M into my course 2.69
Learning how to teach S/T/E/M across the high school curriculum 2.42
Learning how to help students perform S/T/E/M research 2.31
Learning how to teach engineering or design concepts or activities 2.62

*1=little or no impact, 2=confirmed what I was already doing, 3=caused me to change my practice

Most professional development (PD) at GJJ-HTH was an HTH network-embedded experience. The Dean of the Graduate School of Education (GSE) also served in the role of Director of Instructional Support, and he saw the GSE as the “engine of PD for HTH.” The GSE put out workshops, worked with directors, participated in Thursday PD meetings run by the directors, helped to plan how to look at student work, and engaged in coaching and observations. They were able to offer PD on an “as needed basis, as things come up,” according to the GSE Dean.

Cooperative and collaborative project-based learning was the norm at GJJ-HTH, and teachers identified their confidence in teaching to this model. In addition, when asked to characterize their levels of confidence on a variety of reform-based pedagogical strategies, their responses were overwhelmingly positive. It was clear that teachers were provided foundational strategies to carry out the mission of the school in inclusion, engagement, and diversity (Table 7).

Table 7

STEM Teacher Data for Pedagogical Strategies

<table>
<thead>
<tr>
<th>Question - I am confident in my ability to:</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead a class of students using investigative strategies</td>
<td>4.47</td>
</tr>
<tr>
<td>Manage a class of students engaged in hands-on/project-based work</td>
<td>4.71</td>
</tr>
<tr>
<td>Help students take responsibility for their own learning</td>
<td>4.35</td>
</tr>
<tr>
<td>Recognize and respond to student diversity</td>
<td>4.53</td>
</tr>
<tr>
<td>Encourage students’ interest in science</td>
<td>4.65</td>
</tr>
<tr>
<td>Use strategies that specifically encourage participation of females and minorities in S/T/E/M</td>
<td>4.53</td>
</tr>
<tr>
<td>Involve parents in the S/T/E/M education of their students</td>
<td>3.47</td>
</tr>
</tbody>
</table>

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

Even the annual teacher evaluation was designed on a growth model. The school director described the yearly conversation that a teacher had with him as a “chat with Brett” that involved asking teachers to describe their goals and what they were working on in terms of “four things to celebrate” and “four to focus on.”

3.7.2.4 HTH Graduate School of Education

Early on in HTH’s history, the directors found that some of their new teachers were struggling to be successful, but when they were paired with a master mentor, the peer interaction helped them be more successful. The directors also found they were hiring doctorates from industry who could teach college, but were not certified to teach in a high school. To meet the needs of these two groups of teachers, HTH applied to the California teacher credentialing commission and had
been credentialing teachers since 2004. In describing his professional development experience as a teacher relatively new to GJJ-HTH, a physics teacher stated:

*I came in last year as an electrical engineer. I didn't have a teaching license, but by becoming a full time teacher here, I was automatically enrolled in classes at the GSE and take classes several times a week here. In that way, I am very immersed in it here.*

The Graduate School of Education grew out of this credentialing program. At the time of the visit, the GSE offered a Master’s in Education program, primarily a part time program for working educators who were taking classes in the evenings, where students could focus on either Teacher Leadership or School Leadership. The School Leadership students, interested in becoming HTH school directors, were immersed in a school as a yearlong intern, shadowed other administrators, and engaged in coursework. Teacher Leaders were generally long-term experienced teachers who were looking for opportunities beyond a classroom teacher.

### 3.7.2.5 Ongoing learning for all

Teachers were treated as professionals by the administration and had the autonomy to teach to their passions and their strengths; many teachers cited that it was because of this autonomy and respect that they stayed at GJJ-HTH. Adult learning was valued at GJJ-HTH, according to the teachers. Every year, through every project there was something new to learn. Or as one engineering teacher described, “I am a tinkerer and here I get paid to tinker with 60 projects at a time.” Teachers were encouraged to try out new ideas, and collaborate with different experts in the field, “sometimes you repeat what you’ve done, sometimes you try something new.” The advantages were obvious, “It makes it challenging to reinvent the curriculum every year, but it keeps our interest.” One teacher described his experience:

*I came out of industry and didn't plan on becoming a teacher. I said I would do this for a couple years and then do something else and I laugh at this because I am still here 9 years later. It was a total chance encounter if you will. I think one reason why we stick around is because of the change and variety and autonomy and freedom.*

In describing her 10-year association with a biology teacher, a humanities teacher stated, “There is a different focus when you integrate curriculum. I like taking the idea of the humanities in science – there is a human side to it.” She described a rejuvenated approach to the social studies curriculum, explaining how she had “grown from this association.” She described having “garnered an environmental awareness” and a “different focus” by seeking to understand the human side of biomimicry, or the changing perceptions of history through the lens of climate change, integrating books such as Climate Capitalism and Climate of Commerce into her social studies curriculum.

### 3.7.2.6 Autonomy

In the struggle for complete coherence of teaching and learning throughout the school, the CAO spoke of a “hodge-podge” of teaching, but also aligned it with the idea of “letting 1000 flowers bloom,” which was in line with the school’s philosophy. As such, GJJ-HTH gave teachers the flexibility to adapt a program so they could teach to their strengths, and allowed adjustment to meet the changing needs of students. Speaking to this flexibility with respect to the mathematics
curriculum, a science teacher stated, “We have changed the structure quite a bit over the years; we have experimented, we realized the math wasn’t getting addressed so we overhauled it.” This willingness to change, to take risks or to change an approach to learning, was echoed in an engineering teacher’s comment, “We don’t keep going down the same broken path, and we aren’t afraid to make mistakes.”

Although there was more turnover in teaching staff during 2012, usual turnover was minimal, according to the school director. There was, however, a possibility of changing staffing at schools because of within-HTH movement. Teachers could leave one HTH school to go to another, or move into administrative positions within the network, or teachers could be recruited or volunteer to move to another school during its start-up years.

3.7.2.7 Challenges.
Even though there were many supports for teaching at GJJ-HTH, there were also challenges. There was a struggle with the balance between the demands of preparing students for college and for the real world, and teachers described the balance between the different skill sets the students needed in order to be prepared for each environment. There was ongoing conversation about the value of content knowledge and book learning juxtaposed against the skills of collaboration, communication, presentation, and independent learning.

Some teachers described having only experienced teaching through the lens of project-based learning. They came to GJJ-HTH with no other teaching experiences and attended the teaching institute at HTH for credentialing. While they felt confident in their skills to teach through project-based learning, some expressed concerns about a need for content-based professional development. That said, comments from teachers indicated that they were proactive in seeking out each other or experts in the field for assistance and guidance.

3.7.3 Summary
The school’s philosophy of “teach to your passion” was evident in discussions with teachers. Teachers identified feeling empowered to follow explorations where they led. With support from the school and colleagues in terms of planning time and curriculum flexibility, teachers sought out new collaborations with experts in the field, tried new projects and were not afraid of failure.

The teachers expressed that being a teacher at GJJ-HTH was not easy, but neither was it dull. According to one teacher, “We don’t get stale or bored, we work really hard. The creative process is really supported by the team teaching structure. The whole idea of ‘teach to your passion’ is really emphasized here. There is always a way to incorporate the things you care about into your classes. We don’t do ‘bad PBL.’” GJJ-HTH had high expectations for teachers as well as students.

3.8 INCLUSIVE STEM MISSION

3.8.1 Design
This school was a part of the HTH network, specifically, the HTH Village in San Diego, as described in the Context section. As such, its mission was the stated mission of the network articulated on the HTH network website:
The mission of HTH is to develop and support innovative public schools where all students develop the academic, workplace, and citizenship skills for postsecondary success. This is attained through four goals. The first goal is to serve a student body that mirrors ethnic and socioeconomic diversity of the local community. The second goal is to integrate technical and academic education to prepare students for post-secondary education in both high tech and liberal arts fields. The third goal is to increase the number of educationally disadvantaged students in math and engineering who succeed in high school and post-secondary education. The fourth goal is to graduate students who will be thoughtful, engaged citizens.

The first goal relates to the inclusiveness aspect of its mission. The second and third goals relate to the college preparatory aspect of its mission as well as its STEM focus. The design elements of the school’s mission related to inclusiveness and STEM-focused mission are described in this section, followed by a section on implementation.

### 3.8.1.1 Inclusiveness
GJJ-HTH’s student application and enrolment process was designed to produce a student body that reflects the composition of the San Diego metropolitan-wide school district. About half of the ninth graders came from the co-located feeder middle school which, as a HTH network school, had a student body that likewise mirrored that population. HTH used a lottery system that was zip-code weighted to achieve this outcome. The result was a high school serving a diverse student population in terms of socio-economic status and race/ethnicity.

GJJ-HTH’s inclusive mission included serving special education students and English language learners. There were two Educational Specialists who managed the special education program which was classroom-based. The staff also included 6 academic coaches who provided services in classrooms and tutoring from 8 am to 5 pm. In addition, they staffed a Resource Room which any student could choose to use during the school day since it was not used in the typical way to hold special education classes for particular students.

### 3.8.1.2 College Preparation
GJJ-HTH had a college preparatory science and mathematics curriculum with opportunities for students to opt for honors-level coursework to prepare for AP exams, as described in the sections on curriculum and early college-level coursework. Students were supported in planning for college by a college counselor and had access to the Naviance tool as described by the college counselor (see Supports for Students Under-represented in STEM fields for more information about Naviance):

*I think the point with Naviance is critical when you talk about technology and STEM and it helps them find the right STEM colleges and we encourage them with this technology to find the right fit. And that is a key piece. For me, it’s like HTH--where do we get our name? Well we help students with how to use technology. And so in my world of college admissions, well, what are the tools I can give them through technology that they can use to find all the things I talk about? To research, apply, choose, best-fit. And it is all through that system [Naviance]. So, that is my way of helping them.*
The quote from the college counselor above illustrates the connection between GJJ-HTH’s mission as a high tech school and its mission to prepare students for success in college, including success in STEM fields.

