Metro Early College High School
A Case Study of an Inclusive STEM-Focused High School in Columbus, Ohio

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1. INTRODUCTION

The recent wave of education reform publications on the state of science, technology, engineering, and mathematics (STEM) education signals an increased national attention on the field. In the last five years alone, prominent organizations including the National Research Council of the National Academies (NRC, 2011, 2012), the President’s Council of Advisors on Science and Technology (PCAST, 2010), and the National Academy of Education (NAEd, 2009) have released major policy reports and white papers on STEM education. Together, these reports encourage a curriculum that prioritizes depth of coverage rather than breadth and fosters development of scientific skills and habits of mind. They also encourage student-centered instructional strategies that provide opportunities for students to engage with STEM in their classrooms in ways that “connect with their own interests and experiences” (NRC, 2012, p. 28).

One notable recommendation of the PCAST report is to create and expand opportunities for students to learn STEM content through innovative STEM-focused schools (PCAST, 2010, p. 107). These schools go beyond merely providing more instruction on advanced STEM content and practices. They also provide a means of experimenting with innovative approaches to STEM education, such as student exploration of STEM content in real-world contexts and fostering more interdisciplinary connections, including between STEM and non-STEM subject areas. This paper describes one of a new breed of inclusive STEM-focused high schools (ISHSs). These schools have a mission to foster increased engagement and interest in STEM fields among student groups traditionally underrepresented in STEM, including African American and Hispanic students and students who would be the first in their families to go to college (p. 111). These schools are termed inclusive because they do not limit enrollment to students who are gifted in STEM or high academic achievers. On the contrary, they aim to extend access to college preparatory STEM learning opportunities to students from subpopulations historically underrepresented in STEM college majors and careers.

Through a grant from the National Science Foundation (NSF), this study, *Multiple Instrumental Case Studies of Inclusive STEM-Focused High Schools: Opportunity Structures for Preparation and Inspiration* (OSPrI), focuses on exploring the characteristics of a set of successful inclusive STEM-focused high schools in the United States, and developing a theory of action for scaling up successful models. This case, Metro Early College High School (Metro), is the sixth in a set of case studies that describe the design and implementation of opportunity structures and practices at the school level that contribute to student success, as measured by a variety of outcomes including not only STEM learning but also graduation and college-going rates. Since it graduated its first class in the 2009-2010 school year, Metro has displayed a track record of strong student outcomes for all of its students, including a 100% high school graduation rate. It is accordingly an informative case study of a successful ISHS that cohesively aligns its classroom instructional practices with the rigor of college preparatory STEM coursework and extensive school-level reform initiatives.

1.1. FRAMING THE STUDY

This case study of Metro Early College High School (Metro) asks:
1. Is there evidence of each of the candidate critical components\(^1\) (listed in Table 2 and discussed later in this section) in the design of Metro, the school that is the focus of this case study?

2. How are the critical components implemented at Metro? Do other components emerge from the data collected on-site that are critical to the school’s character and success?

3. What are the contextual affordances and constraints that influence Metro’s design, implementation, and student outcomes?

4. How do Metro’s student STEM outcomes compare with those of the school district and state (e.g., STEM achievement measures, graduation rates, college acceptance rates)?

### 1.1.1. Selection of Metro Early College 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 based on their innovative models. By exemplar, we mean that the school had 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. Additionally, the school needed to be well established within the school district or state, with a foundation of thoughtful planning and community support. By inclusive, we mean that the school admitted a range of students; the school’s admissions criteria did not limit applicants to students who demonstrated that they were gifted and talented in STEM or high academic achievers. By STEM-focused, we mean that the school had graduation requirements that included more, or more rigorous, science and mathematics coursework than district and state requirements, or that its science, technology, engineering, and mathematics learning were more integrated, with an emphasis on interdisciplinary connections. We were primarily interested in STEM-focused high schools that required all of their students to complete college preparatory courses including at least four years of mathematics culminating with 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 engineering and technology courses.

Each school, with its own unique context, governing structure, and academic organization that were likely to have broad effects on its implementation and outcomes, was chosen as a critical case (Yin, 2009). Our selection process combined an expert nomination process followed by pre-selection screening of the school’s inclusiveness, STEM focus, and STEM-related student outcomes to ensure that it met our criteria as an exemplar ISHS. The nomination process, begun early in the study, involved 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 they thought represented particularly good examples.

Metro was recommended by education experts in the field. For the 2012-2013 year, Metro served approximately 400 students in grades 9 to 12. According to the Ohio School Report Card framework for that academic year, Metro earned “A” grades for the “Achievement” and “Gap Closing” components, indicating that Metro had high percentages of students achieving at the Advanced, Accelerated, or Proficient levels and met all of the Ohio indicators for percentages of

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\(^1\) Herein after, we simply refer to these as critical components with the understanding that they are theorized to be critical to a successful ISHS model.
students passing the Ohio Graduation Tests (OGT). Additionally, each student group when disaggregated according to “income, race, culture, or disability” attained over the required 80% passing rate (http://reportcard.education.ohio.gov). The Student Outcomes portion of this case study synthesizes and discusses the comprehensive set of outcome data for Metro. After verifying through examination of the school website and publicly available data that the school met our selection criteria of exemplary outcomes, inclusive admissions, and STEM-focus, we approached the school leader with a summary of our intended study. The school leader at Metro, Aimee Kennedy, indicated interest and approved Metro as the focus of this case study.

A Research Framework document detailing the OSPrI study research design and methods is available on the OSPrI website (http://ospri.research.gwu.edu). This document includes the conceptual framework and rationale for the ten critical components.
I read somewhere that students rise to their level of epiphany. When you have a school like this, your epiphany level rises up.
– Metro Parent

Metro Early College High School (Metro) was located on the western half of The Ohio State University’s (OSU) campus in Columbus, Ohio, about a half-mile away from the Olentangy River and sitting on the corner of Kenny Road and Kinnear Road. Various OSU administrative buildings dotted the surrounding neighborhood, and Jesse Owens West Park was nearby, to the north of Metro. The physical school building for Metro was a rectangular, one-story orange brick structure with large office-style windows. A red and gray OSU campus sign stood outside the main entrance to the school, labeling this building 943 as “Metro High School.” An ample parking lot surrounding the building served to direct the traffic flow for the vehicles dropping off and picking up students.

The first thing we saw upon entering the foyer of the building was a large sign composed of sixteen aluminum panels linked together and hanging on the front facing wall. Three quotations were prominently displayed, surrounding Metro’s blue and white logo, the large triangular “Play” symbol seen universally on modern electronic devices. The quotations emphasized values held by the school:

*There is no design without discipline. There is no discipline without intelligence.*
– Massimo Vignelli, Designer

*I define creativity as the process of having original ideas that have value.*
– Sir Ken Robinson, Author

*Just as energy is the basis of life itself, and ideas the source of innovation, so is innovation the vital spark of all human change, improvement and progress.*
– Ted Levitt, Economist
Our research team received a tour of the school led by three Metro students. Although on first glance the interior resembled an office building, with fluorescent lights, white walls, and patterned carpeting, it quickly became evident that this was a building that had been adapted and re-designed to foster a culture of community, openness, and academic collaboration. The wide hallways were decorated with products from the last school-wide Design Challenge, a cross-disciplinary project where teams of students across all four grades explored sustainable farming and living in the local region. These projects incorporated a visual arts component, and the student work products represented regional sustainability results and data through visually appealing displays. Examples of student work from this year’s 3D Art course were also on display in the hallways and open spaces. As shown in the two photos below, these areas were furnished with large, mobile circular tables and benches that had built-in cubbies for backpacks and jackets. The student tour leaders explained that there was a trust system in place at Metro, with no lockers present in the building. Students instead left their belongings in open areas, with no concerns around thefts or loss.

There were two open classrooms, called Commons East and Commons West, located in two corners of the school building. These rooms, along with the rest of the more traditional, four-walled classrooms at Metro, were equipped with projectors and Smartboards, student desks and bookcases. As we walked through the building, classes were going on normally, audible to us in the hallways. There was a resulting overall combined sense in the building of productive academic activity, appreciation for the visual arts, and a trust and openness among the students.

2.1. CONTEXT FOR THE METRO CASE STUDY

This section describes the unique context and governing structure of Metro and the history of the school’s founding with community support.

2.1.1. School District and Locale
Metro Early College High School (Metro) is a public high school located in Columbus, Ohio. Columbus is the capital of and largest city in the state of Ohio, with a population of approximately 800,000, making it the 15th largest city in the United States according to the 2010 US Census. The Ohio State University (OSU) occupies a central location within the city of Columbus, with a campus of 1,765 acres that is bisected by the Olentangy River.
OSPrI’s six-person research team visited Metro in March 2013 and spent four days onsite. At the time of the visit, the Chief Academic Officer (CAO) and Principal of Metro was Aimee Kennedy. Until July 2012, students who attended Metro remained affiliated with their home district. One consequence of this was that prior to 2013, the data and outcomes for Metro’s students were not officially aggregated and reported on the Ohio Department of Education (ODE) website; those data remained connected to each student’s respective school district for accountability purposes. Beginning with the 2012-2013 school year (the year of our site visit), Metro was designated as a “stand-alone regional STEM school” under Ohio code and as its own district in Ohio. As a result, Metro became the official affiliation for its students, and Metro’s data and outcomes were reported on the ODE site as part of Ohio’s accountability framework. After this shift to becoming its own stand-alone district in Ohio, Ms. Kennedy reported directly to Metro’s newly created Governing Board. This CAO role thus combined a superintendent role with the Metro principal role. More details about the school administration are included in the Administrative Structure (CC 9) section of this case study.

2.1.2. School History and Design
Metro opened in the fall of 2006 with a 9th grade class, and the school added a grade each successive year, graduating its first class of seniors at the end of the 2009-2010 school year. Metro was the product of a partnership between OSU and Battelle Memorial Institute (Battelle), a non-profit research and development corporation headquartered in Columbus, Ohio and described on their website as a “global science and technology enterprise that explores emerging areas of science” (http://www.batelle.org). Significant seed funding for the opening of Metro came from OSU, Battelle, and the Coalition of Essential Schools (CES). CES, an organization founded in 1984 by Theodore Sizer, an influential leader of education reform in the United States, supports a network of school, organizations, and individuals who are committed to a vision of “an educational system that equips all students with the intellectual, emotional, and social habits and skills to become powerful and informed citizens who contribute actively toward a democratic and equitable society” (http://www.essentialschools.org/). This support includes professional development in the core principles of CES, community building, and advocacy work.

In addition to support from Battelle, OSU, and CES, Metro was awarded an Early College Grant from the Bill & Melinda Gates Foundation to support operations and education outreach in STEM. The KnowledgeWorks Foundation served as an intermediary for these funds and also was a thought partner with Metro as part of their work in providing professional development services and “strategic assistance, coaching and other valuable services directly to school and community leaders across the country” (http://knowledgeworks.org).

Metro was also a member of the Early College High School (ECHS) Initiative, a network of over 240 schools in 28 states and Washington, D.C., coordinated by Jobs For The Future, an organization that works “to design and drive the adoption of education and career pathways leading from college readiness to career advancement for those struggling to succeed in today’s economy” (http://www.jff.org). Through rigorous yet supportive integrated academic programs, schools participating in the ECHS initiative sought to compress the time required to complete high school and offered early opportunities to enroll in selected college-level courses. Metro’s partnership with OSU and their location on OSU campus correspondingly allowed for a melding
of its program of STEM instruction with rigorous early-college courses; all students at Metro have the opportunity to complete up to two years of college credits at OSU for free. As described on the ECHS website, such schools also often had a particular focus on supporting low-income youth, first-generation college goers, English language learners, students of color, and other student groups traditionally under-represented in higher education (http://www.earlycolleges.org).

When it opened in 2006, Metro was the first STEM high school program in Ohio, and the school served as the model school for the Ohio STEM Learning Network (OSLN). The OSLN network was managed by Battelle and supported the growth and quality of STEM education in Ohio by creating regional hubs to spread innovative STEM education strategies. At the time of our study, OSLN was a member of the STEMx network (also managed by Battelle), a multi-state network of STEM education stakeholders that aimed to “analyze and disseminate quality STEM education tools to transform education, expand the number of STEM teachers, increase student achievement in STEM and grow tomorrow’s innovators” (http://www.stemx.us).

2.1.3. Student Admissions
All students from the Central Ohio region, which encompassed the Delaware, Franklin, Licking, Ross, and Union Counties and served over 200,000 children in 25 school districts, were eligible to apply to Metro through the online application form on their school website or by completing and submitting the application available in PDF format on the website. The application form was for informational purposes only; all submitted applications were placed into the student lottery process. Students were not screened or selected based on prior academic achievement. Prospective students submitted their applications in the winter, after which Metro’s student lottery process had two stages. First, 50% of their student openings were allotted for those students living in the Columbus City School District. Second, the remaining openings were allotted for the rest of the districts in Central Ohio. After the lottery process, those students who were selected came to the school for an informational interview; as with the application form, the interview was not a screening process but was rather an opportunity for the students and families to visit Metro and make sure that the school was a fit for what they wanted in a high school.

The student application form asked for several categories of information, including the student’s address, current home district, and demographic information. Additionally, the application requested that students indicate whether they had any special needs, whether they were interested in participating in Metro’s one-to-one laptop lease program, whether they have internet access at home, and whether there was any notable medical history. In addition, students were asked to submit a three-paragraph essay explaining why they were interested in attending Metro. The application concluded with more informal questions such as what extra-curricular activities interested the student and what plans they had for the future after high school.

As a result of this inclusive admission process, Metro served a student body that was representative of the counties in which their students lived. Table 1 compares demographic data for Metro with Franklin County, where over 96% of Metro’s students came from, according to data provided by the school. Metro’s ethnic and racial demographic proportions align with the county’s data, although Metro did appear to have a lower proportion of economically disadvantaged students and students with special needs. A comprehensive analysis of Metro’s
2012-2013 demographics is provided in the Student Outcomes portion of this case study.

Table 1
2012-2013 High School Demographics for Metro and Franklin County

<table>
<thead>
<tr>
<th></th>
<th>Metro</th>
<th>Franklin County *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students Served in Grades 9-12</td>
<td>394</td>
<td>46,454</td>
</tr>
<tr>
<td>Female (%)</td>
<td>50.2</td>
<td>48.9</td>
</tr>
<tr>
<td>Male (%)</td>
<td>49.8</td>
<td>51.1</td>
</tr>
<tr>
<td>Asian (%)</td>
<td>7.6</td>
<td>4.1</td>
</tr>
<tr>
<td>Black, Non-Hispanic (%)</td>
<td>28.3</td>
<td>28.5</td>
</tr>
<tr>
<td>Hispanic (%)</td>
<td>3.8</td>
<td>5.0</td>
</tr>
<tr>
<td>American Indian/Alaska Native (%)</td>
<td>--</td>
<td>0.3</td>
</tr>
<tr>
<td>Multiracial (%)</td>
<td>5.9</td>
<td>3.4</td>
</tr>
<tr>
<td>Pacific Islander (%)</td>
<td>--</td>
<td>0.0</td>
</tr>
<tr>
<td>White, Non-Hispanic (%)</td>
<td>54.3</td>
<td>57.8</td>
</tr>
<tr>
<td>Economically Disadvantaged (%)</td>
<td>29.4</td>
<td>41.4</td>
</tr>
<tr>
<td>Limited English Proficient (%)</td>
<td>--</td>
<td>5.4</td>
</tr>
<tr>
<td>Students with Special Needs (%)</td>
<td>5.1</td>
<td>12.9</td>
</tr>
</tbody>
</table>

Note. Data retrieved from the Ohio Department of Education school report cards website (http://reportcard.education.ohio.gov/Pages/default.aspx) on September 12, 2013. "--" indicates no data reported for that particular student group since membership was less than 10.

* Franklin County data calculated by compiling demographic data for grades 9-12 for all included districts, except for the Eastland-Fairfield Career & Technical Schools, for which separate data could not be retrieved.

2.2. EXPLORING THE DESIGN AND IMPLEMENTATION DIMENSIONS AT METRO

This study systematically explored both the design and implementation of Metro’s educational program by focusing on the ten critical components summarized in Table 2.

Table 2
Critical Component (CC) Definitions

1. **STEM-Focused Curriculum (CC1).** Strong courses in all four STEM areas, or, engineering and technology are explicitly, intentionally integrated into STEM subjects and non-STEM subjects.

2. **Reform Instructional Strategies and Project-Based Learning (CC2).** STEM classes emphasizing active, immersive, and authentic instructional practices/strategies informed by research; opportunities for project-based learning and student production; performance-based assessment practices that have an authentic fit with STEM disciplines.

3. **Integrated, Innovative Technology Use (CC3).** Technology connecting students with information systems, models, databases, STEM research resources, teachers, mentors, social networking resources for STEM ideas; includes during and outside the school day.

4. **Blended Formal/Informal Learning beyond the Typical School Day, Week, or Year (CC4).** Learning opportunities not bounded but ubiquitous; learning spills into areas regarded as informal STEM education, including apprenticeships, mentoring, social networking and doing STEM in locations off of the school site, e.g., in the community, museums and STEM centers, and business and industry.

5. **Real-World STEM Partnerships (CC5).** Students connecting to business/industry/world of work via mentorships, internships, or projects that occur within or outside the normal school day/year.

6. **Early College-Level Coursework (CC6).** Opportunities for students to take college level course
work and earn college credits, e.g., AP classes, online college courses, college classes at institutions of higher education facilitated by flexible school schedule.

7. **Well- Prepared STEM Teaching Staff (CC7).** Teachers certified to teach in their STEM subject areas and having advanced STEM content knowledge and/or practical experience in STEM careers; opportunities for professional development.

8. **Inclusive STEM Mission (CC8).** Stated mission/goals to prepare students for STEM, with emphasis on recruiting students from underrepresented groups.

9. **Administrative Structure (CC9).** Various structures (e.g., school-within-a-school, charter school, magnet school), affected by the school’s age and provenance, i.e., whether the school was converted from another model or was created “from scratch” as a STEM school; various funding structures.

10. **Supports for Underrepresented Students (CC10).** Bridge programs, tutoring programs, extended school day, extended school year, or looping to strengthen student transitions to STEM-focused curriculum; altered, improved opportunity structures, i.e., students positioned for STEM college majors, careers, and jobs.


Additionally, we analyzed the data to identify themes, patterns, or particularly prominent components that emerged from the data. In this section, each of the ten critical components is discussed at length, including their design and implementation. The case study concludes with a discussion of the overall findings and implications.

We began data collection as part of the school selection process and continued data collection through the school research approval and the site visit. We used publicly available data and documents found on the school and district websites to understand the school’s design and context. Also, two online questionnaires were completed by school staff prior to the visit: a school description questionnaire completed by the school leader, Aimee Kennedy, and a survey completed by the school’s teachers. We conducted phone interviews with the school leader to follow up on questionnaire responses. The OSPrI study team, comprised of researchers whose expertise spanned science, mathematics, technology, and engineering, then visited the school for four days in March 2013 and collected implementation data and additional design data using classroom observation instruments; protocols for focus groups with students, teachers, and parents; and protocols for interviews with key personnel, including the principal, other members of the leadership team within the school, and representatives from college and business partners. A list of data collection activities carried out during our Metro site visit can be found in Table 3.