3.8.2 Implementation

3.8.2.1 Inclusiveness
As a result of the lottery system described in the design section, GJJ-HTH served a student population that mirrored the San Diego School District population. In terms of students underrepresented in STEM fields, GJJ-HTH’s student body in 2012, the year of our site visit, was 46% female, and 52% of its students self-identified as minorities underrepresented in STEM fields (41% Hispanic and 11% African American). Additionally, its graduates in the year of our visit included 36% who would be the first in their families to go to college. In the same year, according to one of the Special Educational Specialists, the student population included 60 students who had Individual Educational Plans, another 20 students who had 504 plans, and about 20 students who were classified as English language learners. This represented quite a significant segment of the student body, approximately 15%.

Members of the GJJ-HTH community talked about their student body in terms of geographic diversity, social class integration, and embracing cultural diversity. The school director described GJJ-HTH as “an example of social class integration. You have a middle class student and an impoverished student working together on projects in a safe and supportive environment.” A teacher during a focus group talked about the large geographic area students were drawn from and this theme of social class integration:

Kids come from everywhere, because we are a charter school. Very few are local. A ton come in on public transit. San Diego public transportation is bad, so it can take almost 2 hours to get here from 5 miles away. But we also then have rich kids coming in brand new Audis. The beauty of our school is that they’re all together, so any classroom will have poor kids, rich kids, every ethnicity.

An alumna describing her experience at GJJ-HTH, elaborated further on why this social class integration was possible:

[It was] my favorite part of growing up. I loved the students. There were no cliques, I never felt at risk of being picked on or bullied, and I loved meeting so many different people [from] around San Diego, which I wouldn’t be able to do if I had gone to private school with everyone the same socioeconomic group around me or a local school which picks people only from one area. There is not one thing I would change about GJJ-HTH.

Parents, students, teachers and alumni also described a tight-knit community which embraced cultural diversity. One parent described the inclusive nature of GJJ-HTH in these words:

What they foster here is that different is not bad; there is an equalization of power in some ways. It’s not about “we’re all the same” because we’re not, but “I am who I am and I accept you as you are,” and all the interactions become part of their being.
Other parents, pleased with the diversity of GJJ-HTH, described it in terms of preparation for adult life:

*They’re learning a lot of acceptance of cultures and way of living.*

*You can see they embrace that diversity, and it makes my heart very happy, seeing all the kids together. It’s why I wanted this instead of a private school with all Caucasians – I wanted the real world, real people. So they develop life skills, they can carry those out to college and business environment. When they work with more challenged kids, they will be able to work in that environment.*

Parents also talked about driving their students to other students’ homes to work on projects and using carpooling, indicating that this inclusiveness extended beyond the classroom. Clearly, parents and students were committed to the choice of GJJ-HTH given the transportation challenges posed: both parents and students talked about choosing GJJ-HTH for its excellent reputation. Parent involvement was purposefully supported through an active Parent Council which met regularly with the school administrators, and a monthly forum with the School Director for Hispanic parents, known as Café con Brett. The section on Supports for Students Underrepresented in STEM fields further details supports for students and their parents.

### 3.8.2.2 STEM-Focused Mission

As noted in the design section, GJJ-HTH’s academic mission was to prepare their students for success in college, including high tech or liberal arts programs of study. This section describes the alignment between that goal and the actual experiences of the students from multiple perspectives. It includes the following themes: high expectations, focus on production, and connections to the world of work.

**3.8.2.2.1 High expectations for success.** At GJJ-HTH, there was the expectation that every student should be able to go to college, although not necessarily in a STEM major. One student described it as part of the school’s culture: “College-going is part of the culture of the school. The norm is to go to college. Actually thinking about logistics, where you want to go, SAT and that sort, starts junior year.”

As noted in CC1, individual students had the opportunity to challenge themselves through customized honors coursework negotiated with their teachers. For example, one student noted that they could “take on a really extensive science fair project [with] a mentor who works at UCSD, bio informatics, all this really intense science—and that’s our choice.” Other students described doing honors coursework intended to prepare them for taking AP exams.

When asked if any student could be successful at GJJ-HTH, 11th graders in a focus group agreed that the key ingredients were self-motivation and a supportive teaching staff: “It's not hard, you just have to be self-motivated. It's not undoable; it’s easy, almost. You have to be self-motivated.”
Anyone can do it, some students may think they are not smart enough, but our teachers give everyone the opportunity to do well and to do what they want to do. It’s their choice if they want to take on honors and take that challenge. But everyone knows that they can if they want to.

Everyone’s here to help you, not just coming here because it’s their job, but because this is what they want to do, help kids. The atmosphere, the different personalities, there’s a culture where everyone can learn.

Community here is different than other schools, because the teachers are more helpful and more willing to give one on one instruction. They’re very friendly. You get one-on-one connection with them. You can go to them [the teachers] with anything, not only school problems, there are no teachers I couldn’t go to - they would answer any questions I ever have.

3.8.2.2 Production. GJJ-HTH emphasized instructional strategies centered on production, which is part of their vision, and was described by a student in terms on hands-on learning:

The school is about hands-on learning, so if you’re good with your hands you can be successful because everything here is hands-on, producing things rather than reading a text book. Group work is also big here. ”

An HTH Network administrator echoed this production theme, linking it to academic success and student motivation:

Passing tests is a worthy goal, but completing a product is incredibly compelling! Kids should be producing high quality work. To actually finish something, to get feedback - not just [something] flashy and technically accurate, but also having evidence-based assertions.

3.8.2.2.3 Real world connections. From the perspective of teachers, GJJ-HTH sought to balance college preparedness with readiness for the real world. They did so by using problem-based learning and integrating subject areas to create more complex challenges for the students.

The whole reason our school started was because the locals said, ‘we are getting these students that are great at calculus--they’re 4.0, 5.0 students--but they can’t do anything in the work place, can’t actually apply it to the real world?’ So that’s what went behind starting this school, making sure the kids are applying what they are learning. We always are struggling with the balance between college and the real world – they are different skill sets, and so we’re always walking that balance.

One mathematics teacher further described the GJJ-HTH instructional approach in terms of linking conceptual understanding, cross-disciplinary connections, and real world connections:

Our strength is that we get the students to think deeper about the concepts, and apply them and connect them to other disciplines. We don’t just emphasize ‘here are the steps’ but rather ‘what does this mean?’ and get them to express in many ways their understanding of what the math concepts mean and how you connect them to other concepts in the real world.
A college calculus teacher noted that GJJ-HTH students develop critical thinking skills that exceed what he sees with other public high school students he teaches; the GJJ-HTH students can “break things down and think critically” when asked to make real world connections.

3.8.3 Summary
GJJ-HTH, as part of the HTH public charter school network, was committed under its charter to mirror the metropolitan-wide San Diego School District population. The zip-code weighted lottery system employed by the network ensured that the ISHS and its feeder middle schools reflected the full range of backgrounds, both in terms of socioeconomic status and race/ethnicity, as well as students with learning disabilities and English language learners. The design included academic support in the classrooms by academic coaches, tutoring between 8 am and 5 pm, and access by all students to a learning resource room. As implemented, GJJ-HTH appeared to meet its STEM-focused mission through a strong college preparatory STEM curriculum, high academic expectations for all its students coupled with teachers willing to help students master the rigorous content, and instructional strategies emphasizing production and connections to the real world.

3.9 ADMINISTRATIVE STRUCTURE

Administrative structures were broadly defined in Table 1 at the school level, but this component includes structures the school was a part of, specifically the High Tech High Network (referred to as HTH Network, to distinguish it from the high school itself, referred to as GJJ-HTH), as well as within-school structures. GJJ-HTH was founded as a public charter school after receiving approval of its charter from the state of California in 1999. Larry Rosenstock, the HTH Network’s Chief Executive Officer (CEO) at the time of this study, was the school’s first leader and it was his vision that underlay the design of the school. Subsequently, the charter was modified to include schools spanning elementary and middle school grades as well as grades 9-12, and the HTH Network expanded, as described in the Context section.

At the time of this study, administrative functions were performed by a network administrative team and administrative teams at each school, including GJJ-HTH. There was a network-level Board of Directors that operated as a California non-profit public benefit corporation. It was the HTH Network that received per pupil funding from the state of California for the schools within the network. This funding plus additional funding from outside sources, such as grant funding, was allocated by the Network to its schools after retaining a portion to cover the administrative functions performed at the network level. A Network-level administrator described this administrative structure by saying, “We are our own district.” The head of the HTH Network, CEO Rosenstock, was supported by a Chief Academic Officer (CAO) and other administrative personnel. Rosenstock was responsible for overseeing the Network’s overarching vision for its schools, and the CAO was responsible for overseeing implementation of academic programs. The two leaders worked seamlessly, based on a 20-year working relationship and shared passion and vision. The CAO described the division of roles:

Larry [Rosenstock] has a big vision, but he is not thinking about how to get the classes in the schedule or get them approved by California. I see my role as to enact the vision. And there are so many choices that I am making - prioritizing this over that - I know where we are heading and
this over that and I can make decisions. That is partly how I see it in enacting vision, by doing the nitty-gritty. Being from the inside gives me the perspective of where we are heading.

At the Network level, there was also a full-time director of development who reported to the CEO. She described her role as follows:

*My role as director of development is to implement a variety of different fundraising campaigns among all 10 of our schools. The bulk of my time is spent raising money from HTH families and friends, from grass roots fundraising, to benefit operation budgets at each school and close the gap from California funding to what it takes to actually run a school. I also do a variety of grant writing for technology budgets and operational needs at each school site. I also collaborate with other colleagues at HTH to do bigger projects; for example, an I-3 grant which is a collaborative effort, and other big grants. I also meet with Larry Rosenstock [the CEO of the Network], the CFO, and the CAO. I stay in touch with what is happening at the school level, such as the needs and priorities of the school and how to do accomplish those. Much of the fundraising comes from the deep relationships with Larry Rosenstock, so I only represent a portion of what it costs to run this network of schools.*

The HTH Network had a unique feature: its own Graduate School of Education approved by the California Teacher Credentialing Commission. The Dean of the HTH Graduate School, who also served as the Network’s director of instructional support, described how it came about and the functions it served in the Network:

*We realized that we hired new teachers that were struggling, they were paired with a master mentor, and we noticed that the peer interaction made them teach really well. We were hiring PhDs from industry who could teach college but were not certified to teach high school. So we applied to CA the teacher credentialing commission, and after a few years we were approved to do so. We have weekly evening classes with our alternative teachers, and after a few years they were credentialed by the state.*

The reason the Network decided to establish its own Graduate School also related to the demand for its teacher development approaches, as the Dean also related:

*Other organizations started approaching us and wanting us to train their teachers. We thought ‘no, we could only do it with our own employees.’ [Then] we thought, ‘if we are going to do so we needed to expand.’ That’s why we applied to be a grad school of education. We wanted to provide additional opportunities.*

Finally, all infrastructures, including information technology, school buildings, and other facilities were administrated at the Network level, but each school also had a technology specialist on staff, who reported to and interfaced with the Network-level information technology administrator.

Thus, GJJ-HTH, as a High Tech High Network public charter school, had considerable support available through the Network, including information technology support, teacher application processing support, and grant proposal and management support. In the following subsections,
the design and implementation of the administrative structure is discussed at the level of GJJ-HTH (school-level), including the interaction of the school-level and HTH Network-level administrators.

3.9.1 Design
GJJ-HTH was a themed charter high school in the HTH Network, as described in the Context section. It had a technology theme and college preparatory curriculum, and the student body consisted of students who, together with their parents, chose to continue attending an HTH Network high school after attending one of the Network’s middle schools, or who chose to apply to a lottery for open ninth grade slots in the Network’s high schools. Transportation was not provided for GJJ-HTH students. With students coming from all over the San Diego metropolitan area, this meant that students needed to use public transportation, carpooling, or their own cars, and this may have influenced some families not to apply.

GJJ-HTH served almost 600 students, including approximately 40 to 50 students with individual education plans (IEPs) but few English learners. GJJ-HTH shared a campus with two other HTH Network schools, a middle school and an elementary school. The campus environment contributed to a strong sense of community across grade levels. Many students spent time outside during the school day to work on projects or eat lunch, and interacted with students from the other schools.

Brett Peterson, the school director, led the school and was supported by a small administrative staff including a dean, a college and career counselor, and an information technology specialist. The reader is referred to the section on the teaching staff for findings related to teacher qualifications and perceptions about teaching at GJJ-HTH, including satisfaction with administrative support.

The HTH Network, as a public charter school system, was not subject to outside policies regarding teacher hiring. The Network processed over 1,000 teacher applications each year, and GJJ-HTH had its own process for interviewing and selecting teachers after the Network winnowed the high school teacher applications down to a reasonable number who met Network criteria and had the qualifications for the open teaching positions.

3.9.2 Implementation

3.9.2.1 School-Network Joint Administration
As a public charter school system similar to a school district, the HTH Network received the per-pupil funding from the state of California and allocated this funding to administrative functions and infrastructure expenses that would be retained by the Network and to individual schools for their functioning. Each school director then had responsibility for this school budget.

3.9.2.1.1 Development. There was two-way support between the Network and the school for new initiatives and school improvements. The HTH Network’s development director explained the process:
Well, let’s say I talk to Brett [Peterson, the GJJ-HTH school director] and he says we need all new furniture and carpeting because we haven’t replaced it in 10 years. So I will talk to the CFO [Chief Financial Officer] and see how much that would cost. Then I would talk to the parents and maybe have them support a carpet fund drive. And then if it’s like we need to retrofit the bio lab and we have new technology we need to update, [then] Okay, let’s talk to the teachers and look at the space and look at the contacts in that industry and see if we have connections for help in that realm, and then another step is grant seeking.

This description by the Network Development Officer illustrates the way the Network and school worked together to enhance available resources for school improvements through outreach to industry partners and parents.

3.9.2.1.2. Staffing. As noted in the design section, the Network received over 1,000 applications for open teaching positions, and conducted the initial screening. The network usually filled other positions, such as dean and school director, from within.

A key component of the HTH culture was a distinct lack of bureaucracy. The vision centered around creativity and the lack of bureaucracy, and the administration, teachers, and students all understood and cherished their autonomy and the climate of respect for their abilities that this autonomy was based on. The CAO explained how this depended on enculturation of the staff in this HTH way of doing things:

We don’t hire people from the outside. We have this intense way of bringing everyone up through. The way we are doing it, we don’t have policy manuals. We have tradition and it is all from conversation. I like how we are doing it. If people come from the outside, they would think it is a preposterous idea. But it works when you bring people up from the inside.

The Graduate School Dean echoed this sentiment as well as he described a hiring process focused on ensuring that any new teachers hired from outside demonstrated their ability to function within the HTH educational approach that emphasized collaboration within a flattened structure and modeling that collaboration for students:

Hiring is the most important thing that directors do. We have the flexibility to be pretty thorough in interviewing people. It helps that we live in a desirable place; we get 100:1 applications for positions. But it makes a big difference in the school that we have that flexibility. How does hiring work? They observe a class and tell us what they see, they teach a class and are observed by kids and teachers, and then they have a speed dating round robin interview with kids and other teachers, and then we give them a text (e.g. invisible backpack) and give them the task to lead a discussion. It’s important to see how they collaborate/interact. In the early years a lot of the people we let go were not bad teachers but they couldn’t work with adults. We really rely on each other; they need to be able to model it for the kids.

The Graduate School of Education (GSE), as implemented, was accredited to offer two master’s programs: one in teacher leadership, further described in detail in CC7, and one in school leadership. The latter was designed to meet the needs for development of administrators within
the Network, including school directors and teachers desiring to pursue career paths in school administration.

At the school level, GSE also supported Network schools in the area of professional development. The Dean explained,

*I am director of instructional support for HTH [the Network] as well as dean of GSE. We saw the GSE as the engine of PD [professional development] for GJJ-HTH [the Network]. Our aspiration was that all the adults would be engaged in some way or another. We view ourselves as people who do workshops, PD, we work with directors, we participate in Thursday PD meetings that the directors run, we help plan: how to look at student work, coaching, observations, what do you look for in an observation. Not much structure, we offer on as-needed basis as things come up. We’re embedded, we don’t have a building. I am an instructor; [name] who is not a GJJ-HTH person, she came in to be the director of the teacher leadership program from UC Davis and teaches action research; [name] started as physics teacher, then became director of GJJ-HTH International, now she teaches the SL [School Leadership] program. Our teachers act as co-teachers; it’s a development opportunity for them, too.*

3.9.2.1.3. Other administrative support. The Network facilitated website maintenance, admissions, and network-level initiatives. The HTH Director of IT also supervised each school-level IT director and they coordinated as a team under his leadership. The Network administered the lottery system for admissions for each school in the Network.

3.9.2.2 School-level Administration
The school director had responsibility for leading his staff in implementing the school-level vision, and coordinating with HTH Network-level administrators. He had final authority on hiring teachers and making decisions about how to allocate the school budget, although the Network was involved in these administrative functions as just described.

When asked about his most important job duty, Brett Peterson, the school director at the time of our study, said, “First, to create a safe place for students. Second, hiring teachers.” Peterson had begun working for the HTH Network as a teacher. In general, school directors tended to begin as teachers within the Network and be trained for administrative roles.

3.9.2.2.1. Staffing. GJJ-HTH conducted its own screening of teaching applicants found highly qualified through the HTH Network’s applicant screening process, and selected applicants to interview. Administrators, teachers and students participated in interviews and advised the school director on applicant selection. Students also participated in teacher hiring decisions, lending their perspectives. According to the school director:

*We are fortunate to have lots of applicants...and the teachers are involved with whom their colleagues are and of course the children should be involved too. So teachers and students are involved in the hiring process. We found one guy that seemed fine, and sure enough, after the students got done with him it was a ‘thumbs down’; the students had an interesting perspective and said they did not feel comfortable with him.*
3.9.2.2 Counseling
The school employed a full time college and career counselor. There was also a fully staffed special education support team led by special education teachers and assisted by academic coaches. Counseling and academic support are detailed in the section on Support for Students Under-represented in STEM.

3.9.2.3 Information Technology
Each one of the HTH schools, including GJJ-HTH, had a dedicated IT director. That person was responsible for all day-to-day operations, creating user accounts, and servicing hardware (e.g., projectors, audio-visual equipment). Further details are provided in the section on Innovative Use of Technology. As noted, the HTH Network facilitated website maintenance, admissions, and network-level initiatives.

3.9.2.2.2 Other administrative functions. Many administrative functions were implemented in a flattened organizational structure at GJJ-HTH. The director emphasized a limit on “administrivia” in order to support teacher and student initiatives. Teachers, as curriculum designers, played a primary role in curriculum design and implementation. Teachers also carried out administrative functions related to running teacher meetings and participating in new teacher selection and mentoring activities.

The flattened structure with de-emphasis on “administrivia” extended to the school’s relationship with the community as well. The line between the school and the city was essentially nonexistent. The GJJ-HTH school director explained how this openness to outside entities benefited the students:

So I really think that the most successful school is one that doesn't have walls. We want to do as much as possible to get outside professionals into our schools. We really try to extend our arms wide open to bring these people into our school. So if you are designing a project, its partnering with an actual laboratory and we limit “administrivia” so if students want to go on a field trip, we get these kids out. The pinnacle is the academic and student internships that happen at the end of junior year where they work for a month from 9-5 and it’s such a rich experience for so many kids. And we have other community partnership through grants and such. If you give us money, we can target that money as efficiently as possible and people in the community value that.