**Table 3**

*Data Collection Activities at Site Visit to Metro*

<table>
<thead>
<tr>
<th>Classroom Observations</th>
<th>Focus Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STEM Classes</strong></td>
<td><strong>Teachers</strong></td>
</tr>
<tr>
<td>Bodies Learning</td>
<td>Teachers of Engineering and Informal Learning</td>
</tr>
<tr>
<td>Center/Science Writing Class</td>
<td>Teachers on Use of Technology</td>
</tr>
<tr>
<td>Spanish</td>
<td>Art</td>
</tr>
<tr>
<td>Algebra 2</td>
<td></td>
</tr>
<tr>
<td>Geometry</td>
<td></td>
</tr>
</tbody>
</table>
For a complete treatment of OSPri’s research design, including the conceptual framework and research literature underlying the ten critical components, the reader is referred to the publication cited in Table 2. This paper is also available on the OSPri website (http://ospri.research.gwu.edu). For a detailed description of the data collection and data analysis methods, the reader is referred to the Research Framework for Case Studies document co-located with the case study on the OSPri website.

2.2.1. STEM-Focused Curriculum (CC 1)

People always [ask], “What is a STEM school, what makes you STEM?” So for us, it’s about this problem-solving design thinking approach to all your issues, part one. And part two, it’s that you’re going to leave us with the level of preparedness that if you wanted to be an engineer, you could.
– Aimee Kennedy, Principal and CAO of Metro

2.2.1.1. Definition

A STEM-focused curriculum includes strong courses in all four STEM areas, or a particular, explicit focus on engineering and technology, intentionally integrated into STEM subjects and non-STEM subjects.

2.2.1.2. Design

Metro was designed to be both a STEM-focused school and an early college high school, and the curriculum reflected both aims. To fulfill the early college goal, Metro’s high school instructional program was divided into two phases. For the first portion of their time at Metro, called the Core Prep phase, students completed the high school graduation requirements for the state of Ohio through what was designed as a strong, accelerated college preparatory curriculum. These Core Prep courses were intensive one-semester-long courses that covered what normally would take two semesters in most high schools. As detailed in the Metro Family Handbook,
students enrolled in four of these intensive academic classes each semester and participated in an Advisory class two days per week. In addition, there was a six-week January term between the two semesters. Thus, with the Advisory class, students had the opportunity to earn up to 9.25 high school credits each year. The graduation requirements for Metro and Ohio are detailed in Table 4.

**Table 4**
*Metro Graduation Requirements and Courses Offered*

<table>
<thead>
<tr>
<th>Subject</th>
<th>Course Credits Required at Metro</th>
<th>Course Credits Required by Ohio</th>
<th>High School-level Courses Offered at Metro (listed alphabetically)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics</td>
<td>4</td>
<td>4</td>
<td>Algebra I, Algebra II, Calculus, Geometry, Pre-Calculus, Statistics, Trigonometry</td>
</tr>
<tr>
<td>English/Language Arts</td>
<td>4</td>
<td>4</td>
<td>American/World Literature, College Reading, College Writing, Literary Analysis</td>
</tr>
<tr>
<td>Science</td>
<td>3</td>
<td>3</td>
<td>Biology, Chemistry, Environmental Science, Physics</td>
</tr>
<tr>
<td>Social Studies</td>
<td>3</td>
<td>3</td>
<td>American History, Economics, Government</td>
</tr>
<tr>
<td>Engineering</td>
<td>1</td>
<td>0</td>
<td>Introduction to Engineering Design, Principles of Engineering</td>
</tr>
<tr>
<td>Communications</td>
<td>1</td>
<td>0</td>
<td>Communications</td>
</tr>
<tr>
<td>Advisory *</td>
<td>1</td>
<td>0</td>
<td>Advisory (.25 credit required each year, for a 4-year total of 1 credit)</td>
</tr>
<tr>
<td>Internship *</td>
<td>1</td>
<td>0</td>
<td>(All students required to complete at least one professional internship)</td>
</tr>
<tr>
<td>Research</td>
<td>1</td>
<td>0</td>
<td>Junior Capstone Project, Senior Research Project</td>
</tr>
<tr>
<td>Foreign Languages</td>
<td>0 **</td>
<td>**</td>
<td>Spanish I, Spanish II, Spanish III</td>
</tr>
<tr>
<td>Fine Arts</td>
<td>1</td>
<td>**</td>
<td>3-D Art, Fine Arts, Photography</td>
</tr>
<tr>
<td>Health/Physical Education</td>
<td>0.5 Health and 0.5 Physical Education</td>
<td></td>
<td>Wellness</td>
</tr>
</tbody>
</table>

*Note.* Information provided by CAO on pre-visit Administrator Survey. Ohio requirements listed on “What It Takes to Earn an Ohio Diploma” retrieved from http://education.ohio.gov on November 4, 2013.

* Students were also required to complete a Service Learning requirement encompassing 30 hours during the school year through Advisory, plus an additional 40 hours outside of school.

** Foreign language courses are electives for Metro students. Ohio required 5 units of electives, which “must include one or any combination of foreign language, fine arts, business, career-technical education, family and consumer sciences, technology, agricultural education or English language arts, mathematics, science or social studies courses not otherwise required” (http://education.ohio.gov).

Aimee Kennedy, Principal and CAO of Metro, explained that this design meant that most students at Metro could complete their Ohio high school requirements in two years and one semester and then begin adding college level courses, gradually increasing the college load. The typical STEM course progression for students at Metro, published in the Family Handbook, is shown in Table 5.
Table 5
Typical Sequence of STEM Courses for Students at Metro

<table>
<thead>
<tr>
<th>Science</th>
<th>Technology</th>
<th>Engineering</th>
<th>Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Environmental Science</td>
<td>There are no technology classes offered at Metro, as technology skills are embedded into every class.</td>
<td>• Introduction to Engineering Design</td>
<td>• Algebra I</td>
</tr>
<tr>
<td>• Biology</td>
<td></td>
<td>• Principles of Engineering</td>
<td>• Geometry</td>
</tr>
<tr>
<td>• Chemistry *</td>
<td></td>
<td>• College-level Engineering</td>
<td>• Algebra II</td>
</tr>
<tr>
<td>• Physics *</td>
<td></td>
<td></td>
<td>• Trigonometry</td>
</tr>
<tr>
<td>• College-level Science</td>
<td></td>
<td></td>
<td>• Pre-Calculus</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Calculus</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• College-level Mathematics</td>
</tr>
</tbody>
</table>

Note. Information provided by CAO on pre-visit Administrator Survey.  
* Students take both Physics and Chemistry, but in either order.

First year coursework focused on core competencies in mathematics, science, and English. Most second year students then enrolled in foreign language and social studies courses, with literature, science, and mathematics rounding out their schedule. During these years, students were able to take art and health courses as their schedules allowed. Metro had previously been a “physics-first” high school, but it recently moved physics to the end of the science sequence because freshmen were not adequately prepared in mathematics, and there was too much variation in their background mathematics knowledge to get ready for a college-level physics course. A physics teacher elaborated:

*I looked it as specific learning targets in physics – I broke it down to 12 or 15 specific learning targets that were necessary. When this student leaves my class, they go to Ohio State, what are the targets they need to have to be successful in their next class in Ohio State? So I say in Exam 1 there are three targets that they have to master, but then a bunch of other targets that they don’t have to master but do have to show progress on for later.*

The students’ third and fourth years were then devoted to completing any remaining high school course requirements and taking college coursework through carefully planned STEM-intensive learning experiences. As they were finishing the last of their high school requirements, students entered the second phase of their time at Metro, called the College Access phase, and enrolled in early college experiences, such as Metro’s Learning Centers and college courses at The Ohio State University (OSU) or Columbus State Community College. The themed Learning Centers were designed to provide transitional experiences from high school to college. The themes varied from year to year, but the offerings at the time of this site visit were Energy, Environment, and Economics (called “E3”); Human Body Systems: Biomedical Engineering (called “Bodies”); and Design. Each Learning Center involved students in activities that included both high school and college-level STEM coursework, humanities coursework designed to support the Learning Center theme and requirements, and experiential learning set in the surrounding community. By their senior year, if not before, some students were taking only college-level courses.

The STEM focus of Metro was apparent in the wealth of STEM offerings shown in Table 5, including the college courses to which students had access after completing the basic high school requirements; Metro did not offer Advanced Placement courses because of this access to college-
level courses. Perhaps more important, however, was how STEM education was viewed at this school. As Metro’s principal explained, all classes at Metro were considered to be STEM, even traditionally non-STEM classes, such as art and Spanish. Principal Kennedy further elaborated that Metro’s curricular approach had a dual focus: literacy (in mathematics and reading) and real world investigation (through social science, life science, and environmental science). The intent was to enact this dual focus through an integrated mathematics and science curriculum where mathematics became part of the “language” of science and was used in context. Students were expected to develop a fluent knowledge of mathematical and scientific processes. Other goals included in-depth student explorations in science activities, use of design principles, and the encouragement of student innovation. These kinds of STEM skills and knowledge and 21st Century Skills (Partnership for 21st Century Skills, 2012) were developed through carefully planned activities that were primarily experiential and non-traditional. They included the semester-long, interdisciplinary Design Challenges for freshmen and sophomores and Learning Centers for upperclassmen, as well as coursework in engineering, projects, and performance assessments across all classes that required students to do more than memorize content, but to develop as STEM students.

2.2.1.3. Implementation
Metro’s approach to curricular planning is described first, followed by sections on each of the STEM content areas. This implementation section concludes with a discussion of Metro’s Learning Centers and interdisciplinary approach to STEM.

2.2.1.3.1. Approach to content standards and rigor. The first two years of Metro’s curriculum focused on getting students through most of the high school course requirements of the state of Ohio, but with the clear-eyed goal of thorough college preparation. After all, for many students at Metro, exposure to college-level classes was only two years away from their admission to the school as 9th graders. In order to ensure that their courses were in fact getting their students college ready, Metro’s teachers used ACT’s Quality Core Standards for high school core courses and End-of-Course Assessments to build their courses, rather than relying on Ohio’s content standards, according to Principal Aimee Kennedy. She added that Metro was also building in the Common Core State Standards for mathematics and English language arts, looking for areas of overlap with their own standards and mapping them in:

*I think that the biggest thing to the Common Core is the push to standards of practice and the push to integrate and look at literacy in the sciences and literacy in social studies. So, we’ve always kind of been there, or at least really wanting to go there... I know we’re not necessarily doing the Common Core, but I know that when we focus on students and the Metro Habits [described in more detail in the Reform Instructional Practices (CC 2) section of the case study]... we also care about ways of thinking and the skills of practice that come together with content to make someone really college ready.*

Metro was also aware of and reviewed the Next Generation Science Standards (NGSS), but as Principal Kennedy explained, they were taking a cautious approach to building them into their own practices, given how often new standards were being developed in the sciences over recent years:
Here’s my approach to the standards... When the NGSS standards are really fully actualized and lots of states are signing on, when Ohio is publishing them and saying here are some sample assessment problems that are going to come along with NGSS, then we’ll take a really hard look at are we meeting them. But until then, it’ll just be a kind of reference, of how science instruction is moving, where are we, should we make some adjustments, are there small adjustments we should make. But we also know that no matter what the states are doing, the ACT and SAT are going to be the college-readiness benchmark that we can pretty safely measure against for at least the foreseeable future.

With Metro’s partnership with OSU and their students’ access to early college-level coursework in OSU classes, described in more detail in the Early College-Level Coursework (CC 6) section of the case study, Metro staff had access to immediate and ready feedback about their students’ level of preparation for college work after studying at Metro. An assistant provost at OSU kept a friendly eye on the progress of Metro students in OSU classes, and Metro had its own OSU advisor to support its students. Furthermore, the principal explained:

We are meeting with the [OSU] biology department to find out how Metro students do in the entry level biology class, compared to other college kids. Were there content areas where our kids are missing; were there standards of practice or lab skills that we didn’t bring to the table? Lots of input and data points about how our kids are doing and what does “college-ready” really look like.

Metro staff accordingly stayed informed of their students’ preparation for college coursework, and they received immediate information about where that preparation fell short, whether it involved content knowledge, study skills, or affective factors. Using this information, Metro administrators and teachers were able to make needed adjustments to their high school curriculum quickly. If any questions around the academic rigor of Metro’s courses arose, they could examine the pass rate and average grade point average (GPA) of the Metro students taking college courses at OSU and see how well they did compared to the full-time college students.

2.2.1.3.2. Mathematics. The mathematics curriculum at Metro aimed to get every student through calculus and ready for college-level work beyond calculus. Some participants in the student and parent focus groups stated that they came to Metro because they liked mathematics and science or were drawn to the accelerated STEM and early college curriculum offered at the school. As an 11th grade student explained, “I came here for math. My high school was good but I’m on my ninth math class, which I wouldn't get at any other school.” Principal Kennedy further contrasted Metro’s approach to mathematics learning with those of other high schools:

In a regular school... 9th graders take algebra I, but [many of those students] can never get through pre-calculus in that system. They spend a year in algebra I, a year in geometry, and maybe there’s algebra II, and maybe trig, maybe pre-calc, but you never get to AP Calculus... [Also.] just enrolling in the classes, in a non-mastery system that doesn’t require you to be excellent in your practices in math, doesn’t require you to understand why you’re solving equations this way.

In order to help their students develop a depth of mathematics knowledge and skills through their
classes, Metro employed a mastery learning and assessment system, described in further detail in the Reform Instructional Practices (CC 2) section of the case study. A mathematics teacher described this aspect of their curriculum:

We are definitely as strong if not stronger than... the typical high school, and I think our kids come out better because of it. Part of it is the mastery system. They have to receive a 90% in order to get [course] credit. In other schools you can move on if you get a 60%. Here, by earning a 90% it ensures that they learn the content and actually reach the learning targets.

This mastery learning system was bolstered by the use of Measures of Academic Progress (MAP) testing to help place each incoming 9th grade student in the appropriate mathematics class. When asked if this could be construed as tracking, a mathematics teacher responded:

I don’t disagree, but I think tracking can get a bad rap. I have kids from varied [mathematics] backgrounds. Our goal isn’t to create homogenized groups, it’s to treat them as individuals. If as an individual you need to be in an algebra I class, people could say I’m tracking to put them in this group, but that’s what they need. I make no apologies if a kid needs algebra I, and I assign them to algebra I, because it’s what is good for the student.

Another mathematics teacher similarly pointed out that one of the biggest differences between Metro and his previous schools was the individualization at Metro that could occur because Metro was a smaller school. This teacher stated in a focus group that Metro’s philosophy for students was that “If you are accelerated, let’s push you on as much as we can to challenge you, and if you really need remedial help, let’s get you there so you can start to excel as well.”

Metro’s mastery learning system also depended on clear learning goals and objectives. Principal Kennedy explained that Metro did not rely on Ohio’s content standards, but rather they focused on the ACT Quality Core Standards and End-of-Course Assessments, along with Common Core standards in mathematics. For example, Metro’s assessments used for mastery determinations were based not on Ohio’s standards but rather on ACT’s standards and curriculum. In order to more effectively build these standards into their mathematics curriculum, a mathematics teacher added, “We have more projects and design challenges that help them apply that math. They get the same content but get more practice and application here.” Metro’s mastery learning system thus kept students focused on learning the material at a high level of understanding, and their close connection with OSU’s courses and the ACT standards helped Metro teachers maintain high benchmark levels.

2.2.1.3.3. Science. The goal of the first two years of coursework was focused on building student understanding of the core of science (e.g., biology, chemistry, and physics) in order to prepare students for the OSU science courses that they would take during their last two years at Metro. Teachers complemented this driving goal of preparing students to be successful in college courses after leaving Metro with a focus on science literacy and problem solving skills in their classes. As a biology teacher who was also an assistant principal described:

We serve two masters... we have philosophical things going on where we want to get kids’ hands on things, but then we’re also trying to prepare them for OSU classes in chemistry, biology, and
physics – we’re trying to do well on both fronts. They don’t really work against each other. I think there are strengths to both.

Students took MAP tests upon entry to Metro, and they were placed in environmental science or biology in their first semester depending on their scores. Regardless of their starting point, however, all students at Metro completed their high school science sequence with a physics course. A science teacher explained the rationale behind the placement in environmental science or biology for 9th graders:

*There are two MAP tests that deal with science... [The data coordinator] made sense of that data, and there came to be two logical groups. We’ve learned in the past that the mastery system works well and you get great gains with the students here as long as their class is within their zone of proximal development [ZPD]. Last year, we had all freshmen first term take bio, and for some of the kids, it wasn’t ZPD. We weren’t going to capitulate and water down the class... if for a kid the stepping stone is too far, they don’t hit it. So the environmental science class was put in. About two-thirds of kids take environmental this year, and... those who came in clearly advanced, they went straight to biology. Last year, there were 20 to 30 percent of the kids who came in who couldn’t handle biology, were overwhelmed, because they came from middle schools where maybe they didn’t learn as much of the prior content.*

An engineering teacher explained that the environmental science course was a good choice for students who came in with weak backgrounds in science because:

*With environmental science, there’s no one right answer, so we want them to be able to say there’s a solution but have evidence to back it up – form a thought, opinion, and have evidence to support it. So that helps them get ready for the science courses at Metro.*

To help students make connections across the science disciplines, each semester Metro developed Design Challenges for freshmen and sophomores. A teacher described one Design Challenge:

*In fall, it was geometry, algebra I, IED [Introduction to Engineering and Design], environmental science, English, art, biology working together to design a sustainable community. We gave students the criteria, and they each had to have the various components to solve the one problem. It went well... It’s definitely hard work, a lot of moving pieces.*

A previous year’s Design Challenge had students building aquariums where the most beautiful aquarium won. This was done in partnership with a local business called Aquarium Adventure, with the goal of having students design the aquarium and pick their plants and fish. The teacher recalled:

*I approached Aquarium Adventure about just a few things, and they gave us a whole rig, top class stuff, and the kids just took off with it... The aquariums provided these ecosystems that kids could manage, and suddenly ecology, photosynthesis, cell respiration, fermentation, organism diversity all had a place... Every day also students would get 15 minutes of hands on lab activity with them. They talked in groups for what to do next, and updated their blog to describe how*
their aquarium is going.

2.2.1.3.4. Engineering. Students and parents reported that some students came to Metro specifically to study engineering. Two engineering classes were offered at the high school level: Introduction to Engineering and Design (IED), which most students took in 9th grade, and Principles of Engineering (POE), which students typically took as juniors or seniors. Both courses were derived from Project Lead the Way (PLTW) and Metro’s engineering teachers were trained and certified by PLTW. However, they stated in a focus group that they adapted the PLTW courses to make them more rigorous.

In explaining the difference between the two courses, a student participating in a focus group said, “IED is more computer design. Students go and learn CAD software and then POE is hands-on building.” Another student added:

To me it’s like you have some problem and then going through a set of steps to get to a solution. For me, I was always interested in that. I always played with Legos and all of that. Metro has given me more of a refined process. It’s not like, “Oh, let’s play with things,” it’s figuring out step 1, step 2, step 3, organizing it, and getting better results because of it.

Beyond Metro’s engineering offerings, students had the opportunity to take more advanced engineering courses at OSU. Students could also gain more engineering experience in clubs at Metro such as the Robotics team or through an advanced computer science game. However, the engineering focus of the school was especially refined during junior and senior year, when most of the students participated in the Learning Centers which essentially comprised their entire curriculum for one year, including humanities and social studies courses.

2.2.1.3.5. Learning Centers. After completing their high school requirements, most students moved on to a Learning Center in their junior year. The Learning Centers were unique combinations of themed coursework at the high school and college levels, bolstered by interdisciplinary connections in the humanities, and a great deal of experiential learning in the community with local business or educational partners. The themes included Energy, Environment, and Economics (called “E3”); Human Body Systems: Biomedical Engineering (called “Bodies”); and Design. Principal Kennedy indicated that the next school year was likely going to have a Learning Center organized around an agriculture theme. Students chose one of the Learning Centers for the entire year, and as the principal described it, they started with “a lot of instruction and focus on getting [students] deep in the content.” The goal by the end of the year, she said, was for the students to “have grown into the mini-professionals in that area who can do a research project under the guidance of the professionals in that area.” Typically, a Metro teacher was charged with running each Learning Center, nearly a full load for the teacher for a year. To spread the Learning Center challenges, Metro also partnered with a different neighboring high school for each Learning Center. Thus, each Learning Center involved teachers and students from two high schools, as well as a university instructor from OSU who taught a regular OSU course that students took which was related to the chosen theme.