This intentional de-emphasis of “administrivia” extended to student project initiatives. The school director and teachers encouraged students to pursue new ideas even if they were risky or unusual. One example was a student project that involved conducting in-depth studies of wildlife found around the San Diego Bay. One group decided to study homeless people who lived near the Bay, and were not discouraged or prohibited from doing so. The project evolved into a sociology study of homelessness issues in San Diego.

Students, like teachers, participated in running school meetings and in teacher applicant interviews. Student participation in administrative functions is described next in the context of student leadership opportunities.

3.9.2.3 Student Leadership
Student participation in leadership and decision-making was strongly emphasized at GJJ-HTH, contributing to the flattened organizational culture. Our team observed an all-school assembly on a Friday afternoon. Students seemed to learn about the assembly through word of mouth, with teachers and students informing one another a few minutes beforehand. Despite this, the entire student body assembled and sat on the floor of the common room with impressive order and efficiency (See Figure 5).

Figure 5. Student Assembly led by Students.

Different groups of students led the entire assembly, which included reminders about the school dance. Awards were given out for performance on recent projects. The assembly concluded with a fun activity involving teachers and students competing for prizes by guessing the lyrics to popular songs. No cliques were evident whatsoever, and upperclassmen seemed to take a personal interest in the development of the underclassmen.

Besides conducting assemblies in a professional manner, students also participated in teacher hiring decisions, making valuable contributions based on their perspectives as learners within a unique learning environment, as previously described in the section on staffing.

3.9.3 Summary
GJJ-HTH’s administrative structure was one of its most salient features. At the school level, the administrative staff, led by a school director, was small, including one dean, one college and career advisor, and one IT director. However, many administrative functions were performed at the HTH Network level and there was close collaboration with their administrative staff. Other functions that might be conducted by administrators were relegated to the teaching staff. The
school-level organizational structure was not hierarchical, and teachers were given considerable autonomy in curricular and instructional decisions, and both teachers and students were in leadership roles for working groups and assemblies, respectively. Teachers and students also participated in interviewing and selecting new teachers. The school’s administration was committed to supporting its teachers and students by limiting administrative hurdles for implementing innovations and supporting students in pursuit of their projects. Thus, autonomy and collaboration were key features underlying the smooth and effective fulfillment of school functions that might otherwise be retained by the school’s administrators.

**3.10 SUPPORTS FOR UNDER-REPRESENTED STUDENTS**

The focus on this critical component is on support structures for students from groups under-represented in STEM college majors and careers (e.g., females, African Americans, Hispanics, students who would be the first in their families to go to college). This critical component, defined in Table 1, includes academic support structures, such as bridge programs and tutoring programs, as well as support structures to position students for STEM college majors and careers and strengthen student transitions to STEM careers.

**3.10.1 Design**

One of the design principles of High Tech High schools was that they would be “diverse and integrated” and that enrollment would be “non-selective via a zip code-based lottery, and there [would be] no tracking of students by perceived academic ability (HTH Website).” GJJ-HTH served a large number of students who were Hispanic or socio-economically disadvantaged, two groups under-represented in STEM college majors and careers, as shown in the Context section on demographics. Academic support, available to all students regardless of whether they had been classified as special needs, was provided through the Special Education program at GJJ-HTH. Academic coaches were assigned to classes, particularly at the ninth grade level; and the resource room, as well as within-class support of the coaches, were available for all students desiring academic support.

Another design principle related to advisors: “Each High Tech High student has a faculty advisor who meets regularly with a small group of students to build community, support their academic progress, and plan for their future. The advisor also visits each of their advisee’s homes and serves as a point of contact for the family (HTH Website).” Advisories were an important support structure at GJJ-HTH for encouraging and supporting students; students stayed with the same advisory group/advisor throughout their four years, and each advisory group had a range of grade levels. In addition to the support students received through their advisory group activities related to college selection and application processes, GJJ-HTH had a dedicated college advisor who worked with students individually and through their advisories and other special events. GJJ-HTH also had programs to support parents in understanding and working through college application and financial aid processes with their students.

To support the large number of Hispanic parents—40% of GJJ-HTH students self-identified as Hispanic/Latino—GJJ-HTH formed a Latino Parent Association where meetings were conducted in Spanish. Spanish-speaking parents also had a regularly scheduled opportunity, known as Café con Brett, to meet with the school director, Brett Peterson, and hold discussions in Spanish.
Finally, GJJ-HTH had financial support structures to ensure that all its students could go on college visits and take the PSAT, SAT, and ACT exams; and a laptop loan program for students whose families could not afford to buy one for their student.

3.10.2 Implementation
This section describes the implementation of academic and college transition supports critical for students from groups under-represented in STEM college majors and careers.

3.10.2.1 Academic Support
The primary source of academic support for all students was through a special education program focused on supporting students in the classroom. Two special education teachers worked to push resources into the classroom, including a staff of academic coaches who assisted in the classroom. These were college educated professionals who had degrees in their coaching subject area. These coaches were concentrated in ninth grade, and also in science and mathematics. Each coach was assigned to a few classes; they mostly worked with students who had IEPs but were available to everyone. These coaches provided academic support before, after, and during school.

In the classroom, the special education department paid for one student in each class to take notes and post it to a blog. These notes were available to every student. The student chosen to take notes was paid $100 per course per semester, but if students would rather opt for community service credit instead of pay, this money could be donated to the student body in the form of travel scholarships for students for college visits.

Students were also able to go to the resource room for assistance in their coursework. This resource room was staffed by academic coaches. Students used this room as a quiet getaway when they needed to concentrate to get a particular assignment completed. The resource room could also be used when students needed extra help from an academic coach or wanted to use a computer for an assignment. The resource room was used by all students, not just special education students, and students said there was no stigma attached to using the resource room.

The culture of support extended beyond a teacher’s individual class or students. Students were aware of the strengths and interests of their various teachers, and would often seek help from other teachers in the form of guidance and resources on their projects. Teachers helped students on projects for any class, not just their own, thus broadening the access to academic support from teachers.

3.10.2.2 Advisories
Students were placed into an advisory that met once a week on Friday, and stayed with the same advisor through all four years at GJJ-HTH. This strategy, known as looping, is intended to allow for the establishment of a close relationship between students and advisor. According to Lee (2002), these close relationships are particularly important for female students and have a major impact on whether they stay committed to a STEM college major. However, as noted by Lee, this impact can begin in the high school years with support from adults important to the student; to the extent these relationships favor STEM involvement, STEM behaviors and interest are
nurtured in the student. Thus, the looping of advisees and advisor across all four years can be a powerful approach to influencing students’ attitudes and behaviors around STEM learning and career choices. Advising was done individually and in the context of peer activities. Additionally, students of all four grade levels participated in the advisory period, which was intentionally designed so that the older and younger students could learn from each other. To the extent students formed close relationships with their advisory peers, they might also support students considering STEM college majors and careers. Both students and staff at GJJ-HTH mentioned that this advisory period was a time when students and staff were able to build a constructive relationship, which supported the college-going culture of GJJ-HTH.

The GJJ-HTH advisory program included a home visit at the beginning of a student’s ninth grade year, which involved an advisor meeting with the student and their parent(s) and/or guardian(s) at their home to introduce themselves and welcome the family to GJJ-HTH. At school, these advisors worked with their students to help them find an internship, edit their resume and cover letters, and offer support on an individual basis. In addition, students traveled with their advisor and the rest of their advisory group on a college visit.

GJJ-HTH’s culture of support extended beyond the advisory period and academic support within the classroom. Students in focus groups indicated that they felt that their teachers and administration cared about them academically and personally, and that they could talk to anyone when they needed academic or personal support. One former student of GJJ-HTH said, “It is nice to feel you were on the same plateau with them, talking about current events, life, arts, movies—you felt like equals.” Another alumnus noted the impact of calling GJJ-HTH teachers by their first names on developing closer relationships with teachers:

It seems petty but it makes a difference. It’s different from professors I had in college, like the one I went to in Europe, needing the title professor, which felt like he was automatically distancing himself from the students.

3.10.2.3 College Preparation and Support
GJJ-HTH had a dedicated college and career counselor on staff, in line with the design of the HTH network of schools. The college counselor at GJJ-HTH saw his role as guiding students towards a successful transition to post-secondary education. He helped them in researching and applying to colleges, finding the best fit, easing their transition to college, and making the adjustment to more traditional educational environments.

The college counselor provided this support through multiple activities that prepared students for college. One such activity was “College Day.” This activity consisted of a student in an advisory group picking out a college either local or distant that they wanted to visit. Once a location was chosen for College Day, the group fundraised for the planned college trip. The college counselor felt that trips like this were important because it helped students to see the world beyond their home city. He said:

One student had never been separated from her twin and had never been on an airplane. For her, it was huge because she was getting away, and the mom realized that this is something that can happen and this helps with that and broadening the horizons of families.
College advising at GJJ-HTH involved more than just counseling the student. GJJ-HTH’s college counselor explained that advising for first generation college-going students, in particular, required a holistic approach of counseling the family, particularly parents or guardians. He said:

*For first generation, it’s tricky because my time is limited. As long as the student is in my office we keep moving forward. Obviously we engage parents when I can. When you counsel a student it’s a holistic program and you are counseling the family system they come from. Every year I get the Hispanic female that says ‘I can’t go to this program in Ohio even though I got admitted and I have a free airplane ride to see the university because [my] parent doesn’t want their kid to go any further than LA,’ and it hurts. So you have to get the parents on board obviously and educate them about the process and sometimes you will have families that won’t let their kid go beyond LA and it’s not all negative, it’s just the reality of the culture and I know there are many students I have worked with that had more options but you work with what you have and move forward.*

Educating the parents about the college process was one of the top priorities for the college counselor at GJJ-HTH. He hosted a number of parent information meetings to educate parents about the college application process. This holistic program of educating parents included general college presentations, grade level meetings for parents, and literature sent home. A sample newsletter is shown in Figure 6.

*Figure 6. Partial sample of College Knowledge, a quarterly newsletter distributed by the GJJ-HTH college advisor to GJJ-HTH parents.*

The college counselor also used Naviance, a comprehensive counseling program, to help communicate with students and parents about college. He noted that “[Naviance] is a comprehensive counseling program and one thing it allows our school to do is have the college going culture it does, but with only having one of me.” The Naviance system pulled aggregate data from HTH high schools so that students and parents could look at all the college application
data from previous students (e.g., where they were accepted or denied, what their scores were). Students using this program could view scatterplots based on this historical data to determine where they fit in the college selection process and tailor their college applications accordingly. The college counselor said:

For me, it’s like HTH, where do we get our name? Well, we help students learn how to use technology. And so in my world of college admission, well, what are the tools I can give them through technology that they can use to find all the things I talk about?-- to research, apply, choose, [determine] best-fit. It is all through that system [Naviance].

In addition to viewing this data, students could use Naviance to take interest and career tests to select a college major and college offering that major that was the right fit for them. The college counselor guided the students through this process.

3.10.2.4 Financial Support
GJJ-HTH supported all their students as just described, but there were additional financial supports for its socioeconomically disadvantaged students. The purpose of these financial supports was to give these students the same opportunities when applying for college. These financial supports helped by providing funding for college test fees, travel for college visits, and technology.

GJJ-HTH required all its students to take the PSAT in their junior year mathematics courses. GJJ-HTH covered the cost of the test for all students; they viewed this test as an opportunity to get students thinking about the college admission process. GJJ-HTH also asked that every student take the SAT and helped students who qualified for free and reduced price lunch to obtain fee waivers. These fee waivers also extended to the ACT and to SAT II subject tests.

Most of the students at GJJ-HTH had Internet at home, according to the administration; however, some families might not be able to afford to buy a laptop for their students. GJJ-HTH offered loaner laptops for students to use. There was no formal policy, but if the school had an extra laptop available, they could decide to let a particular student take it home. In addition, the staff at GJJ-HTH noted that students were welcome to stay into the evening to use the school computers.

3.10.2.5 Targeted Support to Hispanic Families at GJJ-HTH
GJJ-HTH offered some targeted support to Hispanic families in addition to the supports they gave to all their students. The Hispanic parents at the school expressed how welcoming the school was to the Hispanic community and were grateful for the extra efforts to include them within the school community. One Hispanic parent in a focus group said, “We feel very included because they call us to come to meetings and to see how our kids are doing in school academically.” The school director said the most work they had done for parents had been with their Latino group. The school created a Latino Parent Association where all meetings were conducted in Spanish. The need for this group came from the sizeable number of GJJ-HTH students who came from families where Spanish was the only language spoken at home; the school responded by creating the group to include and welcome this group of parents.
In addition to the Latino Parent Association, GJJ-HTH also offered several other supports for Spanish-speaking parents. One example was a regularly scheduled event, “Café con Brett,” where Spanish-speaking parents had the opportunity to meet with the school director and discuss important school topics in Spanish. GJJ-HTH also provided Spanish translations of teachers’ comments on student report cards.

3.10.3 Summary
GJJ-HTH provided academic and college selection and application support for all students, which benefited students from groups under-represented in STEM fields. Academic support was provided in the classroom by academic coaches assigned to ninth grade classes and mathematics and science classes. These academic coaches also staffed a resource room that had an open-door policy for all students, and provided academic assistance before, during, and after the school day. Additionally, students reported that teachers other than a particular course teacher were willing to provide them with academic support, such as advice about their projects.

GJJ-HTH had a robust college advising program that spanned all four years. Students stayed with the same advisor throughout their time at GJJ-HTH and this teacher supported them in making informed decisions about internship placements, college selection, and a host of other issues that arose for individual students. Each advisory made a college visit trip with input from the students. GJJ-HTH had a college counselor who worked with students individually and in groups, and with parents, primarily through special events targeting their concerns about college. GJJ-HTH hosted a College Night each year and other workshops and newsletters for parents about the college application process. One major tool employed by students to decide on which colleges to apply to was Naviance; the college counselor worked with students to help them use the features of this program that was linked to historical data on outcomes by prior graduates.

GJJ-HTH had two initiatives targeted to groups under-represented in college majors and careers: Hispanic and socioeconomically disadvantaged. With 40% of their students from Latino homes, some in which Spanish was the only language spoken, GJJ-HTH formed a Latino Parent Association in which the meetings were conducted in Spanish. With almost half of their students from socioeconomically disadvantaged families, GJJ-HTH also implemented programs to ensure that money was not an obstacle in participating in college admissions steps such as taking the PSAT or SAT, or going on college visits with their advisories. While GJJ-HTH had no formal laptop program, the school did loan laptops to particular students on a case-by-case basis.

3.11 EMERGENT THEMES: VISIONARY LEADERSHIP AND SCHOOL CULTURE

As explained in the Context section, the Gary and Jerri-Ann High Tech High School was the original charter school and Larry Rosenstock was the visionary leader selected to lead the design and founding of this public charter school. The reader is referred to the school history subsection of Context for more details about the involvement of industry and the driving motivation for this school’s founding: to increase the pool of STEM workers to meet the needs of the San Diego high tech industries and organizations.
3.11.1 Visionary Leadership
Rosenstock’s vision for an inclusive STEM-focused school focused on production of learning products and integration of modern workplace expectations, tools, and work experiences. As Rosenstock himself explained during an interview, he attributed some of his educational philosophy to John Dewey’s idea that the members of a school community should be “producing” and not merely “consuming.” Rosenstock related this to the HTH academic environment using the example of books: students are not just reading books but also “kids are making books.” Examples of such learning work products were shown in Figures 1 and 2. Rosenstock explained this philosophy in terms of learning: “People need to do something to things. They need to alter conditions in order to find out and understand them.” The many learning work products GJJ-HTH students produced were evident in every available location throughout the school: walls, display cases, classroom shelves, and administrator offices.

In addition to an emphasis on production of work-place quality learning products, discussed primarily in the sections on Curriculum and Instructional Strategies, Rosenstock’s vision included an accompanying emphasis, evident at GJJ-HTH, on providing opportunities for their students to be connected to the adult world of work. This was one of four key design principles Rosenstock developed to operationalize his educational vision. The other three were personalization, common intellectual mission, and teacher as designer. The four design principles, as published on the HTH website, are shown in Table 8. Some elements of these design principles relate to specific critical component(s) and have thus been included in those sections. For example, the section on Informal Learning discussed internships (adult world connection); the section on Instructional Strategies discussed personalization of projects and supports for students with special needs (personalization) and performance-based assessment (common intellectual mission); and the sections on Curriculum and Teaching Staff discussed the role of teachers in designing curricula (teacher as designer). Shown in italics are elements of the design principles that were not specifically related to particular critical components, or that were found to have a broader context. An emergent theme that arose from our data was that these elements were connected in significant ways to the GJJ-HTH school culture and goal to prepare students for the adult world. The focus in the next section is on this emergent theme.

Table 8

<table>
<thead>
<tr>
<th>HTH Design Principles</th>
<th>Adult World Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personalization</td>
<td>HTH students connect their studies to the world beyond school through field studies, community service, internships, and consultation with outside experts. Students routinely create work for authentic audiences and exhibit that work in professional venues. All high school students complete substantial internships in the world of work and service, where they develop projects that contribute to the workplace. The HTH facilities themselves have a distinctive &quot;workplace&quot; feel, with windowed seminar rooms, small-group learning and project areas, laboratories equipped with the latest technology, ubiquitous wireless laptop access, and common areas where artwork and prototypes are shown.</td>
</tr>
</tbody>
</table>

High Tech High teachers know their students well, and are committed to a learner-centered approach that supports and challenges each student. Through projects, students pursue their passions and continually reflect on their learning and growth. Students with special needs are supported through a full inclusion model. Each High Tech High student has a faculty advisor who meets regularly with a small group of students to build community, support their academic progress, and plan for their future. The advisor also visits each of their advisee’s homes and serves as a point of contact for the family.
Common Intellectual Mission

High Tech High schools are diverse and integrated. Enrollment is non-selective via a zip code-based lottery, and there is no tracking of students by perceived academic ability. All HTH students pursue a rigorous curriculum that provides the foundation for entry and success at the University of California and elsewhere, as well as success in the world of work. Schools articulate common expectations for learning that value 21st century skills, the integration of hands and minds, and the merging of academic disciplines. Assessment is performance-based: all students develop projects, solve problems, and present findings to community panels. All students are required to complete an academic internship, a substantial senior project, and a personal digital portfolio. Teachers employ a variety of approaches to accommodate diverse learners, and recognize the value of having students from different backgrounds working together.

Teacher as Designer

High Tech High teachers are program and curriculum designers. They work in interdisciplinary teams to design the courses they teach. They take the lead in staff meetings and action groups addressing school issues. They participate in critical decisions regarding curriculum, assessment, professional development, hiring and other significant areas of the school. The schedule supports team teaching and teachers have ample planning time to devise integrated projects, common rubrics for assessment, and common rituals by which all students demonstrate their learning and progress toward graduation.

3.11.2 HTH Design Principles and School Culture

According to the High Tech High website (2013), “Responding directly to the needs of students, all four design principles [personalization, adult world connection, common intellectual mission, and teacher as designer] connect to the broad mission of preparation for the adult world.” Besides specific opportunities to interact with the world of work and the emphasis on production of learning products meeting world-of-work quality expectations, implementation of this broader mission was manifest at GJJ-HTH in the way students and adults interacted with each other both personally and around the production of knowledge. There were unique aspects of the school’s culture that positioned students as adult workers in the learning environment that in turn mimicked a high tech work environment. These unique aspects are discussed in terms of the particular design principles.