Principal Kennedy explained that the involvement of other high schools allowed for the requisite number of students needed to make a Learning Center worthwhile and cost effective. It was also
a means of offering Metro’s STEM innovations to other high schools through healthy collaborations. As a result, Metro helped serve as a catalyst for advancing STEM education in the local community. Metro students and teachers benefitted from this partnership as well. Teachers had a strong professional development experience through their collaboration with other teachers and college professors; Principal Kennedy noted that there were some very strong teachers at the other high schools who made substantial contributions to the Learning Center collaborations. Metro was able to take advantage of the other schools’ laboratory facilities as well, along with highly competitive Advanced Placement classes that were not offered at Metro. One student in a focus group described the benefits of this unique learning environment, saying, “The Learning Center is a bridge from taking high school classes to college classes, so you are getting credit for both while taking them. It’s meant to help prepare you for when you begin full time college courses your senior year.”

As one example of the work done in these Learning Centers, the Biomedical Engineering “Bodies” Learning Center had students immersed in a biology class at OSU, a biology class at the high school, and a partnership with a local hospital that provided mentors and experiential opportunities. For this and each of the other Learning Centers, Metro students met with the lead teacher once a week at the school. The lead teacher functioned as a coordinator of activities and as an advisor and mentor, making sure that students were managing their work and completing all assignments. The Bodies Learning Center class observed at Metro had the teacher briefing the students about appropriate attire, hygiene, and comportment as they were about to accompany doctors on rounds at the hospital as part of the course. The students seemed highly engaged, paying close attention to advice about the right sort of shoes to wear. They wanted to look as if they were part of the medical team and fit in with the adult interns. Individual students also gave reports on their progress on ongoing OSU research projects (related to the theme) to which they were assigned as part of the Learning Center. The reports were highly technical and sophisticated. Students in the class seemed to pay close attention to the reports and asked questions of the student speaker. The atmosphere seemed business-like and scholarly as well as supportive and collaborative.

Another example of a Learning Center was E3, addressing energy, environment, and economics. The Metro administrator leading this Learning Center described it as focused on environmental and energy systems and on centering student learning around making “effective, efficient, and sustainable choices when it comes to the environment… how can we as a society maximize [and protect] our most valuable resources.” He further stated that E3 combined:

*Content from the social and physical sciences, along with extensive field experiences, and [was] facilitated through a series of ‘real-world’ design challenges challenging students to create more effective, efficient, and sustainable public policy in regards to energy and the environment.*

The teacher explained that two main classes drove this course: an environmental science course and an AP economics course at the partner high school. Additionally, in a focus group, 11th grade students described taking a related earth science course (Earth Science 1121) at OSU. A shuttle bus took Metro students to the partner high school anywhere from one to three days per week depending on the semester schedule. One of these 11th graders described the different learning environments experienced through these Learning Centers:
The classes are lively. You are mixed in with a big group of high school students. It is busy and confusing and a lot less serious than the OSU classes we take. OSU classes have an intensity. [The partner high school’s] classes are more typical high school classes. It is different between the two schools. Class sizes are not much different, but it is a gigantic building, with 2 or 3 floors... You could fit 5 or 6 Metros inside.

Additional details on the Learning Centers are provided in the Reform Instructional Strategies (CC 2) and Early College-Level Coursework (CC 6) sections of the case study.

### 2.2.1.3.6. Interdisciplinary Courses

These themed Learning Centers helped provide an interdisciplinary approach at Metro. For instance, in the Bodies Learning Center, students were also required to take a 3-D art class in which they constructed anatomical bodies from clay. They were also taking an English class called Science Writing, which would help them to write the research reports required as part of the Learning Center.

This cross-curricular integration aligned with the overall STEM instructional approach at Metro for students in the Core Prep phase as well. The importance of the art program at Metro was apparent as soon as one entered the school building. Student art was displayed prominently, such as various large multi-media mosaic pieces made out of recycled objects like plastic bottle caps. The art teacher team-taught with science teachers and was positive about STEM education and the ready integration of art at Metro. She reported:

> We meet the highest state standards for art education... With the design challenges, art works in very well. I try to incorporate the art fitting in with the math, science, English... In art, we designed labels to sell the product and advertisements [for sustainable foods projects]. We studied how different corporations sell their food... The other time was when the Olympics were in town, we had students make wire sculptures of athletes and incorporated various mathematic and scientific components from the sports. That was another Design Challenge that connected our art to sciences, [like] physics and speed, for example.

It appeared that most interdisciplinary connections were made through Design Challenges and Learning Centers, but the entire school program supported STEM learning. The principal was proud of the fact that the strong humanities program at Metro also led some students to further studies in art, theater, and dance. Alumni that were interviewed were majoring in non-STEM fields, but they nevertheless noted that the STEM background prepared them for social science and other classes that required design principles.

### 2.2.1.3. Summary

The strength of Metro’s STEM curriculum was apparent on several levels, from the school’s design to its implementation of its design elements. While the school required the same number of mathematics and science credits for graduation as the state of Ohio, Metro required students to complete college preparatory coursework in order to meet the four credits of mathematics, including advanced algebra/trigonometry and pre-calculus or calculus as the fourth credit. Similarly, the four credits of science for Metro included biology, chemistry, and physics. By contrast, Ohio mandated only that students earn “one credit of algebra II or the equivalent of
algebra II” as one of their four required units of mathematics, and students could satisfy the science credit requirements without taking either chemistry or physics (http://education.ohio.gov). Metro students completed these requirements on an accelerated schedule, with opportunities to retake courses they had not yet mastered and still complete high school graduation requirements within four years. Based on their individual readiness, students then proceeded to take college-level STEM courses through the integrated high school and college course work known as Learning Centers and regular OSU general education courses or, in some cases, more advanced coursework. Additionally, Metro required engineering coursework whereas no engineering credits were required by Ohio.

Within each discipline, Metro’s focus on preparing their students for college-level work after completing their high school requirements was evident in their use of ACT content standards. These standards ensured college preparatory rigor when combined with feedback from OSU on how well Metro students were performing in their regular college courses. Metro’s mastery learning system also fostered a deeper understanding of STEM concepts, which prepared their students well for the advanced, integrated work expected of them in the themed Learning Centers. The strength of Metro’s science, engineering, and mathematics curricula and instruction, described in detail in the Reform Instructional Strategies (CC2) section of the case study, supplemented with interdisciplinary work conducted in Design Challenges and Learning Centers, served to prepare Metro’s students for a successful transition to college-level work including at least one OSU course involving science, engineering, or mathematics.

2.2.2. Reform Instructional Strategies and Project-Based Learning (CC 2)

2.2.2.1. Definition
Reform-based instructional strategies include STEM classes that emphasize active, immersive, and authentic instructional practices or strategies informed by research, opportunities for project-based learning and student production, or performance-based assessment practices that have an authentic fit with STEM disciplines.

2.2.2.2. Design
As described in the narrative section on Metro’s STEM-Focused Curriculum (CC 1), the student learning experience at Metro was divided into two phases: a preparation and exploration phase called Core Prep and an internship and access-to-college phase called College Access. In the Core Prep phase, classes centered on graduation requirements in mathematics, science, social studies, and language arts, and students had the opportunity to complete these requirements in as short a time period as two years. According to Metro’s website, students demonstrated completion of these requirements by passing the Ohio Graduation Tests (OGT) and through performance tasks that showcased the student’s ability to think critically and solve real-world problems. Students then progressed to the College Access phase in which their learning took place “outside of the school walls” in Learning Centers located within central Ohio. The website also described the focus of the two phases; while the Core Prep phase focused on capacity building, the College Access phase was designed to provide students opportunities for practical experiences, skill development, social maturity, critical thinking, and responsibility.

Metro’s educational philosophy was grounded in the *Metro Habits of Heart and Mind*. These
habits served as a design framework for instructional strategies, elaborating high expectations for students and desired outcomes. Shown below is the list of these habits published on the school’s website underlying the instructional strategies and practices at all levels of the school:

1. Effective Communicators,
2. Inquiring Learners,
3. Active and Responsible Decision Makers,
4. Effective Collaborators,
5. Critical Thinkers, and
6. Engaged Learners.

As noted on its website, Metro’s instructional design was also guided by the Common Principles of the Coalition of Essential Schools (CES), which set forth the notion that “the school’s central intellectual purpose is helping the students to use their minds well.” According to CES’s website, these Common Principles included:

- Learning to use one’s mind well
- Less is more, depth over coverage
- Goals apply to all students
- Personalization
- Student-as-worker, teacher-as-coach
- Demonstration of mastery
- A tone of decency and trust
- Commitment to the entire school
- Resources dedicated to teaching and learning
- Democracy and equity

Finally, Metro’s instructional strategies were based on mastery learning: in order to earn a credit in a course, a student was required to demonstrate at least 90% mastery of the learning targets. These targets were fully ACT standards-driven and performance based. For students in the Core Prep phase, targeted outcomes included a demonstration of habits of mind such as disciplined inquiry, independent thinking, analysis, reasoning, creative problem solving, and evaluation, with specific measurements taken in every course in the Metro Habits of Heart and Mind. As listed on Metro’s website, examples of mastery performance assessment items included laboratory reports, projects, research papers, oral presentations, homework portfolios, and summative mid-term assessments using OGT, ACT, SAT, or AP-style test items. For those in the College Access phase, key performance outcomes also included a demonstration of habits of cooperation and teamwork. Metro used a variety of instructional strategies to facilitate development of in-depth content knowledge and content-specific skills as well as habits of heart and mind, including group projects, debates, exhibitions, laboratory work, simulations, outdoor study, team teaching, and interdisciplinary learning.

2.2.2.3. Implementation

2.2.2.3.1. Metro Habits of Heart and Mind. Metro’s focus on developing engaged and inquiring learners who could make responsible decisions, communicate and collaborate effectively, and
apply critical thinking supplemented Metro’s desire to push their students to take as many challenging mathematics and science classes as possible. However, as elaborated by the principal, this goal went beyond just giving them the content that was covered in these classes; rather, it was about the way of thinking, and the disciplined thinking and thoughtfulness that went into tackling a problem, testing out ideas and hypotheses, and making adjustments based on results and observations. For Metro, then, the term “STEM” referred to using this engineering design process and scientific method all of the time, no matter the class, no matter the situation, and no matter the career that their students ultimately pursued.

Metro’s teachers carried this notion of STEM directly into their classrooms: STEM was not just about the content of the four subject areas, but also the process and way of doing things. As one mathematics teacher described in a focus group of mathematics teachers:

*Everyone keeps mentioning STEM. STEM to me is not science, technology, engineering, and mathematics. STEM here is a process. It’s a way we do things. It’s kind of like a design process where you are going to come up with a problem, develop a solution, work that solution and see if it works, refine that, and retry that and start all over again.*

Teachers in this focus group talked about how this problem solving, design process approach to learning was explicitly and deliberately aligned with the Metro Habits of Heart and Mind, and that they consciously wove it into the classroom instruction at Metro. Incoming students needing further development of such problem solving skills before taking biology were assigned to an environmental science course. The teachers of this class indicated that they continually stressed the importance of students seeking and providing evidence to support their thoughts, opinions, and solutions to problems. According to the teachers, this focus on critical thinking, scientific inquiry skills and the design process worked particularly well in this class where the teachers were able to stress that there is not a single clear, right answer to solving environmental problems. The skills learned in this class served as a foundation for Metro students in their later coursework.

Metro reinforced these reasoning skills in all of the classes throughout a student’s time at the school. For the biology teacher, the key goal of his class went beyond teaching his students the academic content of the subject; he was focused on exposing his students to the scientific reasoning thought process over and over again, “30 or 40 or 50 times.” At that point, the students began to develop a “literacy” and then a “fluency” with the “scientific process and language of reason,” as he described it. On top of these critical thinking skills, the biology teacher was also focused on helping his students become active and responsible decision makers, with strong self-regulation and work management skills that he believed were the foundations for success in any field, not just biology or the sciences. According to the engineering teachers, their engineering classes at Metro were also ideal for such a focus on the scientific and design process, as they were predominantly project-based, with students responsible for building their designs, troubleshooting the results, analyzing errors, and cycling back through their design process with that data.

Students and parents at Metro voiced that they had come to see the value of developing these skills. Although initially wary of the Metro Habits, students and alumni reported that they could
see how they have an edge over other students when it comes to communication, collaboration, and leadership skills. As one student described it: “You get all the content and equations [at Metro], but in the end everything else we learned beyond the content of the class is what’s helped me in college.” Parents had similarly noticed how the students at Metro were “incredible communicators” with strong public speaking skills. One parent in particular who worked in the non-profit sector noted their company greatly valued those employees who could build coalitions and collaborate with diverse groups of co-workers, and this parent sought a school such as Metro where that type of experience was provided to the students.

2.2.2.3.2. Classroom instructional practices. With this prioritization of the habits of mind and critical thinking skills in mind, it is worth noting that the classroom instructional practices in the STEM courses at Metro were primarily traditional in nature and not necessarily “innovative,” with many teachers using mini-lectures, Powerpoint slide decks, and textbook-style worksheets. Ultimately, Metro’s administration left the choice of instructional strategies to the individual teacher. The administration deliberately gave autonomy to their teachers to use those classroom tools and instructional strategies with which they were most comfortable, whether it was laboratory exercises, inquiry-based projects, or direct instruction with other activities interspersed. As an assistant principal explained:

Some [teachers] are great at project management, scaffolding for kids, seeing where they’re at, but others are great at lectures and speaking in front of people…. Some can engage their students in different ways. People can lean on different things. So all the tools are good, and it depends on context. All [strategies] are needed in the sense that inquiry doesn’t work well for [all] topics…. Some teachers are great at constructing labs and activities that are simple enough for the kids to say “Oh, I got the concept.” There’s a real art to get that result.

A veteran engineering teacher summarized this Metro approach to instruction similarly: “I don’t think we have a Metro-specific kind of way [of teaching], other than to use your strengths.” Additionally, Principal Kennedy set forth expectations for Metro’s teachers that they were not just to use off-the-shelf, ready-made curricula or textbooks; teachers were expected to design their curriculum. She also shared that the administrative team had come to tailor their interview and hiring process to make sure that they were finding teachers who had strong foundations in their academic content and could teach it in different ways to their students. As a result, a survey of the teachers at Metro revealed that the vast majority of them either “agreed” or “strongly agreed” that they were confident in their ability to lead a class of students either using investigative strategies or engaging them with hands-on and project-based work.

Metro, however, balanced the desire to expose their students to inquiry-based projects in STEM subjects with a clear-eyed understanding that in the end, they were aiming to prepare their students for Ohio State University (OSU) classes in STEM content areas such as chemistry, biology, and physics. The assistant principal described it as “serving two masters, in that we have [an approach] where we want to get kids’ hands on things, but then we’re also trying to prepare them for OSU classes…. We’re trying to do well on all those fronts.” It was not that these two goals worked against each other at Metro, but rather that there were different types of instructional strategies and assessments that played to those different goals. For example, for the pre-calculus teacher at Metro, his choice of instructional strategies was based on preparing his
students for the next step, which was calculus at OSU:

_I told them this is what you’ll get at Ohio State. You’ll have a professor lecturing to you, you’ll take notes, and then you’ll get the homework. Go practice. This might not necessarily be the best way to do it, but this is what’s going to prepare you for the next step._

Consequently, this mathematics teacher admitted to being “probably more traditional” and lecturing in his class. Similarly, one of the biology teachers relied mainly on mini-lectures and direct presentations to his students for content delivery. Neither teacher, however, was merely a full time, monolithic lecturer. As the pre-calculus teacher explained, “I can sit up here and lecture all I want, but that won’t help them learn until they try it.” As a result, he devoted much time in class for practice problems that the students worked on in collaboration with others. The biology teacher also constantly wove in shorter activities throughout his lessons to get the students interacting with the concepts and developing mini-hypotheses about new concepts before delving deeper into them.

Interviews and focus groups with teachers revealed considerable thoughtfulness about the instructional strategies they employed in their classroom, with a conscious focus on engaging their students in active learning. The research team observed a range of reform-based instructional strategies in both STEM and non-STEM courses at Metro, reflecting the instructional flexibility and diversity fostered by Metro’s administration. A physics/mathematics teacher avoided direct instruction as much as possible, believing that students would tune the lesson out immediately. She had instead implemented a rule in her class that when a student had a question about a problem that they are working on, the student had to first talk with other students to try to solve the question before going to the teacher. As a result, her class was predominantly structured around small group, collaborative work. For the content of her physics class, she also deliberately started by teaching her students how the concepts were applied in the real world before digging into the theoretical aspects of the subject matter, “because if they can do the applied, the theoretical is going to make sense as well, which is how we all learned it in college.”

The engineering courses at Metro were particularly illustrative of the active learning environments found at the school. There were two courses offered at Metro: Principles of Engineering (POE) and Introduction to Engineering and Design (IED). The two engineering teachers at Metro were both trained and certified to teach Project Lead the Way (PLTW), and the courses were based on the PLTW curriculum. However, they indicated that they had also enhanced the curriculum to make it more rigorous; they both felt that while the PLTW curriculum had good projects, the project work could be expanded and strengthened. As a result, they had developed additional projects that were now part of their POE and IED coursework. While the engineering teachers would sometimes introduce topics and concepts by briefly presenting the material to the students, they moved as quickly as possible to the actual project-based work, getting the students to “try it out” and “put their hands on it.” This was supplemented by occasional workshops for students who were having difficulty with particular aspects of the project, including use of the 2-D and 3-D CAD software. Throughout a unit and semester, one teacher indicated that he had his students keep an engineering journal to keep track of their work and what they had accomplished, what was left to work on for the next class, and
most importantly, to document what worked and did not work during their time in class. This opportunity to reflect on their work and think through why a particular part did not work out was critical for his focus on problem-solving skills and the engineering design process; he wanted to push his students first and foremost to think through those challenges, ask the “why” and “how” questions, and creatively come up with their own new solutions.

2.2.2.3. Classroom vignette: Introduction to Engineering and Design (IED). The class started at 12:55 pm, and the thirty students had taken their seats throughout the classroom, many talking quietly with a classmate before the teacher began class. The teacher got everyone’s attention from the front of the class and passed out a packet of AutoCAD diagrams. The diagrams were sample engineering schematics for three-dimensional figures made of varying numbers of cubic components; the students’ task was to examine each schematic and determine any errors in how the dimensions of each one were marked off for production purposes. The students were currently working on a project where they were designing their own wooden cubic puzzles, and this opening activity was meant to help them avoid these types of errors when drafting their own schematics. The teacher split the classroom down the middle and directed each student to pair up with someone from the opposite side of the room to work on these problems together – this way, the students were collaborating with a classmate that they perhaps had not worked with often. There was some good-natured grumbling as the students moved and paired up with their new partners, but everyone found a partner quickly and active conversations began comfortably and without delay.

While the students worked through the packet, the teacher walked from group to group, listening to their conversations and noting their comments. After several minutes, the teacher asked those students who were done to raise their hands. Most of the class did so. The teacher then directed the students to pair up with a different classmate to compare and discuss their answers. While the new pairs were sharing their work, the teacher turned on his computer and projector and put the first problem up on the screen. The class as a whole then went through the problems, with the teacher asking students to volunteer their thoughts on where the errors were on the schematics and why those errors would be problematic during the production of the actual figure. When a student gave an answer that actually was not an error, the teacher followed up with that student with questions that helped him or her see why it was not wrong. Throughout the activity, students were using technical terminology to explain and describe the engineering issues captured in the schematics.

After they reviewed the schematics, the teacher directed their attention to the assignment board to review the work that was due later that week: students were responsible for turning in their schematics and drawings produced using the Autodesk Inventor software (a 3D computer-aided design and mechanical design software) that each had on their laptop. He also pointed out the resources that were available to them online through the school’s learning management system. Additionally, the teacher called attention to one of the students in the class who was an expert with the Inventor application; this student had been using the software on his own to design a violin, and the teacher encouraged students to ask him questions when needed.

The rest of the class was time for the students to work on their projects – designing and building a model of the wooden puzzle using small cubes. Before they broke into working groups, the
teacher directed the students to sit on one side of the room if they were comfortable with their plans and next steps. Those who wanted extra guidance were to sit on the opposite side of the room. Eight students took him up on his offer and received an extra workshop session as he walked them through the Autodesk Inventor program interface and the design process. The other students broke off individually or in small groups to work on their projects. With the time remaining in class, the teacher talked with various groups of students, including those who needed extra help with the Autodesk software and those who had individual questions on their design process. The work continued until 2:30 pm when the class ended.

2.2.2.3.4. Mastery assessment system. With their focus on the Metro Habits and instructional practices that best engender active learning by the students, Metro aimed to prepare students for early opportunities to take college-level courses. The Core Prep phase of the students’ education at Metro was considered a college preparatory program, and students had the opportunity to accelerate the pace at which they earned the full set of high school graduation requirements. This was accomplished through a block system where students took one credit of mathematics, science, and humanities each semester. As noted in the previous section on the curriculum, students were required to earn all or most of their high school credits before progressing to a hybrid high school-college course (Learning Center) and then to college coursework. As noted in the design section, a distinguishing feature of Metro’s instruction was mastery learning with the associated assessment system based on the ACT, SAT, and OGT tests. This mastery system was the backbone of the school’s assessment practices and determined student progression through the high school coursework and then the Learning Centers and early college classes. It ensured that students had mastered rigorous college preparatory subject matter.

Under Metro’s mastery system, there were no traditional letter grades assigned. Instead, there was a set of learning targets for each class and students had to achieve 90% of those learning targets in order to pass the class and earn the high school credit. In essence then, Metro’s goal was to take every student and turn them into an “A” student. Furthermore, the benchmarks and learning targets for each class were fully standards-based, not assignment-based. In other words, it was not simply the completion of the assignments such as tests or reports that directly determined the grades for the students, but rather it was demonstration of content mastery through assessments.

The expected level of performance for students at Metro to earn high school credits was set at a high bar. Not only was the pace of the courses accelerated to give students a year’s worth of content and high school credits in a semester-long class, but the level of performance required to attain those credits was elevated. Some Metro teachers expressed in interviews and focus groups that there was an understanding that, in order for a student to have attained “mastery” in their classes, they must have a full level of understanding of the content to the point that they could rigorously apply their knowledge to new situations and also teach that content to someone else. One teacher opined that at other schools, students typically could earn a high school credit for achieving at least a 60% performance level, the traditional cut off for a passing grade. At Metro, by contrast, the requirement to achieve 90% of the learning targets ensured that the students had learned the content to a much more substantial extent.

Achieving “mastery” in a Metro class, however, involved much more than learning the subject
matter content. In interviews and focus groups, the teachers and administrators at Metro consistently emphasized that it was the Metro Habits, in addition to the content covered in the classes, which were crucial for students to develop and demonstrate if they were to attain the 90% mastery performance level. Given the high level of performance required for passing a class at Metro and earning the high school credit, inevitably there were many students that did not earn that credit in their first attempt and were required to retake the class in the next semester. The data coordinator explained that often when you looked at the reasons why students were not able to attain mastery in their first time through a class, the subject matter content was not the only issue. Instead, often that student struggled because he or she did not have the habits needed to master the class.

The engineering teacher similarly reported that students who had to retake his IED class had to do so primarily because of their habits and because they were not being active, responsible decision makers. He felt the content itself was not particularly difficult, but the volume of material covered was large, and the push towards thinking critically via the engineering design process was often a new and difficult challenge for students. Those students with strong habits of mind tended to succeed, but those without a strong foundation in these habits struggled as a result. The engineering teacher further described a variety of ways through which his students could demonstrate mastery. The teacher started the class with about fifteen learning targets that were necessary for students to succeed in an OSU engineering course. The first exam in the class could require mastery on three of those targets but could also cover several other targets that required only a demonstration of progress by the students. If the students showed mastery of the required three targets, they had demonstrated “mastery” for that exam, even if they struggled with or showed only progress on the other targets. Students who were not able to attain mastery on that test could work with the teacher either online or during a lunch period to relearn the material and attempt to show mastery in other ways, including retaking another form of the exam, or working on supplemental projects that cover those learning targets as well. Likewise, if the whole class struggled with the test and the required learning targets, then the teacher would re-teach the material to the whole class and give the test to the whole class again later.

The physics teacher echoed this theme of the importance of the Metro Habits. As she described it:

*I tell them, if you figure out Metro’s system, I promise you that you will have figured out the majority of what college freshmen have to figure out in their first year. This idea that you are responsible for your learning, you are accountable for it. There’s a self-efficacy here that you need to demonstrate, and we will provide everything in our power to get you there. But you have to step up.*

With the mastery system at Metro, then, came a change in how the teachers structured lessons and assessments. Students were given multiple opportunities throughout the semester-long class to attain the 90% benchmark. Teachers used a variety of assignments and assessments through which students could demonstrate their mastery. For example, a biology teacher gave daily vocabulary quizzes, and if a student did not master one, then they could take a make-up quiz to try to demonstrate mastery again. There were mastery projects in biology as well, and if the students did not attain mastery right away, they could re-work the laboratory exercises, correct
their group presentations, or take on supplementary work such as developing a children’s book to teach concepts around cells to younger students in order to show their understanding in the cell unit.

These examples show that resilience was an important character trait students needed to develop to succeed in their Metro coursework and future college coursework. This was echoed by the OSU liaison to Metro:

*One of the things that make Metro students successful is that they are taught to be resilient.... It’s not that no other college students learn how to do that, but at STEM schools, students are intentionally taught those skills. Metro uses the Mastery method to teach them these resilience skills. You don’t just do it for the first time and then move on. You work on it, and you figure out how to re-approach it until you get to mastery.*

For the most part, parents and students expressed appreciation of the Mastery system at Metro. The system required a new mindset for parents to understand how their children could earn an “88%” in classes at Metro yet not earn “mastery” and thus have to do additional work to earn those credits. Additionally, because the program at Metro was accelerated with students taking a full credit each semester, they appreciated the opportunities for students to retake a semester-long class without “wasting” time or falling behind the normal pace of high school credit progression. As the school counselor explained, it was actually better to be giving the students a solid foundation in a course rather than merely passing them on without having that foundation: “I think letting them know that it’s okay to take that course again, it’s okay to take all your courses again, and the next time you’re going to do so much better.” Accordingly, most parents reported being able to see how Metro was getting their children ready to succeed in college, helping them be more self-directed, and putting more responsibility on students to do the work needed to achieve mastery.

There were challenges to the Mastery system, however, and the parents and staff of Metro were open in acknowledging those challenges. Some parents reported that it could be a frustrating transition period for their child from middle school to Metro as they got used to the demands of the Mastery process. Others noted that it could be difficult when their child was at mastery for certain learning targets, but other students were not, leaving teachers in the complicated position of having to both progress forward for those students who were at mastery while also circling back for those who were struggling. These parents appreciated that this Mastery system could make the teachers’ job much harder as a result, and similarly it could be a frustrating experience for those students who had to wait for or help those other students catch up. Some students echoed these sentiments but also noted that students who were struggling had ample opportunities to set up one-on-one office hours and tutoring sessions with the teachers.

An assistant principal and teacher at Metro also remarked that the Mastery system worked particularly well for students in classes which covered content within their “zone of proximal development.” As an example, he brought up the Biology course that used to be required for all incoming freshmen but was sometimes beyond their capabilities due to an inadequate preparation both in content and habits of mind from their middle school experiences. Rather than leave some students behind, teachers had to dilute the difficulty of the class. As a result, as noted in the
previous STEM-Focused Curriculum (CC 1) narrative, Metro had since developed an Environmental Science course that many freshmen took before jumping into Biology. The Environmental Science course provided preparation in science content and critical thinking skills closer to their zones of proximal development, as well as opportunities to develop the Metro Habits and apply the design process to problem solving.

The teachers and administrators at Metro described their work as constantly thinking through and addressing these challenges. With the support that was provided to the students through initiatives such as tutoring sessions outside of the classroom, advisory classes that focused on helping students develop those critical habits of mind, and multiple opportunities to re-address any missed learning targets through alternative assessments, Metro’s Mastery system provided a structure for ensuring true mastery and understanding by their students when earning credits for their high school courses. As one parent noted: “My senior struggled a lot. She took quite a few courses more than once. As a parent, you’re like, ‘Is that very fair?’ As you get the scholarship offers, you’re like ‘Yes, it was very fair.”

2.2.2.3.5. Advanced student work: Design Challenges, gateways, and capstones. Metro’s emphasis on helping their students attain mastery and develop habits of mind came to fruition in several important ways beyond just the earning of high school credits. Each semester at Metro culminated with students from all four grades working together on interdisciplinary projects called Design Challenges. These large projects involved cross-curricular work, crafted by two teams of about 10 teachers each semester. The teams included teachers from all subjects, so that mathematics, sciences, and humanities were all incorporated into the final project. As an example, a previous Design Challenge project on sustainable farming and living in the Columbus region had aspects of biology, mathematics, English, and visual arts. This way, students were responsible for learning the cross-disciplinary subject matter, as well as collaborating and communicating successfully with their teammates, self-monitoring their workloads, and managing their time commitments.

Teachers reported that these Design Challenges were particularly valuable for the 9th graders in that they offered these younger, newer students the opportunity to apply the habits and skills that they developed through their courses in a much larger, more wide-ranging project. In some ways these Design Challenges were still a work in progress for Metro staff; teachers acknowledged that some projects had been more successful than others in combining rigorous content knowledge with meaningful application of skills in the creation of the final product. Nevertheless, these Challenges had been effective in fostering interdisciplinary learning as well as the creativity, critical thinking, and collaboration skills that make up the Metro Habits of Heart and Mind.

Students who completed their high school credit requirements were ready to participate in a Gateway process to prove that they were ready to take on college courses through the College Access phase and Learning Centers. Students generally finished their high school coursework at the end of their second year or at some point during their third year, though administrators noted that the timing was different for each student. The Gateway served as a formal defense of their mastery-level achievements and their attainment of the Metro Habits of Heart and Mind. Students were asked to think about how they were using those habits of mind, what areas of
growth they may still have, and how they had demonstrated those habits in the classroom during their time at Metro. Upon a successful presentation of their evidence of achievement, students were then allowed to move on to a Learning Center course and its companion OSU course.

The learning opportunities that students were exposed to during their time at the Learning Centers is described in more detail in the STEM-Focused Curriculum and Early College sections of this case study (CC 1 and CC6). The goals in having the students take both high school and college courses during this phase of their time at Metro included not just the academic content learning, real world experience, and college credit attainment that comes with the Learning Centers, but also the further development of responsibility, self-efficacy, and work management that started with the Metro habits of mind.

By the end of their senior year, students were required to complete a Capstone project that involved the work they had done during the internship that they completed during their time at Metro, described in detail in the section on Informal Learning (CC 4). These Capstone projects were designed to represent a culmination of the content and skills learning that they had attained at Metro. After completing all of the Metro requirements, then, at the end of their senior year, students presented a formal defense to a panel to demonstrate that they were ready for graduation in a process called the Senior Gateway. According to the Metro Family Handbook, the panel for each student was comprised of a community member with whom the student had worked, a parent or adult advocate, the student’s advisor, a Metro administrator or staff member, and a peer advocate chosen by the student to speak on his or her behalf. The student’s advisor graded the Senior Gateway which had to meet the mastery requirement (90%) for credit.

2.2.2.4. Summary
Metro’s instructional strategies were designed to achieve two goals: readiness for rigorous college coursework and development of skills supportive of learning and future job success. Each teacher at Metro had considerable autonomy in developing his or her own instructional practices based on individual teaching strengths whether inquiry-based activities, laboratory exercises, or direct instruction interspersed with active learning and collaborative learning. The engineering courses used project-based learning and focused on the design process, with students responsible for building their designs, troubleshooting the results, analyzing errors, and cycling back through their design process for revision and improvement. This design process has since been adopted by other content area teachers, and has become a school-wide practice.

The assessment system employed at Metro used mastery learning at the 90% level combined with opportunities to relearn content and retake portions of the assessments not yet mastered. If necessary, students could retake a course the following semester. In addition to mastery of content, Metro also stressed the development of habits of mind, expecting students to be inquiring and engaged learners, critical thinkers, active and responsible decisions makers, and effective communicators and collaborators. Metro used a variety of instructional strategies to help students develop in-depth content knowledge, content-specific skills, as well as the Metro Habits of Heart and Mind; these included group projects, debates, exhibitions, laboratory work, simulations, outdoor study, team teaching, and interdisciplinary learning in the form of yearly challenge designs worked in small groups. Examples of mastery performance assessment items included laboratory reports, projects, research papers, oral presentations, homework portfolios,
and summative assessments using OGT, ACT, SAT, or AP test items.

Administrators and teachers were unified in reporting that those students who had gotten through Metro “have figured out what most college freshmen have to figure out… [they have] demonstrated self-efficacy, responsibility, and advocacy.” And students confirmed that sentiment; as one student summed it up succinctly, “I would say Metro taught you that you’re allowed to be a different kind of learner. Instead of just taking notes from PowerPoint, in general I think they opened us up to a lot of different ways of learning.”

2.2.3. Integrated Innovative Technology Use (CC 3)

2.2.3.1. Definition
Technology connects students with information systems, models, databases, STEM research resources, teachers, mentors, or social networking resources for STEM ideas, and it includes connections made both during and outside the school day.

2.2.3.2. Design
As explained by the CAO, Metro intentionally did not offer any required technology courses; instead, technology was meant to be embedded into every class, with the development of technology skills incorporated into the assignments and projects that students worked on. Similarly, there was no dedicated computer lab at Metro; instead, every student was equipped with his or her own laptop, either one that they owned or one that they obtained through Metro’s one-to-one laptop lease program, further described in the implementation section below. At the time of the site visit, Metro was primarily an Apple Macbook environment, but in the year following the visit, the school shifted to Google Chromebooks. Overall, technology was designed to be ubiquitous at Metro, an indispensable part of the teachers’ instruction and the students’ learning.

Metro’s school year calendar was aligned with OSU’s schedule, with two semesters separated by one 6-week term in January, called “January term” or “J-term.” During J-term, students enrolled in one academic class where students and teachers worked in a blended learning environment, using a combination of in-person classroom sessions and online webinar-style meetings. As the CAO explained, the J-term was intended to be a place where Metro could experiment with a virtual instruction model. Metro also worked closely with Battelle’s STEM Innovation Lab, serving as a validation site to technology products prior to distribution among the other schools in the STEMx network. For example, Battelle and Metro had worked together on innovative uses of TaskStream, MovBand, and Assistments. These innovations are described more fully below.

2.2.3.3. Implementation

2.2.3.3.1. Technology-rich culture. Metro was a fully wireless campus, and students and teachers at Metro used technology in their classrooms daily. This allowed students and teachers to develop technology skills on an ongoing basis. In a focus group discussing the use of technology at Metro, teachers reported that incoming 9th graders at Metro had a very diverse range of technological abilities when starting at the school, with some able to write programs and others quite unfamiliar with the internet and computers in general. Nevertheless, the teachers
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reported that all students ultimately graduated from Metro with a solid foundation of skills as a result of constantly working with technology and software.

Students also confirmed Metro’s emphasis on technology. One student commented that, “We basically couldn’t function in this school without technology.” And another student quickly confirmed, “If you don’t have your laptop for a day, that’s a really bad day for you.” Summing up the conversation, a third student said, “We’re a nerdy school; we like our technology and are proud to admit it.” A focus group of parents also commented on the strength of Metro’s technology approach. One parent expressed it in terms of preparation for the world of work:

My son can do anything he needs to do on that computer. When he goes into the workforce, I don’t see there being too many tasks he’s not going to be able to do. He has no fear of the technology. It just adds to their [Metro students’] confidence.

2.2.3.3.2. Student laptops and home internet access. Students at Metro were required to have a laptop computer during their time at the school. They could bring their own laptop if they had one; otherwise, Metro had a one-to-one student laptop lease program. The full laptop lease cost for students was $150 for the year, with discounts for students that qualified for Free or Reduced Price (FRP) lunches. The discounted lease cost was $40 for students eligible for reduced-price lunches, and it was free for those who qualified for free lunches. Students were responsible for any damage to or loss of the computer, and they could purchase laptop insurance from a company that Metro had a partnership with and offered a discount to students.

In addition to computers, students were expected to have internet access outside of school in order to be able to complete their school work, access the various online platforms used at Metro, and participate in online, virtual classrooms. As a student explained in a focus group, “We pretty much can’t live without the internet. We’re dependent.” In a school where a significant portion of the student body qualified for FRP lunches (nearly 30% in 2012-2013), the teachers and administrators were sensitive to the fact that some families could find the cost of home internet access beyond their reach. However, teachers reported that almost all of their families did have internet access at home; students who did not went to public wifi spots such as the local library. Overall, teachers and administrators reported that no parents had raised this as an issue.

2.2.3.3.3. Technology and classroom instruction. When hiring new teachers, Principal Aimee Kennedy looked for teachers with some technology literacy and comfort. The job descriptions for teachers at Metro included a requirement for literacy in electronic communication and online course management; early on, new teachers also received training on the platforms and instructional technology at Metro. All twenty-one teachers at Metro completed an online survey prior to the research team’s site visit, and on this survey, each of the teachers at Metro, both in STEM and non-STEM courses, reported having their students use the available technology in some way to create, present, and work on their class assignments and projects. Table 6 presents results from this survey:

Table 6
Use of Technology in Classrooms at Metro
Question – Identify all of the following ways that students use computers in your classroom:

<table>
<thead>
<tr>
<th>Question</th>
<th>Percent responding “Yes”</th>
</tr>
</thead>
<tbody>
<tr>
<td>To organize and store information</td>
<td>100%</td>
</tr>
<tr>
<td>To collect data and perform measurements</td>
<td>57%</td>
</tr>
<tr>
<td>To manipulate/analyze/interpret data</td>
<td>57%</td>
</tr>
<tr>
<td>To communicate information as a result of investigations</td>
<td>76%</td>
</tr>
<tr>
<td>To create visual displays of data/information (e.g., graphs, charts, maps)</td>
<td>90%</td>
</tr>
<tr>
<td>To plan, draft, proofread, revise, and publish written text</td>
<td>95%</td>
</tr>
<tr>
<td>To create graphics or visuals of non-data products (e.g., diagrams, pictures, figures)</td>
<td>76%</td>
</tr>
<tr>
<td>To create visual representations</td>
<td>90%</td>
</tr>
<tr>
<td>To perform calculations</td>
<td>52%</td>
</tr>
<tr>
<td>To create models or simulations</td>
<td>38%</td>
</tr>
<tr>
<td>To support individualized learning</td>
<td>90%</td>
</tr>
<tr>
<td>For remediation for basic skills</td>
<td>90%</td>
</tr>
<tr>
<td>To compensate for a disability or limitation</td>
<td>67%</td>
</tr>
</tbody>
</table>

Note. This survey question was completed by all twenty-one teachers (STEM and non-STEM) at Metro.