3.11.2.1 Personalization

Personalization of student learning has been discussed in the section on Instructional Strategies as it relates to student selection of project topics of interest to them personally and differentiation to support diverse learners in a classroom environment that serves students with special needs through an inclusion model. However, these discussions did not capture fully the element that “High Tech High teachers know their students well, and are committed to a learner-centered approach that supports and challenges each student.” Because the school’s goal was to prepare students for the adult world of work, the learner-centered approach went beyond allowing students to select project topics to encompass treating each individual as an active participant in the production of knowledge.

Students in focus groups agreed that students and teachers interacted in such a manner that that students were primarily responsible for their learning and relied on both their own peers and their
teachers as resources for, and supporters of, their learning. One student said, “At HTH, things are more conversations instead of lectures. I mean that in the literal sense: we are talking to teachers and are not just told things by them. And also in the metaphorical sense: everything we do is through conversations with both the teachers and outside world.” Students described this type of learning as part of the HTH culture, and noted that the transition occurred gradually: “Little by little, they loosen the reins as we are more independent.” When engaged in projects, teachers and students learned reciprocally as these projects are often personalized to match the interests of individual students. Rather than relying on the teacher or curricular materials for knowledge they needed for their projects, students were taught skills to support their production of knowledge independent of teachers. Teachers in post-observation interviews talked about their interactions with students in similar ways, and noted, for example, that their role included teaching these skills: “Here it’s more about having the life skills and figuring out how to get information and utilizing resources that are new.” The teachers acknowledged acting more like learning coaches, suggesting ideas and directions to consider in order to help each learner to meet the objectives for the project. The teachers readily acknowledge that students know more than they do about some things, and that their students often amazed them with the depth of knowledge displayed in the projects they developed in class.

With this type of learning approach, the boundaries between teachers and students blurred. Their interactions took on more of a tone of collaboration between peers such as might be seen in a knowledge-based work environment. Besides the different relationship around knowledge, this was manifested at GJJ-HTH in the way students called teachers by their first names, and by the way teachers took interest in their students personally. Students appreciated this aspect of their relationship with teachers at GJJ-HTH based on comments made by students in focus groups, for example, “Everyone [teachers] is interested in me personally--how I am doing in class and what my grades are. The one thing that I noticed is that the teachers truly care.” This sense that teachers care would, in turn, support a learning environment in which students were expected to reach out to teachers for help on projects that the students were independently exploring. The school administration was similarly supportive of personalization of learning opportunities. For example, the director emphasized that there was a deliberate effort to limit administrative barriers that might discourage student initiatives and collaborate with teachers and students to acquire resources necessary for both teacher and student initiatives, such as materials needed for projects.

3.11.2.2 Adult World Connection

There were two elements of adult world connections that were italicized because they go beyond simple participation in the world of work through internships, community service, or field trips, which were captured in the section on Informal Learning. The first is the workplace level of expectations for learning products: “Students routinely create work for authentic audiences and exhibit that work in professional venues.”

This element was implemented at GJJ-HTH through teacher expectations for learning products, specifically rubric elements that went beyond typical content or quality expectations to include consideration of non-academic expectations that might be encountered in the workplace. One teacher described a particularly humorous example:
’I’m having my students do a project right now, and one of the rubric points is that it has to be visually appealing, and we were kind of joking about how that’s subjective. [But] in the real world, with your boss and a project, if the boss says they want it red, then it has to be. We’re modeling that subjective requirement.

Presentation of workplace-quality projects to peers, teachers, and adults from the community were common requirements for GJJ-HTH students. Experiences meeting workplace expectations also extended to learning products students created that would potentially be used in a workplace setting. For example, GJJ-HTH students created learning products for collaboration with the RH Fleet museum, and students were expected to meet museum exhibit criteria, as explained by a museum representative:

[The student-created exhibits] are going to be showcased and it’s going to be out there in a real world setting. One of the things that we emphasize is that what we are trying to teach you here is that its real world stuff. If I am telling you, you need to change that type font because it’s unreadable, that is something you are going to hear when you are doing design out in the real world.

The second element highlighted in this design principle relates to the physical learning environment: The GJJ-HTH facilities themselves had a distinctive workplace feel, with windowed seminar rooms, small-group learning and project areas, laboratories equipped with the latest technology, ubiquitous wireless laptop access, and common areas where artwork and prototypes were displayed. Although described in the Context section, it deserves mention that immersing students in an environment mimicking a high tech work environment designed for collaborative work efforts, knowledge production, and presentation of work products might certainly enhance a school culture focused on student production of knowledge and collaboration with teachers as well as peers as fellow members of a learning community. As noted by the school director, respect was the foundation for such a school culture, and he attributed the positive interactions between students to respect: there was no bullying, theft, or unwillingness to work with students because they were different. Again, holding students to workplace interaction standards and immersing them in a physical environment mimicking a workplace setting may have contributed to a higher level of maturity and professionalism in their peer relationships.

3.11.2.3 Common Intellectual Mission
Most elements of the common intellectual mission design principle have been discussed in the sections on Mission (inclusiveness, with all students taking the same college preparatory curriculum and completing internships) and Instructional Strategies (performance-based assessment practices, senior projects, digital portfolios, and differentiation). But there was one element that went beyond those aspects: Schools articulate common expectations for learning that value 21st century skills, the integration of hands and minds, and the merging of academic disciplines.

The merging of academic disciplines was discussed in the Curriculum and Instructional Strategies sections: GJJ-HTH employed integrated courses, except in mathematics. It was the teachers who collaborated to create and team-teach these double period classes and they were respected by the administration for their professionalism and encouraged to teach to their strengths and interests, just as students were encouraged to explore topics of interest to them
personally and to reach out to others, peers or teachers, with strengths in particular areas when they experienced challenges.

What has not been previously discussed in the sections on Curriculum and Instructional Strategies are the expectations for learning that value 21st Century skills and the integration of hands and minds.

The Partnership for 21st Century Skills (2009) published recommendations for a learning environment to support development of 21st Century Skills, shown below:

- Create learning practices, human support and physical environments that will support the teaching and learning of 21st century skill outcomes
- Support professional learning communities that enable educators to collaborate, share best practices and integrate 21st century skills into classroom practice
- Enable students to learn in relevant, real world 21st century contexts (e.g., through project-based or other applied work)
- Allow equitable access to quality learning tools, technologies and resources
- Provide 21st century architectural and interior designs for group, team and individual learning
- Support expanded community and international involvement in learning, both face-to-face and online

GJJ-HTH created learning practices that supported the teaching and learning of 21st Century skill outcomes that went beyond mastery of core coursework. As noted in the P21 website publication (2009), “Learning and innovation skills increasingly are being recognized as those that separate students who are prepared for a more and more complex life and work environments in the 21st century, and those who are not. A focus on creativity, critical thinking, communication and collaboration is essential to prepare students for the future.” Through project-based learning combining opportunities for students to be individually creative on individual projects and to work collaboratively with their peers on group projects, GJJ-HTH was preparing their students for work in the 21st Century. Additionally, communication and critical thinking were stressed at GJJ-HTH: students were required to formally communicate what they learned and use critical thinking skills to meet challenges that arose in their projects and reach out to knowledgeable others, whether peers or teachers, for help. A further discussion of 21st Century Skills at this ISHS is beyond the scope of this study.

3.11.2.4 Teacher as Designer

In this last section on the connections between design elements and school culture, the focus is on teacher roles extending beyond curriculum and instruction, which were already discussed in detail in the sections on Curriculum, Instructional Strategies, and Teaching Staff. The focus is on the element not incorporated into any of the critical components: They take the lead in staff meetings and action groups addressing school issues. They participate in critical decisions regarding curriculum, assessment, professional development, hiring and other significant areas of the school.

There was some discussion in the section on Administrative Structure that alluded to a flattened hierarchical structure in this relatively small school (about 600 students) with a correspondingly small administrative staff. Teachers, as well, as students participated in the teacher hiring process
and decision making, for example. Additionally, teachers were given significant decision-making authority related to curriculum and assessment, as already described in the sections on Curriculum, Instructional Strategies, and Teaching Staff. They accomplished this work without oversight by administrators, arranging their own collaborations and working groups. The administration respected their professionalism and actually focused on a role of supporting their teachers and students through a minimization of what the director called “administrivia,” probably referring to cumbersome procedures and paperwork. This stood out as a unique feature of GJJ-HTH—the flattened hierarchical structure with an administration focused on supporting teacher and student initiatives, with students and teachers positioned as experts in their learning and teaching.

3.11.3 Summary

GJJ-HTH, and indeed all HTH schools, was designed by a visionary leader, Larry Rosenstock, to support a learning environment based on four design principles: personalization, adult world connections, common intellectual mission, and teacher as designer. Students and teachers were positioned as professionals and experts in their own learning and teaching in a flattened hierarchical structure, in which the administrators’ roles were to support them as they exercised considerable autonomy in curriculum and assessment decisions, in the case of teachers; and in choice of project topics and internships, in the case of students. The expectations were that students would be producers of knowledge and workplace quality learning products; and that teachers would support them more as coaches and mentors than deliverers of knowledge.

To further support Rosenstock’s vision of a learning environment focused on production of knowledge rather than consumption, the school culture resembled that of a knowledge-based workplace, and students had a plethora of opportunities in a project-based learning environment to develop 21st Century skills, such as communication, collaboration, and critical thinking. The design of the school building and the workplace quality of facilities and technology contributed further to the workplace feeling. GJJ-HTH met many of the recommendations for a learning environment to support 21st Century Skills (2009) including, besides project-based learning and a professional learning community in which teachers collaborated as curriculum designers, “equitable access to quality learning tools, technologies and resources” and “21st century architectural and interior designs for group, team and individual learning.” Taken together, these features of GJJ-HTH supported a school culture based on workplace expectations for producing knowledge and creating work products of professional quality. Just as in a modern knowledge-based work environment, students collaborated with peers and teachers on projects and presented work products to members of the learning community and members of the community.