Metro’s teachers used three main platforms to manage their classes and assess students. Teachers and students primarily used a learning management system called TaskStream, a cloud-based platform on which teachers could post course materials such as homework assignments, project-related documents, supplemental external resources (journal articles and other such source materials), and even videos of their lectures for students to access at any time. Teachers also posted their course schedules, syllabi, and learning targets on TaskStream so that students could see what was covered in class if they had missed any classes. Likewise, students posted their completed assignments to TaskStream in order to turn them in to their teachers; the submissions were automatically time stamped, thus holding students accountable and responsible for getting their work in on time. New teachers were trained by veteran teachers and administrators on the TaskStream platform in their initial professional development days before classes began, and they were given the freedom to use the platform however it fit best with their instructional style. Several teachers reported taking the platform to innovative levels, setting up a comprehensive cloud-based portal for their class that allowed students the flexibility and autonomy to access critical materials from any location.

Teachers at Metro also used an online program called Assistments to administer their class tests and exams. The program allowed them to create questions and answer keys in any format they liked—multiple choice, short answer, or longer essays—and then release the test for the students to take on their laptops during class. One valuable benefit of the platform was that teachers were able to track in real time how the students were responding to questions as they were taking the assessment. For example, a mathematics teacher explained that if she noticed that a student was stuck on a question for several minutes, she could go over to that student and “nudge them and say ‘get to work.’” Since the platform graded work in real time teachers were able to immediately post class results for shorter quizzes, allowing prompt discussion of the questions and concepts covered, increasing the formative value of these assessments.

The third main platform in use at Metro was PowerSchool, an application widely used by schools to track mastery grades, attendance, demographics, and other administrative matters. Metro used
PowerSchool to track the students’ progression towards mastery in their courses, and students and parents had login access to their own profiles allowing them to monitor and keep track of their progress. The PowerSchool platform, along with in-person meetings, Skype technologies, and email communication, allowed teachers and parents to remain in constant contact about their students’ performance at Metro.

In terms of hardware in the classrooms, teachers reported that Metro had gradually become a primarily Apple-centered environment. Students leased MacBook Pros from the school (although, since the time of the site visit, the school shifted to Google Chromebooks), and classrooms were outfitted with Apple TV equipment, Airplay, and wireless projectors with Bluetooth speakers. These resources allowed teachers to easily display videos, interactive documents, and virtual whiteboards from their Apple laptops or iPads during their classes. During a trigonometry class, for example, the teacher reviewed a problem worksheet with his students using an application on his iPad that allowed him to project an interactive version of the sheet onto the main screen in the room. He was free to walk around the room while writing on his iPad as a virtual whiteboard, making eye contact with and asking follow-up questions directly to all of the students as they talked through the problems as a class. The teacher, in other words, was not handcuffed to the front of the room where a traditional chalkboard or whiteboard is usually situated, and he was better able to engage with his students as a result. Additionally, he was then able to post a video of the class with the recorded progression of work on his iPad and virtual whiteboard to TaskStream for students to review at home when needed.

In a focus group on technology, an English teacher noted that she included technology activities knowing that her students would need technology skills to succeed in the future at college. There was no separate class at Metro that taught the basics of Microsoft Word, Excel, or Powerpoint; rather, assignments using these programs were intertwined into all of the classes in the school such that students graduated and went to college as relative experts in these programs. Additionally, students had the opportunity to use more advanced, up-to-date programs and applications for their assignments and presentations. For example, students and teachers alike reported a routine use of iMovie and Prezi (a cloud-based presentation software) for the many ten-minute presentations that students did in science and other courses. Other courses asked students to create podcasts. For example, the social studies teacher used a project on Supreme Court cases where students took on the roles of each of the justices and created a podcast acting out a justice’s ruling on a case; the students then uploaded the podcasts to YouTube making them available to the public. The English teacher also described an instance where a small group of students participated in an event known as WebSLAM (http://www.webslam.org). These students participated in workshops to learn advanced web skills then applied these skills to design and develop websites for non-profit organizations in the Columbus area. They then presented their work in a capstone event judged by Columbus’ top technology, design, education, and business leaders.

Because every student had his or her own laptop computer to use during class and outside of class time, administrators indicated that there was no need for a dedicated computer lab at Metro. Science classes were held in fully equipped laboratory classrooms. The chemistry lab was outfitted with a chemical fume hood, safety shower, preparation room, and ample access to equipment such as micropipettes. Similarly, the biology classroom was filled with aquariums and
other living specimens, a full set of microscopes, and other advanced biological equipment, such as centrifuges and incubators.

A larger departure from typical high school lab facilities was the up-to-date engineering technology and equipment. Metro procured this equipment early in its history using a $50,000 Ohio STEM grant awarded to the school through a competitive process. Metro’s fabrication laboratory (Fab Lab) included several 3D printers and computer numerical control (CNC) machines that had the capability to build models or cut objects out of starting materials such as plywood, plastics, or metals. Students in the Principles of Engineering and Introduction to Engineering and Design classes were taught how to use 3-D computer aided design (CAD) software to design objects that they then built using these 3D printers and milling machines. For example, one student reported that his group used CAD software and CNC machines to design and build a roller coaster for a prior school-wide Design Challenge—the large scale, interdisciplinary project in which all Metro students participate in each semester. This group eventually took their completed roller coaster to a regional competition at the Center of Science and Industry (COSI) museum in downtown Columbus, where they competed against several other STEM schools.

Metro also had a strong robotics team called the Metrobots, described in further detail in the section on Blended Formal/Informal Learning (CC 4). This robotics team also used the CAD software and Fab Lab equipment extensively as they designed and built their robots for national competitions. In addition to the 3D printers and CNC machines, the work space also included etching tools, large saws, and cutters that could cut materials up to 4’ by 8’. This work space was housed in a building across the street from Metro provided by the PAST Foundation, a partner organization described in more detail in the Real-World STEM Partnerships (CC 5) section.

Overall, in the online survey administered prior to the site visit, the STEM teachers indicated that they had good access to technology resources and that this access had a positive effect on their STEM instruction, as shown in Tables 7 and 8.

<table>
<thead>
<tr>
<th>Table 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers’ Access to Technology Resources</td>
</tr>
<tr>
<td>Question – Rate your access to the following resources:</td>
</tr>
<tr>
<td>Funds for purchasing technology for STEM</td>
</tr>
<tr>
<td>Access to calculators for STEM instruction</td>
</tr>
<tr>
<td>Access to computer hardware for STEM instruction</td>
</tr>
<tr>
<td>Access to computer software for STEM instruction</td>
</tr>
<tr>
<td>Access to other instructional technology for STEM instruction</td>
</tr>
</tbody>
</table>

*Note. *1 = No access, 2 = Limited access, 3 = Adequate access.

<table>
<thead>
<tr>
<th>Table 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers’ Value of Technology Resources</td>
</tr>
</tbody>
</table>

37
Question – Rate the effect of your access to the following on your STEM instruction:

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean of Responses, on a Scale of 1-5*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Funds for purchasing technology for STEM</td>
<td>4.6</td>
</tr>
<tr>
<td>Access to calculators for STEM instruction</td>
<td>4.3</td>
</tr>
<tr>
<td>Access to computer hardware for STEM instruction</td>
<td>5.0</td>
</tr>
<tr>
<td>Access to computer software for STEM instruction</td>
<td>4.8</td>
</tr>
<tr>
<td>Access to other instructional technology for STEM instruction</td>
<td>4.8</td>
</tr>
</tbody>
</table>

Note. *1 = Inhibits effective instruction, 2 = Somewhat inhibits effective instruction, 3 = Neutral or mixed, 4 = Somewhat facilitates effective instruction, 5 = Encourages or enables effective instruction.

2.2.3.3.4. Virtual classrooms. Metro’s teachers had access to the Adobe Connect platform that allowed them to establish a virtual classroom fully equipped with video, audio, whiteboard, and content uploading capabilities. They primarily used this platform for their “January term” or “J-term,” their 6-week session between their fall and spring semesters during which every teacher offered a blended in-person and virtual course. Typically, these courses met twice per week in person, twice per week online, and once a week for those doing independent studies, but each teacher set up his or her class slightly differently. For example, the Wellness class met online twice a week and spent three days a week onsite at the OSU activity center for physical activities. The English teacher set up her class to meet twice a week onsite at Metro for certain lessons, assessments, and discussions; the other two days a week were spent online in the virtual classroom, where they would have group discussions and also break out into smaller group work sessions.

With these virtual classrooms, teachers and students were able to hold their classes even during snow days. As a parent reported, “One thing I liked about this technology is that when we have snow days, the learning doesn’t stop. He can get into Adobe Connect, and there’s no problem.” A student also explained:

When a snow day is announced, everyone stays home and teachers send out links to class. We have Adobe Connect meetings or group Skyping, and we don’t miss any class, and so we don’t run longer into summer.

Parents and students liked the convenience of being able to continue their classes during snow days. “It’s not bad to have class in your pajamas and eat when you want to,” as one student said. Teachers similarly appreciated the ability to avoid major disruptions in their course timelines and schedules by delivering lectures and other instructional activities over the Adobe Connect platform.

2.2.3.3.5. IT support and new technology. In order for these instructional technology innovations to work for Metro’s students and teachers, the technology infrastructure had to be strong and reliable. Metro had two technology support staff, one full time and one part time, hired from a technology services support organization. Students and teachers universally praised this technology support staff, who were treated as members of the Metro family and were
responsible for the maintenance and troubleshooting of Metro’s servers, network, and hardware. As one teacher stated, “These guys earn their paychecks. They’re always a great resource to have.” Additionally, they trained several of the Metro students who were interested in advanced technological skills and capabilities; these students were then available to provide technical support to teachers and students when needed. Not only did this serve to flatten the hierarchy of technological knowledge at Metro, but it also served to extend student learning. As a teacher explained, “The ability to troubleshoot, with that analysis and critical thinking portion, is further developed. That happens without them thinking about it or knowing that it's happening” as they help address a technology issue on campus.

Finally, teachers reported that Metro’s partnership with Battelle had been very beneficial for continuing to build their instructional technology capacity. For example, Battelle provided mentor engineers to help teach Metro’s robotics team the C++ or Java programming for their robots. Battelle and Metro also partnered as Metro served as a demonstration and validation site for new instructional technology innovations before scaling up among more schools. As a result, when new technologies were being developed for the education field, Battelle was able to provide them to Metro for a first test of how well they work in classroom settings. As an example, Metro tried out the Assistments platform to build, administer, grade, and analyze their tests and exams. After Metro’s trial, Battelle distributed Assistments more widely in its STEMx network, and Metro teachers became the trainers for teachers from other schools in how to use the program. Similarly, for the Wellness class, the Metro teacher reported using a new MovBand technology which allowed his students to collect more detailed data around their full movement during activities, rather than simply counting the number of steps they took in a workout, for example. This data could then be uploaded to each student’s and the teacher’s computers, allowing students to more comprehensively track their work and progress, and enabling the teacher to get a better sense of how his students were doing.

2.2.3.4. Summary
Students at Metro came in with varying degrees of technological capabilities and comfort, but they all graduated from Metro having had many opportunities to develop both foundational and advanced technology skills. Metro’s teachers had a constantly growing range of instructional technology available for their classes, allowing them to better engage their students, manage their classrooms, deliver their content, and use their assessments for formative purposes. This technology had also been seamlessly integrated with students’ coursework and informal STEM activities, particularly in the case of the engineering classes and robotics team. The facilities, equipment, and support that Metro students could access gave them excellent opportunities to apply their content knowledge creatively and further develop their problem solving and critical thinking skills.

2.2.4. Blended Formal/Informal Learning Beyond the Typical School Day, Week, or Year (CC 4)

2.2.4.1. Definition
This component includes learning opportunities that are not bounded but ubiquitous, where learning spills into areas regarded as informal STEM education, including apprenticeships, mentoring, social networking, and doing STEM in locations off of the school site, e.g., in the
community, museums and STEM centers, and business and industry.

2.2.4.2. Design
The learning experience designed for students at Metro included several forms of informal learning opportunities. First, students were expected to participate in 70 hours of service learning each year – including 30 hours within their advisory, and 40 hours on their own outside of school. As students described them, these service learning experiences were designed to allow them to engage with organizations or causes of their choice and in ways they chose.

Second, students participated in professional settings through internships and job shadowing. Semester-long internships occurred during students’ third or fourth year at Metro. As the CAO of Metro explained, these internships were intended to provide opportunities for students to apply the skills they had built in classes in a professional work setting. At the end of the internship, students participated in an exhibition, presenting quantitative and qualitative research data, results, and recommendations related to a question they found of interest and explored during their internship. The school had an internship advisor who provided assistance to students in landing an internship with a local business or organization. In addition to internships, students were also expected to participate in a one-day job-shadowing experience each year, which they arranged themselves.

Finally, among the available clubs at Metro was the large and active robotics team. The robotics club, known as the Metrobots, connected to the school engineering curriculum, particularly the 9th grade Introduction to Engineering and Design class. The Metrobots participated in FIRST robotics competitions, had three staff advisors, and received financial and material support from the PAST Foundation and other corporate sponsors.

2.2.4.3. Implementation

2.2.4.3.1. Service learning. Students and parents reported that service learning work was woven into several contexts at Metro. Their “signature student-led service learning event” was MetroThon, an annual philanthropic event started in 2010 and described as “A Party With a Purpose.” This six-hour dance marathon was a charity fundraiser to benefit the Hematology/Oncology Department of Nationwide Children’s Hospital in Columbus, Ohio. As described on their Children’s Miracle Network Hospitals website (http://www.helpmakemiracles.org):

Our students are committed to helping families of children dealing with pediatric cancer. 100% of the money we raise goes to our local Children's Hospital. MetroThon [involves] the entire student body dancing and playing games in order to "stand up for those who cannot stand up for themselves." Each student has been asked to try and raise at least $25 in pledges.

In its first 5 years of operation, MetroThon raised over $55,000 for the hospital. In their focus group, several parents noted how well Metro fostered this extension of student service work into the local community:

[Parent 1] Last year they had their fundraiser for a children’s hospital; everyone was focused on
METRO EARLY COLLEGE HIGH SCHOOL: A CASE STUDY

MetroThon... The children all knew about cancer and what was going on in these kids’ lives. It was like the recipients were part of the school as well, even though they had never met them. They were working for the cause and that educated them. This school teaches you that you need to be involved in the community as well.

[Parent 2] I think Ms. Kennedy says it best, she says, “We love our juniors and seniors but we want them out in the community.” The learning doesn’t just go on in this building.

Students publicized their MetroThon work through videos posted on YouTube (see, for example, http://www.youtube.com/watch?v=hRazGHzrfKY) and Facebook pages (https://www.facebook.com/pages/MetroThon/172922129404186).

Additional service learning opportunities included members of Metro’s robotics club (the Metrobots) providing robotics support and mentoring to students in nearby middle schools. Students explained that, while this counted as service hours, it also functioned as a recruiting strategy, showing middle school students the experiences and opportunities they could have at Metro. Other service projects included running e-cycling events and “helping the PAST foundation coordinate the Annual Spring Fling, a STEM-centered challenge and competition for Columbus-area elementary, middle and high schools” (http://robotics.themetroschool.org/outreach) in which participants constructed machinery such as catapults.

Another context of service learning was in advisory, where each advisory group selected a project for the year. Students reported that “the advisor usually picks an organization they care about.” One advisory, for example, was working on behalf of Dress for Success, a national organization serving disadvantaged women by “providing professional attire, a network of support and the career development tools to help women thrive in work and in life” (http://www.dressforsuccess.org). These students created an iMovie about how to use PowerPoint and other computer applications, to help program participants build computer skills and increase their chance of gaining employment. Other advisory service projects included taking a group of 4th graders to the Center of Science and Industry (COSI) located in downtown Columbus to learn about science, and creating a senior wall for the front lobby of the school. Challenges to these advisory service projects included scheduling conflicts between advisory and Ohio State University (OSU) classes for those in upper grades that delayed service projects, and the ability of advisors to enact these projects—as one student opined, “some advisors are lazy and don’t do very much.”

Individual student service projects included working with local businesses during the summer and working at a summer music camp, in which students designed programs and conducted community outreach.

2.2.4.3.2. Internships and job shadowing. All students at Metro completed a semester-long, 60-hour internship in professional settings. According to Principal Kennedy, the internships were normally completed during junior or senior year so that “we already know that they have worked on their Metro habits, are responsible, and show good behavior.” Additionally, the internship was a graduation requirement because, as the principal explained, “we want every kid to have at least one internship, no matter whether you’re going to college early or not, we think it’s
important that you experience the context of career, business world.” One parent confirmed this view of the role of internships in student growth:

_They force them to step outside their comfort zones. My son ended up doing an internship this year at OSU. Not something he was interested in, but it ended up being a good fit. He was studying neurons, helping tag the mice, etc. I think he would be content to be a science teacher. From the time he met a couple people on staff here he was like I’m going to get my PhD. It forced him to think, “I don’t have to limit myself to this. I can do as much as I want and take this as far as I want to go.”_  

Metro’s internship coordinator provided support for Metro students throughout the internship process. His normal teaching load included two Wellness classes, a reduced teaching load compared to other teachers that allowed him to dedicate the rest of his time in the middle of the school day to visit and mentor Metro students at their internship sites. Additionally, students enrolled in an internship course run by the coordinator during their intern experience. At the beginning of the term, students met “for about a week, every single day, kids getting resume ready,” as described by the internship coordinator. “We have a list of internship sites where people have been willing to host Metro students... We don’t really have trouble getting anyone placed.” Students reported that “You can also set up your own if you have a contact at a local business… If you know someone in the community, who you are interested in working with and they are interested in working with you, that’s fine.” The coordinator also reported that:

_Internships run the gamut from working at the flower shop next door and helping them systematize their ordering process and develop a brochure, all the way to joining an NSF-funded research study in a lab at OSU that requires training around working on human subjects. The whole range of opportunity exists for kids._

After students were placed in their internships, the internship coordinator conducted a weekly seminar for Metro students at the Metro campus during the rest of the internship experience. These seminars provided time for students to discuss their experiences with each other and for the coordinator to monitor their work and progress in their positions. Students earned the required high school internship credit by completing this seminar and the 60 hours of internship work over the semester.

Parents spoke positively in focus groups about the internship experience:

_My daughter went through the energy program [a Learning Center], got a C in her first college class in OSU in physics, and her internship is the environmental steward program at the mayor’s office. She wants to be an environmental advocate now. It transformed her life. She was going in and giving presentations to adults, and they thought she was a professional. Even though there is this little girl part of her that feels she’s stupid, now she feels she can change the word and that’s all due to Metro._

Two themes emerged about internships from student and parent focus groups: the professional skills students developed and the benefit of the experience from the perspective of future career goals. Parents and students both commented on the benefits of having the opportunity to give
presentations in the world of work and linked those experiences to required formal presentations at Metro such as the Gateway and Capstone projects. Some students and parents also commented that, even if the student found out they were not interested in a particular career trajectory through their internships, it was still a benefit to them to have had the opportunity before high school graduation to learn those lessons. There were, of course, a number of students whose internship experiences positively reinforced their career interests. For example, one student described the progression of her internship experience and career interests:

I am interning at the OSU sustainable farm. It is student-run, facilitated by a professor in horticulture and a doctoral student in organic farming. I work with their head of marketing. It’s a really small group; I work on the farm too, work in the greenhouse. I wanted to do a research project and thought it would be perfect for my internship poster. They’ve been having problems with water retention and soil, needed optimal soil to use, so I told them I would take that on, find a better soil mix. Now I have 800 kale plants in greenhouse, testing to see how much fertilizer helps during seeding and growth stages. Right now I’m using compost tea—brewed like tea—and looking for a better soil mix. Now five to six weeks into this experiment, I think I have found one....

I will probably keep working there this summer, will probably stay and help with marketing, help on the farm. Try to continue there for my capstone and next fall. People are really great, a lot of fun. And they realize I know what I’m talking about, there are things I can teach them and things they can teach me. I’m very interested in continuing with farming and environmental science, particularly food science... I want to know where food comes from, what it means when an ingredient works, the chemistry of food, but also the economic side and social side of food.

All students were also required to complete a job shadowing activity at a local business or non-profit organization each year. This was a one day experience arranged by the student. Students in a focus group described their job shadowing experiences, and it was clear that each had connected to an area of interest to them personally:

[Student 1] I found it very helpful because I got to go to a few place I was actually interested in working at. I went to Write-Patterson Air Force base to do some aeronautical engineering. I also went to the NASA-Glenn research center and I got to talk with engineers in the field and find out what their day-to-day life was like. Most people just see the rocket go off, but I was able to see what actually goes into that.

[Student 2] I went to PetSmart and work with Veterinarians to find out if I wanted to be a vet, and now I’m in robotics because I found out I didn’t necessarily want to be a Veterinarian. I have more information work with.

[Student 3] I shadowed my neighbor who works at Honda. He was making a new car that he scaled down and sent it to a toy company that makes the actual car to send to the leadership as examples.

2.2.4.3.3. Robotics. The Robotics club was an important part of Metro. While other student clubs (such as a journalism club, a drama club, and an environmental club) rose and fell based on
changing student interest, the robotics team persisted in attracting consistently high levels of interest among Metro’s student body. The team in the 2012-2013 school year consisted of 67 students. As one student put it, “Robotics? That is our sport.” The team attended competitions across the state, and they had financial and volunteer support from organizations such as the PAST Foundation, Boeing, Honda of America, Battelle, OSU, and Ohio Power Tools. Students worked in teams, and they built robots weighing up to 100 pounds. A student described the inclusive feel of the team:

*The robotics team loves everyone who wants to be there. It doesn’t matter if you have an engineering background or experience. We even have people on the team who don’t necessarily want to be engineers, but there are so many different aspects to it. Our goal is to teach people more about building things works, the design process, and what engineering is as well. Our goal is take everyone and turn them into tiny little engineers.*

Students accordingly spent extensive hours designing and building their robots, and described it as “a big time commitment.”

In addition to its robot building and competition, the Metrobots also completed service hours by mentoring younger students in various middle schools in the area. This was a mentoring opportunity, but it also served as a recruiting strategy, showing middle school students the experiences and opportunities they could have at Metro.

2.2.4.3.4. Networking and professional interaction. Finally, outside of the informal learning opportunities specifically designed and supported by the school, alumni students described one of the most important informal learning experiences was their interactions with the many adults which they worked while students at Metro. “I remember sophomore or junior year we had this awful assignment and I have never called so many people in my life. It was a dead end. But it did teach me professionalism.” Another student, after failing to get enough students signed up for a workshop, went back with her project members to discuss the issue with their Metro teacher. After that, they “met with everyone again and this time they took us seriously, so all the applications kept coming in. It really taught us to network.” Now that they were in college, these alumni felt that these experiences of reaching out to the community, regularly interacting with staff from the district and the Battelle Foundation, and faculty from OSU helped them to develop networking skills and a professional manner far more polished than students from other high schools. “I always ask for business cards and send out an email [afterward]. To me it’s common sense but to others it’s so new.”

2.2.4.4. Summary

Students at Metro had extensive and varied opportunities to work and learn outside the classroom. Their service learning hours, job shadowing activities, and internship experiences all put them in positions of representing themselves in a professional manner, experiencing the workplaces of various occupations, and helped them rehearse various types of work for themselves. Even within some classroom assignments at Metro, students had extensive interaction with adults, and they had to successfully network. Responsibility and the Metro “habits of mind” were emphasized within the school, yet students were regularly asked to put these skills to work outside the classroom as well.
2.2.5. Real-World STEM Partnerships (CC 5)

2.2.5.1. Definition
This component includes students connecting to the business and industry world through mentorships, internships, or projects that occur within or outside the normal school day or year.

2.2.5.2. Design
Metro had two major institutional partners, Battelle Memorial Institute (Battelle) and The Ohio State University (OSU). Both Battelle and OSU were founding partners of Metro, contributing to the planning and design of the Metro early college high school model. Each organization also held three seats on Metro’s nine-member Governing Board, with the remaining three seats held by a combination of representatives from local school districts, two of which were from the Columbus City Schools District. According to Metro’s website, the Governing Board “advises and assists the school with matters such as curriculum, school evaluation and research, professional development, funding and community relations” (http://www.themetroschool.org).

Battelle and OSU have donated generously to the Metro program, approximately $9 million combined over five years, according to a Battelle representative. They also have contributed significantly to the implementation of the school’s design, as described in the section that follows.

For its educational program, the design of Metro was organized around an agreement with OSU and Columbus State Community College for Metro students to take college-level courses. OSU also partnered with Columbus State on a “pathway program” in which students could go to Columbus State for two years after high school and then transfer to OSU. According to Metro’s school counselor, the intent was to provide a smooth transition with students transferring to OSU after completing the first two years of their program including core requirements. The students in the pathway program had both Columbus State and OSU advisors. This agreement provided free tuition if students completed their first two years at Columbus State and then completed their second two years at OSU. Thus, together with the early college coursework completed during high school, Metro students had the opportunity to complete their bachelor degrees tuition-free.

In addition, according to the school’s website, Metro intentionally provided their students with the opportunity to work with other partners aside from OSU and Battelle through their Learning Center experiences. These partners included “COSI, the Franklin Park Conservatory, WOSU, Edison Welding Institute, Mid-Ohio Regional planning Commission, the PAST Foundation, Defense Supply Construction Center (DSCC) and others” (http://www.themetroschool.org). All students at Metro were also required to complete a one-day job shadowing activity at a local business or non-profit organization of their choice each year. According to the CAO of Metro, the intent was to provide exposure to career work in a field they might be interesting in pursuing in college or future career. More importantly, Metro had a high school graduation requirement for a 60 hour internship and accompanying internship seminar. Metro had an internship coordinator on staff who coordinated this program and provided students and their business partners support before and during their internships. Additional details on these requirements are described in the Blended Formal/Informal Learning (CC 4) section of the case study.
2.2.5.3. Implementation

2.2.5.3.1. Educational and college partnerships. Metro’s partnerships with OSU and Columbus State provided opportunities for their students to have college-related experiences beginning in ninth grade and extending throughout their high school years. Each year, Metro scheduled a college visitation day during which time the entire school went on college visits. Principal Kennedy explained:

We’ll take freshman, sophomores, juniors, and seniors, and they have to go. There is no excuse. We put them on a bus and go to different colleges throughout the state. That in itself is amazing, and lots of schools don’t have that opportunity. By the time they are seniors, they have at least been exposed to three college campuses.

These college visits included Columbus State, a partner with OSU located 10 minutes from the Metro campus. A teacher described taking a group of 15 students there and the opportunity Columbus State provided for the Metro students:

They had a STEM day and the kids got to choose different hands-on projects and had to choose a project that wasn’t the gender norm for them. Let’s say there was a vet tech, construction, and they had to do hands-on experiences and one of them had to be something that wasn’t a career heavily in their gender which was really cool because it exposed them to that. And of course they gave all the info on what the college offers and how they’re partnered with OSU. They got exposed to the careers and the college.

These students’ college experiences were successful partly because Metro and OSU worked closely together during the implementation stage of their early college program. Teachers and administrators reported that OSU and Metro faculty met on a regular basis to align their curriculum, make changes to improve the program for Metro students, and plan and implement new college-level learning opportunities for Metro students. For example, early feedback from OSU led to the implementation of a transitional program, which one teacher described as an “on ramp.” More details on the early college program are provided in the section on Early College-level Coursework (CC 6).

In addition, OSU was a critically important partner in Metro’s themed Learning Centers (e.g. Biomedicine, Design, Energy) that combined high school courses with OSU courses. OSU provided faculty from STEM departments to teach the college component of these hybrid courses. OSU had a committee focused on issues related to Metro, chaired by an Assistant Provost, and this committee worked with OSU deans and STEM faculty to solicit their involvement and support of Metro. Metro could also reach out to this Assistant Provost when they had ideas for potential Learning Center topics. The OSU-Metro partnership was further bolstered by the full-time academic advisor that OSU provided and who was located at Metro. She was dedicated to supporting the Metro students and their families and figuring out whether the Learning Center classes would work with the students’ needed credits and requirements. Finally, OSU provided tutoring support after normal school hours on Tuesdays, Wednesdays, and Thursdays at Metro, with both OSU professors and students coming to the Metro campus to tutor in specific content areas.
In addition to OSU, Metro developed partnerships with other high schools in the local Columbus area with which to offer Learning Centers. This partnership provided college faculty resources for dual enrollment courses through the Learning Centers. As a result, the Learning Center courses were not just for Metro students; Principal Kennedy indicated that they had developed these partnerships with other local school districts to share teachers and students in this focused, career-exploration, early-college program. The Principal reported that once Metro and OSU prepared a new Learning Center, they took the idea to other local high schools. There are five different high schools that have partnered with Metro on Learning Centers, some for an extended period of time, and both the administration and students commented on the benefits of mingling teachers and students from different schools as a transition from high school to college. These Learning Centers are described in more detail in the sections on STEM-Focused Curriculum (CC 1), Reform-Based Instructional Practices (CC 2), and Early College-Level Coursework (CC 6).

2.2.5.3.2. Business partnerships. Metro’s business partners played a large role in the internships and job shadowing opportunities that students were required to complete. While Battelle was a major founding partner and hosted about 15 Metro interns all together, there were other business partners involved in the internship component of Metro’s model. Students could find an internship themselves with an organization, or reach out to one or more businesses that had hosted Metro interns previously. These internships and other learning opportunities outside the classroom are described in more detail in the Blended Formal/Informal Learning (CC 4) and Supports for Under-Represented Students (CC 10) narratives of this case study.

The PAST Foundation, a non-profit organization in Columbus, Ohio dedicated to “promoting transdisciplinary, problem-based STEM learning” (http://pastfoundation.org), worked closely with Metro’s teachers through professional development work. As the principal explained, the PAST Foundation hired some of Metro’s teachers to provide professional development services to local elementary schools, thus adding to the formal and informal connections that Metro had with businesses and schools in the area. The PAST Foundation was also a major sponsor and partner of the Metro Robotics team, called Metrobots, providing both mentors and facilities for the team across the street from Metro. There were other mentoring partners as well, including Battelle and local companies such as Honda, American Electric Power (AEP) Ohio, Ohio Valley Testing, and other local technology and engineering firms. These partners provided critical resources including mentors, tools, and supplies. Some also contributed to the funds the Robotics club needed to compete, including the $5,000 entry fee. Major partners supporting this club at the time of our visit provided four Battelle professionals who mentored students particularly on the programming, and four engineers each from Honda and Ohio Valley Testing. Business partners were acknowledged on the team t-shirt as shown in Figure 1.

The PAST Foundation reached out to Metro to support informal learning in other ways. For example, at the time of our visit, they were sponsoring a challenge competition known as “Spring Fling.” Students designed and constructed catapults to throw water balloons and other projectiles. During a faculty meeting we observed, the Principal and an engineering teacher, whose students had participated the previous year, encouraged teachers to consider having their advisories participate in the competition this year. They thought that it would serve as a fun, multi-week project for their advisories, built-in and structured for them already.
2.2.5.3.3. Battelle and STEM learning networks. As described in the Design portion for this critical component, Battelle, the world’s largest non-profit research and development organization (http://www.battelle.org), was a founding partner of Metro that continued to actively support the school through its STEM education initiatives. According to their website, Battelle’s priorities around STEM education included a focus on “developing and spreading innovative STEM education practices and leveraging state-based STEM learning networks” (http://www.battelle.org). Battelle and OSU founded Metro, the first school with which Battelle was involved with these priorities in mind according to the Battelle representative we interviewed during the site visit. She further explained that after Metro began operations, Ohio’s governor’s office took notice and let Battelle know that this STEM high school model was something the state wanted to pursue. The Gates Foundation later became involved and provided funding to help Battelle’s Ohio STEM Learning Network (OSLN) replicate the Metro model with matching funds from the state of Ohio, according to the Battelle representative. More details on the founding and development of Metro are provided in the Administrative Structure (CC 9) section of this case study.

In addition to the OSLN, Battelle managed STEM learning networks in Tennessee and Washington, DC, and were involved with STEM high schools in Washington state, as reported by the Battelle representative. Battelle has also built and managed a multi-state STEM network called STEMx, which was composed of 19 state STEM networks at the time of the site visit; STEMx aimed to provide “an accessible platform to share, analyze and disseminate quality STEM education tools to transform education, expand the number of STEM teachers, increase student achievement in STEM and grow tomorrow’s innovators” (http://www.stemx.us). According to Principal Kennedy, this STEMx network served to enhance their members’ leverage for STEM policy initiatives:

*If [these] states want to lobby about innovative schools or math and science education, they have
that power. It also provides a way for best practices to be shared and for innovative educators to share and be connected, either formally or informally.

Battelle’s educational strategy thus had a national reach, but they maintained an active role with Metro that benefitted the school greatly. As Principal Kennedy described it, the relationship between Metro and Battelle had both formal and informal aspects. On the formal side, she explained as an example, Metro had a Battelle project manager who evaluated Metro’s work around distributing various college-readiness tools to other schools and training them to use those tools. That manager collected data about the effectiveness of the training and the schools’ feedback, and shared those with Metro. Informally, Metro was in constant contact with Battelle, through bi-weekly check-ins and other conversations.

The partnership between Battelle and Metro worked both ways. According to the Battelle representative, “Battelle’s education portfolio and national prominence would not exist without Metro.” She explained that without Metro, Battelle would not have built the OSLN or the national STEMx networks. Principal Kennedy likewise reported that Metro was the “veteran” school in Battelle’s OSLN and STEMx networks. While there were other schools in the networks that had much experience in STEM education and initiatives, Metro as a more established school served as a source of information and support for those newer schools that were “still struggling to get something like an interdisciplinary project going.”

2.2.5.4. Summary
Not only were Battelle and OSU the founding partners of Metro, but their continued involvement and partnership with the school expanded the educational and work-related opportunities that were available for Metro’s students. Metro had an agreement with OSU to provide access to early college-level courses for their students, but perhaps more importantly, an OSU college advisor was located full-time at Metro and was dedicated to supporting Metro’s students. In addition, this partnership had grown and flourished through joint efforts to create hybrid high school and college learning experiences through the Learning Centers, providing an “on ramp” to gently transition Metro’s students to the rigor and instructional demands of the college level.

Metro also developed significant and strategic partnerships with local and national businesses and organizations to support provide internship opportunities for their students and to provide mentorship to students and financial support for the school’s activities. For example, in addition to their major institutional partners of OSU and Battelle, Metro worked closely with the PAST Foundation, which supported both Metro students and Metro teachers through mentorships and professional development opportunities. In particular, students in Metro’s Robotics club had the opportunity to work with engineers from local high-tech businesses who mentored them on the more difficult aspects of designing and programming their robot. Finally, Metro’s work with Battelle not only provided access to programmatic support, financial support, and educational innovations, but it also was the root of Metro’s involvement and, at times, central role in the state-wide Ohio STEM Learning Network and the national STEMx network, opportunities that greatly expanded the amount and type of resources to which the school, teachers, and students had access.
2.2.6. Early College-Level Coursework (CC 6)

2.2.6.1. Definition
This component includes opportunities for students to take college-level course work and earn college credits, such as through AP classes, online college courses, or college classes at institutions of higher education facilitated by a flexible school schedule.

2.2.6.2. Design
Metro was a member of the Early College High School Initiative (ECHS), a national organization comprised of thirteen partners coordinated by Jobs for the Future, a research and policy organization (http://www.earlycolleges.org). The goal of this ECHS initiative is to provide opportunities to students to complete up to two years of college coursework during high school tuition-free. Thus, early college programs aim to reduce the time and cost of completing a college degree and to begin the transition into college enrollment while students are still in high school. The ECHS initiative’s website identified the following design elements related to early college coursework: small learning environments with rigorous academic work and extensive supports, opportunities to earn up to two years of college credit tuition-free while enrolled in high school, and a process of easing the transition from high school to college through early college enrollment and focus on fulfilling credits required for an associate’s or bachelor’s degree.

As described in the section on Real-World STEM Partnerships (CC 5), OSU was involved from the beginning in planning the design of Metro’s early college program. It continued its involvement through meetings of high school and college faculty, a program committee led by an Assistant Provost, and most importantly, housing a dedicated OSU college advisor at Metro.

OSU entered into an agreement with Metro that set a reduced cost of $175 per OSU credit hour for Metro students, approximately half of what in-state OSU students normally paid. Metro paid OSU directly for these tuition costs, books, and other fees associated with the classes that Metro students were enrolled in; this arrangement therefore allowed Metro students to earn credits at OSU at no personal cost. This OSU-Metro agreement also stipulated that Metro students could enroll and begin taking full-time college classes at OSU after earning 18 high school credits. Metro students were scheduled for OSU enrollment last, after all OSU undergraduates had already enrolled in their classes; Metro students thus filled in seats in OSU classes that would have been unfilled otherwise. Additionally, OSU accepted transfer credits from a local partner institution, Columbus State Community College, giving Metro students the alternative option of completing general education coursework there if that was in the best interest of the student. Metro aligned its academic year schedule to OSU’s and gave students the opportunity to earn their high school credits at an accelerated pace. Students could complete these high school requirements in two years and one semester. However, students did not have to be juniors when they enrolled at OSU; they were able to take OSU courses earlier if the OSU counselor agreed with the Metro staff that they had the requisite preparation for a particular course. Thus, this early college program was intentionally designed to be personalized for each Metro student.

2.2.6.3. Implementation
Metro’s implementation of its early college coursework program gradually transitioned students from college-preparatory high school core courses, to transitional hybrid and dual enrollment courses, and then to full-time college courses, as the individual student was ready. Principal
Kennedy described this transition process:

Generally, students in their Phase 1 or Core Prep part [see the STEM-Focused Curriculum section for more details on the phases of Metro’s high school program] are getting what we consider a college preparatory diploma... all the things like physics, chemistry, and biology, math all the way up to pre-calculus or calculus, or parts of English, anything that we can think of that we probably all took in some form in some public high school is what kids are getting. But we created a system that accelerates the pace at which they can earn those credits. So some kids finish all that stuff in two years and one semester, but what happens is once they finish the bulk of their stuff, in that one semester where they could finish up all their high school stuff, we start to add in a college class. So it’s a transition of two high school classes and one college class to then maybe the next semester two college classes and one high school class, until finally we could have kids in their fourth year completely at college. But at the same time, we do have kids still here in their fourth year working all day to finish their high school coursework. Because we do ask kids to earn an A, to master their content, before they move on.

2.2.6.3.1. Transition from high school to college-level courses: Learning Centers and Gateways. Metro students first completed the majority of their high school curriculum in the Core Prep phase of Metro’s educational program, which was designed to prepare those students for the rigor of college courses. This curriculum is described further in the section on STEM-Focused Curriculum (CC 1). Based on feedback from their university partner, OSU, Metro built an educational program that helped ease the transition between high school and college coursework for students. These transitional experiences, known as Learning Centers, were implemented through joint planning with Metro and OSU. Learning Center courses, which were interdisciplinary and combined high school and OSU courses, are also described in further detail in the sections on STEM-Focused Curriculum (CC 1) and Reform Instructional Practices (CC 2). According to Principal Kennedy, most Metro students finished the required high school credits in two years and one semester. For these students, then, their first college-level coursework was typically the dual enrollment Learning Center course taken during their junior year. Students earned college credit for the OSU science college course associated with the Learning Center.