4. OUTCOMES

Having explored the design and implementation dimensions in the above sections, the study now examines the student outcomes produced at GJJ-HTH. There is overall agreement that ISHSSs should improve underrepresented students’ preparation in STEM in ways that inspire and provide requisite background knowledge and skills, instilling confidence and desire to seek more STEM education, jobs, and careers (Means et al., 2008; NRC, 2004). To capture this student outcome information for GJJ-HTH, OSPrI compiled 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 GJJ-HTH.

4.1 ASSESSMENT SCORES: HOW ARE GJJ-HTH STUDENTS PROGRESSING AND ACHIEVING ACADEMICALLY?

GJJ-HTH focuses on student outcome data that they feel is most relevant to the lives of their students. In particular, GJJ-HTH’s prioritization of college acceptance, persistence, and completion rates for their graduates leads them to hone in on outcomes such as SAT and ACT scores, much more so than with the state-mandated standardized test scores used for school-level accountability. This view of student outcome data aligns well with GJJ-HTH’s overall educational philosophy of teaching the whole student, as opposed to teaching to the tests that are required by the No Child Left Behind Act. GJJ-HTH is nevertheless keenly aware of these California assessments that their students are required to take each year, due to the role such test scores play in the operational side of school accountability.

4.1.1 California Standards Tests

The California Department of Education website details the history behind the state assessments administered to all students in California (see http://star.cde.ca.gov/). The overarching California Standardized Testing and Reporting (STAR) Program was originally authorized by the California governor in October 1997, and throughout its history, 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 encompassed four components: 1) the CSTs, 2) the California Modified Assessment, for eligible students with Individualized Education Programs (IEP), 3) the California Alternate Performance Assessment, for students with significant cognitive disabilities, and 4) the Standards-based Tests in Spanish, for eligible Spanish-speaking English learners. The CSTs were accordingly a major component of California's accountability system for schools and school districts, used for calculating each school’s Academic Performance Index. As California’s Department of Education website 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 9 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 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. GJJ-HTH students did
not take courses that corresponded with every EOC subject listed in the table; those assessments that were administered to GJJ-HTH students are presented in boldface, with results that will be examined in subsequent tables and figures.

Table 9

2012-2013 California Standards Tests

<table>
<thead>
<tr>
<th>English-Language Arts</th>
<th>Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All students in grades 2 through 11</strong></td>
<td>Students in grades 8 through 11, for the below subjects:</td>
</tr>
<tr>
<td></td>
<td>• General Mathematics (grades 8 and 9 only)</td>
</tr>
<tr>
<td></td>
<td>• Algebra I</td>
</tr>
<tr>
<td></td>
<td>• Geometry</td>
</tr>
<tr>
<td></td>
<td>• Algebra II</td>
</tr>
<tr>
<td></td>
<td>• Integrated Mathematics 1</td>
</tr>
<tr>
<td></td>
<td>• Integrated Mathematics 2</td>
</tr>
<tr>
<td></td>
<td>• Integrated Mathematics 3</td>
</tr>
<tr>
<td></td>
<td>• Summative High School Mathematics (grades 9 through 11 only)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Science</th>
<th>History-Social Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>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:</td>
<td>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:</td>
</tr>
<tr>
<td>• Biology</td>
<td>• World History</td>
</tr>
<tr>
<td>• Chemistry</td>
<td></td>
</tr>
<tr>
<td>• Earth Science</td>
<td></td>
</tr>
<tr>
<td>• Physics</td>
<td></td>
</tr>
<tr>
<td>• Integrated/Coordinated Science 1</td>
<td></td>
</tr>
<tr>
<td>• Integrated/Coordinated Science 2</td>
<td></td>
</tr>
<tr>
<td>• Integrated/Coordinated Science 3</td>
<td></td>
</tr>
<tr>
<td>• Integrated/Coordinated Science 4</td>
<td></td>
</tr>
<tr>
<td>• 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</td>
<td></td>
</tr>
</tbody>
</table>

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

As defined on the Department of Education website (http://star.cde.ca.gov/star2013/help_scoreexplanations.aspx), California uses five performance levels to report student achievement on the CSTs:

**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.
Basic: This level represents a limited performance. Students demonstrate a partial and rudimentary understanding of the knowledge and skills measured by this assessment, at this grade, in this content area.

Far below /Below basic: This level represents a serious lack of performance. Students demonstrate little or a flawed understanding of the knowledge and skills measured by this assessment, at this grade, in this content area.

Figures 9, 10, and 11 present the percentages of HTH students that have achieved at or above the “Proficient” level on the CSTs, broken out into the Science, Mathematics, and Humanities disciplines. Data was not available on GJJ-HTH students specifically. Additionally, these figures compare HTH’s results to the outcomes from the surrounding district, county, and state. HTH’s outcomes were mixed across the subjects, at times outperforming the district, county, and state on the particular assessments, and at other times not doing so. This is likely a reflection of HTH’s overall educational philosophy of not focusing on these state-mandated assessments or “teaching to the tests,” an instructional strategy that may be more prevalent across the other public schools in the surrounding area.

Figure 9

Spring 2013 Science CST (California Standards Tests) Results for HTH, District, County, and State (Percent at Proficient or Advanced, for all grades tested)


Figure 10

Spring 2013 Science CST (California Standards Tests) Results for HTH, District, County, and State (Percent Advanced only, for all grades tested)

Figure 11

Spring 2013 Mathematics CST (California Standards Tests) Results for GJJ-HTH, District, County, and State (Percent at Proficient or Advanced, for all grades tested)


Additionally, some may argue that “academic excellence” reflects more than achieving at “proficient” levels, instead defining such excellence as performing at a “superior” level, as described by the California Department of Education. Figures 12, 13, and 14 address this distinction, presenting the percentages of students achieving at the “Advanced” level on the CSTs across the disciplines. As before, HTH’s results were mixed, again perhaps a reflection of the school’s relative under-prioritization of these state assessments as student outcomes.

Figure 12
Spring 2013 Mathematics CST (California Standards Tests) Results for GJJ-HTH, District, County, and State (Percent Advanced only, for all grades tested)


Figure 13

Spring 2013 Humanities CST (California Standards Tests) Results for GJJ-HTH, District, County, and State (Percent at Proficient or Advanced, for all grades tested)


Figure 14

Spring 2013 Humanities CST (California Standards Tests) Results for GJJ-HTH, District, County, and State (Percent Advanced only, for all grades tested)
4.1.2 SAT and ACT Outcomes

Rather than focusing on these state-mandated assessments which are mostly tied to school-level accountability, GJJ-HTH instead placed greater importance in their students’ SAT and ACT performance. Because the SAT and ACT serve as gatekeepers for 4-year college acceptance and entrance, GJJ-HTHN encouraged all of their students to prepare for and take these assessments. Their students outperformed the surrounding district, county, and state on the SAT and ACT, as detailed in Table 10 for the most recent available data from the 2011-2012 school year. These results provide an informative counterpoint to the CST results presented previously and again likely reflect the instructional philosophy of GJJ-HTH.

Table 10

2011-2012 SAT and ACT Outcomes, for GJJ-HTH, District, County, and State

<table>
<thead>
<tr>
<th></th>
<th>GJJ-HTH</th>
<th>San Diego District</th>
<th>San Diego County</th>
<th>California</th>
</tr>
</thead>
<tbody>
<tr>
<td># Students taking SAT</td>
<td>124</td>
<td>4,833</td>
<td>16,985</td>
<td>194,191</td>
</tr>
<tr>
<td>SAT Critical Reading Average</td>
<td>519</td>
<td>480</td>
<td>503</td>
<td>491</td>
</tr>
<tr>
<td>SAT Math Average</td>
<td>541</td>
<td>495</td>
<td>519</td>
<td>510</td>
</tr>
<tr>
<td>SAT Writing Average</td>
<td>513</td>
<td>475</td>
<td>499</td>
<td>491</td>
</tr>
<tr>
<td>% Scoring Higher than 1,500 Total</td>
<td>61.3%</td>
<td>42.8%</td>
<td>51.1%</td>
<td>46.7%</td>
</tr>
<tr>
<td># Students taking ACT</td>
<td>43</td>
<td>1,869</td>
<td>8,027</td>
<td>87,016</td>
</tr>
<tr>
<td>ACT Average Score</td>
<td>22.6</td>
<td>21.6</td>
<td>22.7</td>
<td>21.8</td>
</tr>
<tr>
<td>% Scoring Higher than 21 Total</td>
<td>69.8%</td>
<td>57.0%</td>
<td>65.0%</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) on August 13, 2013.
4.2 LONGER-TERM OUTCOMES: COHORT GRADUATION RATES AND POSTSECONDARY OUTCOMES

With their prioritization of graduation and postsecondary outcomes as the most relevant outcomes for the lives of their students, GJJ-HTH has shown high levels of success around high school graduation and college acceptance rates. Table 11 compares GJJ-HTH’s 4-year high school graduation rate with those rates of the district, county, and state. Both for their students overall and for particular student groups that are traditionally under-represented in college and STEM fields beyond college, GJJ-HTH has posted significantly higher high school graduation rates across the board.