Most Metro students took a Learning Center interdisciplinary course in their junior year, but students could take a Learning Center course earlier than junior year based on their individual college readiness. For example, students who were in the Robotics Club took the Design Learning Center during the intersession J-term, the short term between the fall and spring semesters in January, described in more detail in the Integrated Innovative Technology Use (CC 3) section: “That’s when we build the robot.” Some Learning Centers continued to be offered each year, such as the Design Learning Center. Others were developed based on identifying a STEM career area experiencing high growth and collaborating with OSU to see if there was a college course that could be matched with a high school course with appropriate real-world project based learning. Principal Kennedy explained:

We find a career area in our local context that has possibility for growth. Then we find what college classes that people in that career area take. Then we find what a high school class that is a bridge between real world experience and the college class might use. Learning Centers are yearlong and start with a lot of instruction and focus on getting kids deep in the content, and by
the end of the year the kids have grown into mini-professionals in that area who can do a research project under the guidance of the professionals in that area. We have ones around biochemical, around energy, and should have one next year around agriculture.

Metro and OSU were collaborating to develop an agriculture-themed Learning Center at the time of our site visit. Prior Learning Centers mentioned by alumni interviewed included a Learning Center combining a high school art class and a college botany course, a calculus Learning Center, and a Biomedical Learning Center. Metro teachers reported that approximately 75% of Metro students completed a Learning Center course, earning OSU credits for the college component, typically a natural science course. Upon successful completion of a Learning Center course, the student could begin taking full-time OSU courses subject to approval of their Gateway presentation.

This process of transitioning to full-time college coursework was intentionally tailored and personalized for each individual student at Metro. Each student was required to defend their readiness for college-level work through a Gateway presentation. Students had to defend not only their academic readiness but also their mastery of the Metro Habits of Mind that demonstrated that they were ready to take on the responsibility of learning rigorous content on a college campus. The Metro parent information sheet described it as:

The presentation a student makes before s/he is eligible for the early college phase of the Metro program. The presentation is a defense of the student’s readiness for college level work. Those in attendance include parents/guardians, a teacher of student’s choice, the student’s advisor, a representative from OSU or Battelle, and fellow students. Generally, 18 Metro credits are required before Gateway.

Once Gateway approval was obtained, every student was supported individually by the OSU college advisor who worked full time at Metro, assisted students in selecting and registering for OSU classes, and mentored each student in how to get academic help at OSU. Students were provided a Metro-OSU Handbook that outlined the OSU General Education curricular requirements, which were recommended to be completed first, since they were required for either a Bachelor of Arts or Science degree and would be accepted by other Institutions of Higher Education (IHE): Writing, Quantitative and Logical Skills, Natural Science, Social Science, and Arts and Humanities. For the sciences, Metro students who were interested in pursuing college coursework in this content area were advised on which OSU courses they should consider and in what sequence. Each student’s full-time college coursework was ultimately personalized, although they were encouraged to earn General Education credits that would apply to a bachelor’s degree. According to the OSU advisor, for some students, their first college course at OSU was a studies skills class. For other students, it ranged from a humanities or foreign language course to a college science or mathematics course. Some students even decided to take another Learning Center course.

According to Principal Kennedy, there were 95 Metro students taking courses at OSU at the time of our visit, which represented approximately 25% of the student body. The Dean of Students said that the average student took about five or six OSU courses, while some took 12 or 13. It all depended on when the student completed the high school credits through their Core Prep phase,
usually followed by one Learning Center course, and successfully defended their readiness for college coursework within the structure of the Gateway presentation. The principal also reported that for the most part their students were fully integrated into the normal OSU courses, rather than being placed in a special, separate section just for Metro students. She explained:

*If you can’t make it in an integrated class, then you’re probably just not college-ready yet. I don’t want to create this false college access component where we’ve controlled for all these different variables, and it’s impossible to not do well. We want to prove that this preparation really prepared kids to do well in college, and you can see it in their success in classes like this.*

Mathematics was the one content area where Metro students were required to take a specially designed calculus class for high school students before taking the OSU calculus classes. This was a special section of the standard OSU course (Math 1151) and used the same textbook, *Calculus for Scientists and Engineers: Early Transcendentals* (Briggs, Cochran, Gillet, & Schulz, 2012). Metro students watched videos of the OSU calculus class taught by an OSU instructor, and this instructor came to the Metro campus for recitation sessions twice a week. Metro students took the same assessments as the college students taking the course at OSU. Teachers and staff from OSU and Metro also met during the school year to discuss how the OSU early college program for Metro students could be improved. The Metro calculus teacher noted that this course was implemented because of an OSU request that Metro make sure students were ready:

*So they wouldn’t be struggling in the Ohio State class and possibly have to take it over or pay for it. They asked us to design a high school calculus class to make sure they are ready for the Ohio State calculus class. So, fewer take calculus at Ohio State because they can take the high school version.*

According to the teacher of this hybrid calculus class, approximately 15 to 20 Metro students took this mathematics course each semester and about three or four of these students then took additional OSU courses. It should be noted that Metro students still had to take the OSU Mathematics Placement assessment to determine their first college mathematics course. Metro was proud of their student achievement in the calculus class; a Metro teacher noted that their high school students scored 89% on average on the Math 1151 midterm, 20 percentage points higher than the OSU student average.

2.2.6.3.2. **Financial aspects and family perspectives.** As described in the Design section, a key aspect of the ECHS Initiative was the financial support provided to the families and students, with a stated goal of providing opportunities to earn two years of college credits tuition-free during high school. Metro served a large number of students from low and moderate income families, for whom the cost of tuition and books could normally be a major barrier to college enrollment. Principal Kennedy described the arrangement between Metro and OSU whereby Metro paid $175 per credit hour or $825 for a typical five-credit course for each student taking courses at OSU. Metro also gave students a book voucher to buy textbooks. Thus, from the perspective of the student and family, college attendance during high school was tuition-free, and there were no additional costs for textbooks. Principal Kennedy explained that the rationale was that Metro would not have the costs of classroom space and teaching staff so this transfer of
school funding to OSU came from these savings. Additionally, if Metro needed a college instructor for a Learning Center but the number of students enrolled did not meet the OSU threshold, Metro would pay the salary of the instructor to teach that class.

Metro’s early college program with OSU was cited by parents and students in focus groups as a key attraction for deciding to apply to Metro. Parents talked about Metro as “more like a mini college. It’s for getting them ready for college.” The OSU academic advisor at Metro provided support for parents as well as students in understanding how the college program worked and making recommendations specific to each student. Parents talked about this individual student college readiness goal:

There was one teacher we came up against where there was no way they could master the class. We were three points away from mastery, and I said I’m not fighting the battle anymore. So yeah, he didn’t go to OSU until this year, but you know what? He wasn’t ready. We’ve talked about it. Not every student is going to come through here and do the mastery program in two years and take college classes but that’s the beauty of it. You take as long as you need and you’re ready when you’re done.

Another common theme voiced by parents was the desirability of students taking on the challenge of college coursework while in high school. If they made a poor start, they could withdraw from the college course and try again after completing more high school level work or Gateway dual enrollment courses. One parent described it this way:

My daughter has had a lot of college courses here. Not all of them have been successful. She just withdrew from one yesterday. It’s better to learn to crash and burn now when your mom and dad are here and your teachers are here.... I like the Learning Center model because they get to take college classes, and she can still get access to her teachers here. I like that they ramp up the difficulty level within the learning center so they are ready to start to take the college classes. I think the support they get moving into college is really well done.

Additionally, students in focus groups talked about how they support each other in addition to the support they get from Metro and the OSU academic advisor at Metro:

When in an OSU class with a lot of other Metro students, we help each other. We have intervention specialists who can help.... Advisors are always there to help solve any problems with classes, schedule, a teacher. They know what they are doing, and they try to know us pretty well. Advisors do a lot of activities exploring what kind of student you are. They say it is about group advisory bonding, but it is good for a teacher also to know how you work. I’m not here much but they like me and know me.... Students are your support system as much as teachers. You are bombarded by assignments and expectations, so we get through it together. It’s hard to go it alone, and we have to do group assignments anyway. Biggest support structure here is the students themselves.

2.2.6.4. Summary
Metro was designed as an early college high school, meaning that the school focused on providing opportunities for its students to complete college coursework during high school, thus
reducing the cost and time to complete a college degree. Metro partnered with OSU on the design and implementation of the early college program. As originally designed, Metro students would take college courses after completing 18 credits of high school coursework. But, early in the implementation, OSU provided valuable feedback that students would benefit from a more gradual transition. This led to a collaborative effort between Metro and OSU to develop Learning Centers, hybrid high school-college courses in which the high school component was themed and emphasized connections to real-world contexts that could be explored with project-based learning. This course component was intended to support students in learning the rigorous science content of the OSU course. Approximately 75% of Metro students completed their first college course within the context of one of these hybrid courses known as Learning Centers. The average Metro student went on to take about five or six OSU courses, while some even took 12 or 13. The students were well supported by OSU, including access to a dedicated OSU academic advisor at the Metro campus and OSU tutoring after school. Students also learned to look to each other for support, an important college readiness skill. Metro’s early college program with OSU was cited by parents and students in focus groups as a key incentive for deciding to apply to Metro. This component stood out as extremely well planned, well designed, well-coordinated, and well-resourced.

2.2.7. Well-Prepared STEM Teaching Staff (CC 7)

2.2.7.1. Definition
Teachers are certified to teach in their STEM subject areas and have advanced STEM content knowledge and/or practical experience in STEM careers; they also have ample opportunities for professional development.

2.2.7.2. Introduction
Prior to the site visit to the school in March 2013, all twenty-one Metro teachers completed an online survey for the current study based in part on the 2000 National Survey of Science and Mathematics Education (Westat) and the 2006 Teacher Questionnaire: Local Systemic Change through Teacher Enhancement (Horizon Research, Inc.). This survey elicited information on their background and qualifications as well as professional development and instructional strategies at Metro. In addition, interviews with the principal and other school administrators provided background information on teacher hiring, teacher professional development, and the collaborative nature of teacher work at the school. During the school visit, researchers observed 11 classes (8 STEM and 3 non-STEM) and interviewed the teachers afterwards. Finally, teachers participated in focus groups to describe the design and implementation of their instructional practices and the Metro curriculum.

2.2.7.3. Design
Metro, as described on its website (http://www.themetroschool.org), developed program expectations and performance targets for all members of its community, students and teachers alike, based on best practices from sources such as the Common Principles of the Coalition of Essential Schools (http://www.essentialschools.org), Breaking Ranks II – a vision for high school reform published by the National Association of Secondary School Principals (http://www.nassp.org), and the International Baccalaureate program (http://www.ibo.org). These expectations and attributes were then organized by Metro into categories of performance
targets: student achievement, classroom practice, leadership practice, organizational practice, and community connections. Because Metro was its own district and a stand-alone regional STEM school under Ohio state code, Principal Aimee Kennedy had the autonomy to recruit and hire teachers directly and not through a central district office. To that end, Metro listed the expectations and performance targets for all teachers and staff organized by these five categories.

Specifically, teachers were expected to provide rigorous content instruction and foster the development in all students of the Metro habits of mind. This support was intended to continue even after their students began to take college-level courses at Ohio State University. The expectations included the following, according to Metro’s website:

- Curricula that begin with the Ohio Academic Content Standards and Indicators and end with successful participation in college level work without remediation.
- Curricula that employ essential questions and are aligned with developing the Metro habits of mind, i.e., to be a critical thinker, engaged learner, active and responsible decision maker, problem solver, inquiring learner, effective collaborator, and clear communicator.
- Classroom activities that are structured democratically so that students are able to play a variety of roles in a variety of settings.
- On-going discussions of ways in which a curricular approach of “less is more” (depth vs. breadth) leads to effective teaching and learning
- Teachers who know and share information about students’ emotional, academic, and social needs, strengths, weaknesses, and how they mesh with the norms and expectations of students’ communities.
- Teachers who analyze their teaching practices (i.e., ratio of teacher talk to student talk, opportunities for student initiated intellectual pursuits, quality and variety of learning activities, opportunities for multiple learning styles).
- A curriculum that is flexible enough to allow for independent exploration, student generated questions, and student reflection.
- Teachers who see their role in the school as one that goes beyond their immediate sphere, classroom, or subject area (i.e. advisor, counselor, coach, learner).
- Teachers who work across grade levels and/or disciplines and share resources and expertise with each other.
- Teachers who believe that understanding various student cultural differences (such as ethnic, gender, economic, linguistic) is a fundamental part of being a generalist.

2.2.7.4. Implementation
All twenty-one teachers at Metro responded to the online Teacher Survey administered prior to the site visit; eleven identified as STEM teachers and ten as non-STEM teachers. Approximately 75% of the staff was female and 80% identified as White. Four teachers identified as Black or African-American, and one identified as Hispanic or Latino. There was a wide range of ages represented in the Metro teaching staff, evenly spread between the under-25 to 55 age range. Over 50% of the staff was over the age of 35, with 19% of the staff in the 50 to 55 year range. Correspondingly, the staff also represented a wide range of years of teaching experience, from a first-year teacher to a teacher with 34 years of experience. The average years of experience was 9.7 years, with the median at 6 years of experience.
Every teacher at Metro had earned a bachelor’s degree, and they had come from colleges and universities from across the country; notably, eight graduated from the nearby Ohio State University. Ten teachers reported earning their bachelor’s degree in a STEM-related major, such as Chemistry, Ecology, and Mathematics, among others. Additionally, sixteen teachers reported earning a master’s degree, the majority in education but several in disciplines such as Communications and Chemistry. Every teacher also held an active teaching certification in the subject areas that they were teaching, and the two engineering teachers had been trained and certified to teach the Project Lead the Way curriculum. Finally, over half of the Metro STEM teachers had significant research experiences, including, for example, as a graduate-level chemistry researcher on biodegradable polymers, a psychology research assistant, and as a field assistant researching cutthroat trout in rural Nevada.

2.2.7.4.1. Teacher hiring. Ohio has a long tradition as a teachers union state, with a longstanding statewide federation of teachers unions called the Ohio Federation of Teachers, affiliated with the American Federation of Teachers, AFL-CIO. However, as Principal Kennedy explained, Metro specifically was not affected by the collectively bargained conditions for public school teachers in Ohio, because it was its own district and a stand-alone regional STEM school. As a result, Principal Kennedy possessed the autonomy to direct her own teacher hiring practices and to specifically hire the teachers whom she thought were aligned with the mission, culture, and instructional mindset of the school.

Principal Kennedy prioritized this alignment between her new teachers and Metro’s mission as she made the final teacher hiring decisions with her assistant principals. In her view, she would ideally be able to hire teachers with a couple years of experience who had therefore “kind of worked out all of the kinks.” However, she knew that such experienced teachers were not always available. Additionally, she was wary of hiring teachers who would then come in with preconceived notions of education that did not fit with Metro’s instructional philosophy. As she explained:

You could have someone that’s spent the critical years of their teaching career forming these perceptions about how schools should work. And then, even though they can manage their class better and they have a system for managing parents, I’m trying to change what they think about education. I would rather help you form your thoughts about education and then give you some tips about how to grade your papers instead of trying to change what you think.

Consequently, Principal Kennedy developed her own “recipe for success.” She looked for people who came to teaching “kind of in a backwards way.” For example, one of her biology teachers had originally planned on being a zoologist, majoring in zoology and working at a zoo for several years before being drawn to teaching and obtaining her teaching license. One of her English teachers was an art history major, initially intending to pursue a doctorate in art history. Another biology teacher had first planned on going to medical school. Her testing coordinator previously worked in the federal government. A chemistry teacher was pursuing a doctorate in chemistry before realizing that she preferred teaching over research. In other words, as the principal explained:
It’s not always this notion of second career teachers, but people who thought they wanted something and then realized, ‘Hey, wait a minute, I really love teaching.’ I like that, someone who really picked teaching for a reason, even if they picked it six months into their undergrad. Sometimes I think people become teachers, because they have this perception of what it means to be a teacher, because of their own experience in school, which we could probably extrapolate backwards and say [they] played the game of school well. But we don’t have kids here who necessarily come prepared to play the game of traditional schools, so we need people who aren’t teachers just because they love the traditional game of school.

In addition, Metro looked closely at candidates who had gone through Teach for America (TFA) or who had worked for innovative networks of schools such as the Knowledge is Power Program (KIPP) or the New Tech network, “because someone’s done the work somewhere to get you to think the right way” about education, as Principal Kennedy stated. During interviews with prospective teachers, one example of how she determined whether the candidate thought about academic content and instructional practices in different, innovative ways was to provide a Design Challenge prompt, such as “eradicating malaria,” and ask the candidate to talk about what they would have students produce in class, what other content disciplines they would work with, and what they think they could measure through that project. Similarly, given the increasing role of technology both in instructional innovation and in the culture of Metro itself, Principal Kennedy explained that teacher job descriptions included a requirement for comfort with instructional technology, and interviews with candidates built in questions around their experience with such technology.

2.2.7.4.2. Instructional practices and pedagogies. Teachers at Metro were intentionally given a large amount of autonomy by the administrators in deciding how they would teach their classes. As the assistant principal explained in using a metaphor of instructional strategies as tools:

We think it’s all good, labs, projects, inquiry. To me, [it] is always like asking a master woodworker whether a band saw or table saw is best. But they all do different things, for different purposes. So for us, what’s the best tool, depending on someone’s strength, and they’ll be really good with one particular tool. So we’ll give autonomy to teachers to be better at certain things and use certain tools more.

As a result, so long as the teachers covered the academic subject matter content, as benchmarked against the ACT college readiness standards when available, and the Metro Habits of Heart and Mind were fostered and developed in the students, teachers had the flexibility and freedom to employ the pedagogical practices that they felt most comfortable with. For example, a biology teacher reported that he preferred mini-lectures and direct instruction as a means of engaging his students and teaching the content, while a mathematics/physics teacher explained that she tried not to teach lecture-style if she could help it.

I’m not a big fan of teachers being information dispensers. My goal is not to give information. If I could do whatever I wanted for these kids, I would teach them to love learning and to figure out how to learn if no one is around to teach them.

Both styles were valued at Metro. There was an understanding among the administrators and
teachers that getting students to the point of true understanding, whether relying on an inquiry-based instructional method or a direct engagement with the content, was an art rather than a science. The best tools for achieving that result depended on each particular teacher’s strengths. As one teacher reported, “When I was hired, the idea was ‘I don’t care how you use Taskstream [Metro’s online learning management system], just use it somehow....’ We have a lot of freedom; they just want to see what we come up with.” Some parents have also appreciated this autonomy in the teaching staff at Metro, with one parent stating, “Classrooms are not your normal classrooms. You don’t get stuck in this ‘Well, this is how I’ve always done it,’ mentality. The staff are pushed to try different things.” The result was a staff that parents felt was extremely dedicated and committed to their students. As one parent reported:

*The amount of time these teachers put into planning and implementing their curricula is far beyond what most teachers do.... The dedication of these teachers here is unlike anything I’ve ever seen.*

Perhaps as a result of this autonomy, coupled with the trust placed in the teaching staff, teachers were quite confident in their abilities to employ a wide range of reform-based pedagogical practices to engage students and encourage interest and participation in the STEM fields, as reflected in the responses on the Teacher Survey, presented in Table 9.