Table 11

4-Year Adjusted Cohort High School Graduation Rate for Class of 2011-2012, for GJJ-HTH, District, County, and State

<table>
<thead>
<tr>
<th></th>
<th>GJJ-HTH</th>
<th>San Diego District</th>
<th>San Diego County</th>
<th>California</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Total Cohort Graduation Rate</td>
<td>128</td>
<td>96.2%</td>
<td>6,443</td>
<td>86.9%</td>
</tr>
<tr>
<td>Females</td>
<td>67</td>
<td>95.7%</td>
<td>3,307</td>
<td>90.0%</td>
</tr>
<tr>
<td>Males</td>
<td>61</td>
<td>96.8%</td>
<td>3,136</td>
<td>83.8%</td>
</tr>
<tr>
<td>Hispanic or Latino of Any Race</td>
<td>38</td>
<td>97.4%</td>
<td>2,453</td>
<td>80.2%</td>
</tr>
<tr>
<td>American Indian or Alaska Native</td>
<td>&lt;10</td>
<td>100%</td>
<td>29</td>
<td>100%</td>
</tr>
<tr>
<td>Asian</td>
<td>11</td>
<td>100%</td>
<td>654</td>
<td>92.1%</td>
</tr>
<tr>
<td>Pacific Islander</td>
<td>n/a</td>
<td>n/a</td>
<td>55</td>
<td>85.9%</td>
</tr>
<tr>
<td>Filipino</td>
<td>&lt;10</td>
<td>100%</td>
<td>580</td>
<td>94.6%</td>
</tr>
<tr>
<td>African American</td>
<td>&lt;10</td>
<td>100%</td>
<td>750</td>
<td>83.9%</td>
</tr>
<tr>
<td>White</td>
<td>62</td>
<td>93.9%</td>
<td>1,757</td>
<td>93.8%</td>
</tr>
<tr>
<td>Two or More Races</td>
<td>n/a</td>
<td>n/a</td>
<td>165</td>
<td>94.3%</td>
</tr>
<tr>
<td>Not Reported</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>English Learners</td>
<td>&lt;10</td>
<td>100%</td>
<td>786</td>
<td>63.9%</td>
</tr>
<tr>
<td>Special Education Students</td>
<td>13</td>
<td>92.9%</td>
<td>510</td>
<td>54.3%</td>
</tr>
<tr>
<td>Socioeconomically Disadvantaged</td>
<td>50</td>
<td>98%</td>
<td>4,144</td>
<td>82.5%</td>
</tr>
</tbody>
</table>


GJJ-HTH also devoted many resources to tracking and using postsecondary-related outcome data to guide and improve the services provided to their students. Table 12 demonstrates the highly detailed level of data that the school collected for its graduating classes. The postsecondary outcomes reflected in the table also appear to represent high levels of success for GJJ-HTH students around college enrollment. By way of comparison, according to the most recent data published by the National Center for Education Statistics, for the class of 2011, 68.2% of “recent high school completers” were enrolled in college, with 25.9% in 2-year institutions and 42.3% enrolled in 4-year institutions (http://nces.ed.gov/).

Table 12

Postsecondary Outcomes for GJJ-HTH, for 2012 and 2013 Graduating Classes

<table>
<thead>
<tr>
<th></th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>% of Class</td>
</tr>
<tr>
<td>English Learners</td>
<td>&lt;10</td>
<td>100%</td>
</tr>
<tr>
<td>Special Education Students</td>
<td>13</td>
<td>92.9%</td>
</tr>
<tr>
<td>Socioeconomically Disadvantaged</td>
<td>50</td>
<td>98%</td>
</tr>
</tbody>
</table>

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### Students Attending College/University in Fall

<table>
<thead>
<tr>
<th>Category</th>
<th>Attending University of California Campus</th>
<th>Attending California State Campus</th>
<th>Attending Private California College/University</th>
<th>Attending Out-of-State College/University</th>
<th>Attending College/University with a 25% Admit Rate or Lower (“Highly Selective”)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students Applying to At Least One 4-year College/University</td>
<td>121 (96%)</td>
<td>118 (92%)</td>
<td>122 (95%)</td>
<td>105 (82%)</td>
<td>118 (95%)</td>
</tr>
<tr>
<td>Students Who Took SAT/ACT 4-year College/University</td>
<td>126 (100%)</td>
<td>122 (95%)</td>
<td>122 (95%)</td>
<td>105 (82%)</td>
<td>118 (95%)</td>
</tr>
<tr>
<td>Students Accepted to At Least One 4-year College/University</td>
<td>120 (95%)</td>
<td>105 (82%)</td>
<td>105 (82%)</td>
<td>82 (65%)</td>
<td>105 (82%)</td>
</tr>
<tr>
<td>Students Attending: 4-year College/University</td>
<td>99 (79%)</td>
<td>93 (76%)</td>
<td>93 (76%)</td>
<td>73 (57%)</td>
<td>93 (76%)</td>
</tr>
<tr>
<td>Students Attending: 2-year College</td>
<td>26 (21%)</td>
<td>35 (27%)</td>
<td>35 (27%)</td>
<td>27 (20%)</td>
<td>35 (27%)</td>
</tr>
<tr>
<td># of First Generation College Bound Students</td>
<td>35 (28%)</td>
<td>46 (36%)</td>
<td>46 (36%)</td>
<td>36 (27%)</td>
<td>46 (36%)</td>
</tr>
</tbody>
</table>

Note: Data obtained from GJJ-HTH on August 14, 2013.

Additionally, as described by HTH network administrators, the network, had partnered since 2008 with the National Student Clearinghouse to examine the college persistence and completion rates for its high school graduates. No data was available specifically for GJJ-HTH graduates, however. As of January 2011, 77% of the 1,854 alumni from the five HTH network high schools were still enrolled or had graduated from a postsecondary institution, with 25% of the college graduates earning degrees in STEM fields. By way of comparison, in 2011, 389% of California’s 20 million working-age adults (25-64 years old) held a two or four year college degree, according to 2011 Census data (http://www.luminafoundation), on par with the national average of 39%. Additionally, according to the National Center for Educational Statistics, in 2011, only 15.6% of all Bachelor’s Degrees in the United States were conferred in the STEM fields of Biological/Biomedical Sciences, Computer and Information Sciences, Engineering and Engineering Technologies, Mathematics and Statistics, and Physical Sciences and Science Technologies (http://nces.ed.gov). Thus HTH graduates earning a degree in these STEM majors exceeded the national average.

The Clearing House data for the HTH network also showed that 69% of their first-generation college-going students and 67% of their students who qualified for the National School Lunch Program had graduated college or were still enrolled. While not a direct comparison, an analysis of nationwide data conducted by the Higher Education Research Institute at UCLA showed that in 2004, only 50.2% of first-generation students completed their degrees within six years.
Similarly, only 8.3% of students from low-income families earned a bachelor’s degree by their mid-20s.

4.3 SUMMARY

Publically available data for the 2011-12 school year showed that the Gary and Jerri-Ann Jacobs High Tech High School graduated 96% of its seniors (N=128), with no significant difference between male and female graduation rates. The graduation rates for students from groups under-represented in STEM college majors and careers were high, as well: 97.4% of Hispanic/Latino students (N=38) and 100% for African American seniors (N<10). There were fewer than 10 English learners in the graduation class and all graduated. Of the 50 graduating seniors classified as socioeconomically disadvantaged, the graduation rate was 98%. More significant were the college acceptance and attendance rates. Data provided by the school director indicated that 95% of their students graduating in 2012, and 100% of their students graduating in 2013, were college-bound. College-bound seniors included 35 students in 2011 and 46 students in 2012 who would be the first in their families to go to college. Over 70% of college-bound students were going to four-year institutions of higher learning, and this included 61 graduates from 2012 and 55 graduates from 2013 attending a University of California or California State University institution.

Achievement tests were less of a priority at GJJ-HTH than the tests associated with college admissions, the SAT or ACT. Because the SAT and ACT serve as gatekeepers for four-year college acceptance and entrance, GJJ-HTH encouraged all of their students to prepare for and take the SAT. For the class of 2012, all but four students had taken the SAT, and 61% scored over 1500 on the SAT. This was a higher percentage than the San Diego School District (43%), San Diego County (51%), and the state of California (47%).

Thus, student outcome data supports a conclusion that GJJ-HTH was highly successful in achieving its mission to inspire their students to go to college and provide them a college preparatory program that would enhance their competitiveness for college admission and prepare them for college-level rigor.

5. CONCLUSION

Of the ten components examined a priori in this study, many were prominently featured at GJJ-HTH. Early college-level coursework was the only component that was not present, but students could prepare for AP exams by taking on extra work in a particular course through an honors designation. GJJ-HTH was characterized by a strong commitment to reform teaching practices, real-world STEM partnerships, a well-prepared and effective teaching staff, and blended formal/informal learning. These components were supported by innovative, integrated technology and a well-designed and supported administrative structure.

The most salient features of GJJ-HTH as identified by our analysis include:
1. Blended informal learning beyond the school walls
2. Partnerships with industry
3. Well-prepared and supported teachers  
4. Reform teaching practices  
5. Innovative technology use

GJJ-HTH was driven by the singular vision of its founder that students be producers of knowledge and prepared for the world of work. The school immersed their students in a learning environment with work-place expectations supported by a unique school culture. Just as in a modern knowledge-based work environment, students collaborated with peers and teachers on projects and presented work products to members of the learning community and members of the community. The learning environment, therefore, created and sustained a flattening of the hierarchy of knowledge since students producing knowledge potentially knew more than their teachers about particular topics they chose to explore in depth. GJJ-HTH was a STEM-focused school that stressed integrating subject content and a project-based learning approach that supported students in developing 21st Century skills. In fact, GJJ-HTH met many of the recommendations of the Partnership for 21st Century Skills (2009) for a learning environment supportive of development of these skills, as briefly discussed in the section on the school vision and culture. The school’s design was a direct result of this vision, operationalized through a set of design principles: personalization, adult world of work connections, common intellectual mission, and teacher as designer. GJJ-HTH was strategic about building a team that would embrace and faithfully enact these design principles, and the teaching staff was given autonomy, support, and resources to do so.

GJJ-HTH student outcomes suggested that the school model worked very well in the context of the high-tech San Diego metropolitan area, particularly when recognizing that GJJ-HTH, as an inclusive STEM-focused school, embraced students from diverse backgrounds without regard to prior academic achievement, and required all their students to complete a rigorous college preparatory curriculum including four years of college preparatory mathematics and science, two more years each than the state requirements. Graduation, college acceptance, and college attendance rates were all above 95%, clearly evidencing the strength of the school model to achieve its mission of inspiring and preparing all of their students for post-secondary education.

6. REFERENCES


President’s Council of Advisors on Science and Technology (PCAST). (2010). *Prepare and inspire: K-12 education in science, technology, engineering, and math (stem) for America’s future.* Washington, DC: Author.