**Table 9**

*STEM Teacher data for Pedagogical Strategies*

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean of Responses on a Scale of 1-5*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead a class of students using investigative strategies</td>
<td>4.2</td>
</tr>
<tr>
<td>Manage a class of students engaged in hands-on/project-based work</td>
<td>4.5</td>
</tr>
<tr>
<td>Help students take responsibility for their own learning</td>
<td>4.5</td>
</tr>
<tr>
<td>Recognize and respond to student diversity</td>
<td>4.4</td>
</tr>
<tr>
<td>Encourage students’ interest in S/T/E/M</td>
<td>3.3</td>
</tr>
<tr>
<td>Use strategies that specifically encourage participation of females and minorities in S/T/E/M</td>
<td>4.0</td>
</tr>
<tr>
<td>Involve parents in the S/T/E/M education of their students</td>
<td>4.0</td>
</tr>
</tbody>
</table>

*Note. *1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5 = Strongly agree.*

2.2.7.4.3. *Curriculum development.* One common aspect to all Metro classes was that they did not rely upon textbooks or other off-the-shelf materials. Instead, teachers were expected to design their own curricula, a task which Principal Kennedy acknowledged was both freeing and yet more difficult and challenging, particularly for teachers new to Metro. She accordingly tailored her interview process to help ensure that incoming teachers were both aware and capable of tackling the work that came with developing curricula in this way. Additionally, she adjusted the course schedules at Metro to provide time for new teachers to work closely with veteran mentor teachers as they learned to make their own curricula. For example, a new biology teacher who had never taught before was paired with a veteran biology teacher, with their schedules
arranged such that they team taught together for two whole periods each day. As a result, for 180 minutes per day, the new teacher received on-the-job training from the more experienced teacher for the first semester. Similarly, the schedules for the English teachers were arranged to allow for team teaching, as Principal Kennedy explained:

So I arranged the schedule so that there was this on-the-job training where ideally [the new teacher] wouldn’t have to plan because the experienced teacher has planned it, and you’re just kind of learning it, sort of like a fellowship, an enhanced student teaching. So that’s what we did last year in the fall, and it worked really well, because then we had the J-term where people refined it, and the spring, they had already taught it one time, so they were starting and teaching what they already taught.

The process of actually developing their curricula was “all pretty organic and constructivist in nature,” as Principal Kennedy described it. Metro did not employ any separate specialists who were fully dedicated to curriculum development. Instead, as new standards and measures were brought to their attention, such as the Common Core State Standards or the ACT End of Course standards, classroom teachers worked together to break down the materials and experiment with developing curricula and lessons that align with those standards. Teachers were also encouraged to bring their own content and subject matter interests into their classrooms so long as those lessons were academically challenging and could be aligned with the appropriate content standards. Through this process of curriculum development, the staff developed expertise in the relevant standards and ensured that their classes provide rigorous coverage of those standards for their students. Principal Kennedy explained:

The reason why we can be so flexible is because we don’t buy textbooks. We are not tied to textbooks, we are tied to content and context…. We know that we’re going to align to content standards and not curriculum materials. We can be really flexible and fit [new pieces] into our content in a way that’s pretty seamless because teachers are designing the work that they’re doing…. It’s not easy; it’s hard if you came from somewhere where they give you lots of teacher materials and handouts. It sounds like that’s a really negative way to work, but it’s not necessarily for a brand new teacher. That’s a great way to learn…. But here, we really need them to be a couple steps beyond that, and either have already moved into the world where they’re creating their own stuff or be really interested and excited to see someone who’s creating their own stuff.

2.2.7.4.4. Teacher collaboration. In general, collaboration among teachers for curriculum development occurred on a class-by-class basis at Metro, with biology teachers working together, physics and engineering teachers working together, and chemistry teachers working together. For some teachers, this collaboration on lesson development was a major aspect of their work. The trigonometry teacher, for example, stated that he collaborated with other teachers “all of the time,” and that this staff at Metro was the strongest teaching staff he had ever worked with. As an assistant principal acknowledged, however, often the time available during the school year for this kind of teacher collaboration on course curricula and planning was limited. At the time of the visit, common planning time was set aside from 7:00 to 8:00 AM, but this time was usually spent on other tasks such as working on Design Challenges or other administrative tasks throughout the year. There were no other breaks built into or after the school day for
teachers to collaborate. Metro was, however, in the process of hiring substitute teachers for each content area. This would allow the assistant principals to occasionally release a set of teachers during a school day to work together on planning curricula while the substitutes covered their classes.

Teacher responses on the Teacher Survey reflected this sense of having limited time to collaborate with other teachers at Metro to the extent desired, presented in Tables 10 and 11.

**Table 10**  
*Teachers’ Time for Collaboration*

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean of Responses, on a Scale of 1-3*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time available for teachers to plan and prepare lessons</td>
<td>2.0</td>
</tr>
<tr>
<td>Time available for teachers to work with other teachers</td>
<td>2.2</td>
</tr>
</tbody>
</table>

*Note. *1 = No access, 2 = Limited access, 3 = Adequate access.*

**Table 11**  
*Teachers’ Value of Collaboration*

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean of Responses, on a Scale of 1-5*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time available for teachers to plan and prepare lessons</td>
<td>3.2</td>
</tr>
<tr>
<td>Time available for teachers to work with other teachers</td>
<td>4.1</td>
</tr>
</tbody>
</table>

*Note. *1 = Inhibits effective instruction, 2 = Somewhat inhibits effective instruction, 3 = Neutral or mixed, 4 = Somewhat facilitates effective instruction, 5 = Encourages or enables effective instruction.*

Teachers reported overall that they had limited access to time for planning lessons and working with other teachers collaboratively, matching the assistant principal’s description above. Interestingly, it also appeared that, on average, the teachers believed that the value of having time available to plan and prepare lessons together was neutral or mixed. However, upon examination of the actual responses from the teachers on the survey, only one teacher rated that value as a “3” or “Neutral or mixed” for this particular question; the remaining responses were nearly evenly split between stating that such time “inhibits” effective instruction and “encourages” effective instruction. The underlying explanation of this split was unclear. Notably, though, the teachers did generally agree that the value of working with other teachers—perhaps excluding work around planning and preparing lessons—was positive, with 8 teachers (nearly 40% of the staff) rating this value as a “5” or “Encourages or enables effective instruction.”

Interdisciplinary teacher collaboration occurred each semester around the Design Challenges in which students across all grades participated. These large-scale, cross-curricular projects brought together teachers from multiple disciplines as they planned out the themes and components for
students in their classes. An assistant principal described a previous Design Challenge around designing sustainable communities that brought the geometry, algebra, Introduction to Engineering Design, environmental science, English, art, and biology teachers together to plan the projects. Teachers spent much time together planning these Design Challenges to ensure that the work being done by students incorporates rigorous content requirements from across all of the disciplines involved. The assistant principal explained, “It’s definitely hard work, a lot of moving pieces.” During this work, every teacher was involved at staff meetings in coming up with the themes and assignments together.

Additionally, a survey of the eleven STEM teachers at Metro indicated that these teachers had opportunities to work with other local teachers to integrate content from other disciplines. A consistent majority reported having participated in such collaborative efforts either in the current school year or in the last year, as displayed in Table 12.

Table 12
Cooperation and Collaboration: PD Experiences

<table>
<thead>
<tr>
<th>Question</th>
<th>Percent responding “Current school year” or “Last year”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Met with a local group of teachers on a regular basis to study/discuss S/T/E/M teaching issues</td>
<td>90%</td>
</tr>
<tr>
<td>Collaborated with a group of S/T/E/M teachers with the express purpose of integrating content from diverse disciplines</td>
<td>100%</td>
</tr>
<tr>
<td>Collaborated with a group of non-S/T/E/M teachers with the express purpose of integrating content from diverse disciplines</td>
<td>64%</td>
</tr>
</tbody>
</table>

2.2.7.4.5. Teacher support and professional development. With a relatively small teaching staff of twenty-one total teachers, Principal Kennedy actively focused on and fostered positive relationships among her teachers. Her work in this area began before the fall semester, when she emphasized the notion that they were a team and the importance of personal connections. She described the Gallup poll about job satisfaction that has shaped her philosophy on staff team development:

One of the things was, ‘I have a best friend at work.’ And that is an indicator of someone who has more happiness in their job, because they have someone at work that they consider their best friend. So I think that’s an important piece, because the work is really hard here, and if you don’t have a connection to other adults here, you can get really disgruntled. So that’s been one of my missions.

This supportive environment for the teachers at Metro was further developed through opportunities that were provided to teachers starting on their first days at the school. Teachers who were new to Metro receive three days of training before the rest of the staff arrived at the beginning of the school year; this training covered Metro-specific infrastructure and systems such as TaskStream, the online learning management system that teachers and students used for all courses at the school, and their mastery assessment system. Mentor teachers worked with
each of the new teachers to help them become comfortable with these systems. As an assistant principal explained, not only did this mentoring and training help new teachers better understand matters such as the mastery assessment system, which was often quite different from the traditional grading and evaluation structures, but it also helped new teachers manage their work-life balance, “encouraging [them] to develop systems so that [they] aren’t continuously working all day and night.”

For professional development opportunities during the school year, Metro previously sent teachers to conferences on a regular basis. However, as Principal Kennedy explained, she came to realize that the costs of these conferences were outweighing the benefits for her teachers because the content covered was not advanced enough:

*With the travel, the stress on the classroom, the money, that’s a lot of effort and time to put in to go somewhere and sit at a professional development event and have someone say something like, “Hey, maybe you should think about alternative grading practices that give kids more than one chance.” And we’re saying, “We are so far beyond that conversation.” We want to talk to other schools like us and say, “Hey, so you guys have this alternative schedule, how do you make it work?”*

Consequently, she decided to leverage the content expertise among Metro teaching staff and embed more professional development working sessions into the weekly staff meetings. She and her assistant principals tailored these professional development opportunities to the needs of the staff and to ensure that the content being covered was of a high enough level to be of use for her teachers. For example, one such meeting was devoted to a structured working session around their project-based Design Challenges. Principal Kennedy explained:

*You could take that out of context and say that was a project-based learning professional development, which it is, but we didn’t just bring someone in to talk to us about “Hey groups, come up with a plan and backwards map your plan for project-based learning.”*

Teachers have noted the value of these staff meetings. One teacher reported:

*I would say the staff meetings, 98 percent of the time, are some type of professional development or strategy work…. In our staff meetings, we accomplish things, which is nice. It might be something small to change something up, but we will at least go over it in the staff meetings and try to implement it.*

Even with this effort to embed professional development sessions into the weekly staff meetings, teachers at Metro were fully encouraged to search for and pursue other opportunities that “pushed the envelope” and offered content that was new and a true learning experience. An assistant principal pointed out:

*You are always encouraged to keep growing. Teachers, if they find a professional development they want to go to, they look up the information and if there’s money in the funds, we send them. They don’t get a certain number of professional development days per semester. [Instead], if we see something we like, we will send someone to it.*
The teachers at Metro confirmed this supportive atmosphere around external professional development opportunities. As one teacher said, “The admin will set it up if there is a good opportunity to do that.” Various teachers accordingly reported examples of professional development sessions they participated in, including, among others:

- An Apple training day to work with and gain expertise on iPads;
- Classes at the Ohio State University or meetings with OSU faculty to help plan Learning Center courses;
- A two-week course on Project Lead the Way (PLTW) led by master teachers to learn the content and CAD tools used in Introduction to Engineering Design;
- Participating in the Ohio Energy Project and teaching it in the environmental science course at Metro;
- An Ohio Council of Teachers of Mathematics conference; and
- An Association for Supervision and Curriculum Development (ASCD) training on differentiation.

Additionally, Principal Kennedy described a STEM leadership academy that she was going to be facilitating with four other principals in Ohio and Tennessee who work in the Battelle STEM networks; she was planning on sending several of her teachers to that conference.

Teacher responses on the Teacher Survey further reflected the availability and access that Metro teachers had to various types of professional development opportunities. A majority reported participating in collaborative, STEM-related professional development opportunities during the current school year or in recent school years, as seen in Table 13.

**Table 13**

*Teacher PD Opportunities: Collaboration, Workshops, and Conferences*

<table>
<thead>
<tr>
<th>Question</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed other teachers teaching S/T/E/M courses as part of your own professional development (formal or informal)</td>
<td>81%</td>
</tr>
<tr>
<td>Used telecommunications to collaborate on S/T/E/M teaching issues with a group of teachers at a distance</td>
<td>65%</td>
</tr>
<tr>
<td>Attended a workshop of S/T/E/M teaching</td>
<td>81%</td>
</tr>
<tr>
<td>Attended a national or state S/T/E/M teacher association meeting</td>
<td>67%</td>
</tr>
</tbody>
</table>

Similarly, 56% of all teachers at Metro reported having “adequate access” to time for teacher professional development. 44% reported having “limited access,” and no teachers reported
having “no access.”

2.2.7.4.6. **Teacher evaluation.** Metro’s process for evaluating its teachers had evolved in recent years. Previously, according to Principal Kennedy, Metro used a more informal process for teacher evaluations, with the principal observing and meeting with all of the teachers each year. However, in line with current national trends around teacher evaluations emphasized by the No Child Left Behind (NCLB) and Race to the Top (RTTT) regulations, Ohio developed a new teacher evaluation system called Ohio’s Teacher Evaluation System (OTES), which Metro adopted. Under this system, teacher evaluations had two components, each weighted at 50%. First, a teacher performance rating derived from a professional growth plan, classroom walkthroughs, and two 30 minute formal observations; and second, a student academic growth rating derived from value-added data from Ohio’s state assessments if available, or otherwise from approved vendor assessments or locally determined measures (see http://education.ohio.gov).

The principal and assistant principals assessed and rated teacher performance using the required rubric provided by Ohio’s state department of education. The rubric used a four-point scale to grade three categories of teacher performance: Instructional Planning, including use of assessment data and prior content knowledge; Instruction and Assessment, which covered how well lessons are delivered, differentiation, and classroom management, among other issues; and Professionalism, which involved collaboration and professional growth plans (OTES Evaluation Rubric). The principal and assistant principals explained that they conducted the classroom walkthroughs on a rotating basis, but each teacher had an assistant principal assigned to do his or her formal observations.

In addition to this formal evaluation system, Metro’s teachers also took part in peer observations. An assistant principal explained that they wanted their new teachers to observe several of the more veteran Metro teachers to see how they handled classroom management, how they structured their classes, and how they managed projects and in-progress student work. Groups of four new teachers conducted rounds of 30 minutes observations and debriefed their observations afterwards. This reflective process allowed the new teachers to consider their strengths and areas of improvement and to provide feedback to one another in an effort to foster continuous growth.

2.2.7.5. **Summary**

As Principal Kennedy acknowledged, working at Metro as a teacher could be an intense, challenging experience. Teachers were expected to create their own curricula rather than rely on a textbook or an off-the-shelf curriculum, while ensuring that all relevant content standards were met. The mastery assessment system at Metro was also quite different from what was typically seen at traditional schools and could require a major transition from conventional methods of assessment. Metro was able, however, to recruit and hire teachers that fit the school’s philosophy, particularly in the STEM fields where the principal sought teaching candidates with diverse expertise and experiences in STEM. The administrators at the school were also very conscious of providing support and growth opportunities to teachers to ensure that they developed and built expertise in their practices and content knowledge. Furthermore, teachers were given the freedom and autonomy to employ the instructional practices and strategies that fit best with their style and strengths.
2.2.8. Inclusive STEM Mission (CC 8)

2.2.8.1. Definition
This component addresses the school’s stated mission or goals to prepare students for STEM, with an emphasis on recruiting students from underrepresented groups. There are thus two aspects to this component’s definition: inclusiveness and STEM focus. This component goes beyond the initial description of the admissions policies and procedures included in the Context section at the beginning of the case study. Similarly, the STEM-focused aspect of the mission builds on findings on the curriculum and informal learning opportunities.

2.2.8.2. Design
Metro’s mission statement is posted on its website (http://www.themetroschool.org):

Metro’s mission is turning college aspirations into reality through personal relevance, academic rigor and transformative relationships.

Building on this mission statement, Metro framed its STEM focus by describing itself on its website as:

A small and intellectually vibrant learning community designed to serve students who want a personalized learning experience that prepares them for a connected world where math, science and technology are vitally important. All Metro students engage in a personally relevant and academically rigorous curriculum within a safe and trusting environment.

Metro similarly defined itself in a School Profile document as “a small, intellectually vibrant, Ohio public STEM school open to 9th through 12th graders in the state of Ohio. It is an early college program focused on problem based learning with an emphasis on science, technology, engineering and math” (Metro School Profile 2012). A detailed description of Metro’s educational goals was set forth in Metro’s Family Handbook, which further placed the school’s educational philosophy in the context of effective citizenry:

One of the primary goals of the Metro program is to prepare students for effective citizenry. Students are encouraged to be critical thinkers, monitoring and modifying their behavior as needed. Metro staff and administration also monitor student behavior, with an emphasis on problem solving with students as they reflect on their behavior.

Taken together, these statements from Metro’s website built an argument that the school was designed to offer a rigorous STEM academic program leading to early college experiences for all of its students. In this way, the school sought to support students regardless of how well they were prepared, including a stated goal to “serve average or underperforming students looking to be challenged and to improve themselves in a different environment—not the ‘cream of the crop’ student.”

2.2.8.3. Implementation
This section begins with a description of how Metro built a student body that was diverse, not
only in terms of race, ethnicity, gender, and income level, but also in terms of prior educational experiences and achievement. Then, the perspectives of students, parents, teachers, and partner organizations are presented to draw conclusions about the extent to which there was agreement among Metro’s stakeholders about Metro’s inclusivity and STEM-focus and how these dual aspects were implemented.

2.2.8.3.1. Inclusiveness and admissions. Incoming students entered Metro through a blind lottery system. The only factor that was considered for the lottery was the student’s home district; Metro’s lottery formula ensured that 50 percent of its incoming students came from the Columbus City Schools district, where Metro was physically located. The remaining 50 percent was open to all of the other districts in Central Ohio, and as a result of this process, over 28 school districts in Ohio were represented in the student body at Metro. Aside from this home district factor, Metro did not use any selective factors, such as prior academic performance or other attendance or behavioral data, to narrow down its incoming students.

According to the principal, this also meant that Metro did not use any factors in its lottery formula to ensure a particular proportion or balance in gender, ethnicity, or socioeconomic status in its student body. Consequently, the school relied on its student recruiting efforts to reach out to and draw in those students who were under-represented in STEM. Principal Kennedy explained that previously, before Metro became its own stand-alone district, the school recruited students by going to middle schools in other districts, participating in their high school fairs, and talking to 8th grade students. Whether those students would be able to attend Metro from those other districts depended on the superintendents of those districts granting access. This limited Metro’s ability to predict its incoming student enrollment numbers and fill their enrollment to capacity. Becoming its own district allowed families, parents, and students to decide on their own whether they wanted to apply to and perhaps attend Metro, without permission from their home districts.

In accordance with its inclusive mission, Metro made a concerted effort to recruit students who were economically disadvantaged, first-generation college goers, English language learners, and members of those demographic groups that were traditionally under-represented in STEM fields. These efforts included activities to reach as broad an audience as possible in Ohio, such as print and radio advertisements, stories in the press and media, Facebook advertisements, and open houses at the school. Additionally, as Principal Kennedy explained, Metro had a relationship with several local charter school networks such as the Knowledge is Power Program (KIPP) and the United Schools network which were known for working mostly with low socioeconomic and minority students:

*We’ve tried to make sure that we don’t get into this position where we’re just really a school of choice for anyone who can get their kids here. So we have a really close relationship with the local KIPP school. We hosted their 8th graders here on an open house, and we went there for their college fair.... There’s another charter school network in the area called United Schools network. It’s Columbus Collegiate Academy, and we invited their 8th graders here.*

Interestingly, Metro’s analysis of the data on incoming students revealed that a significant majority of students came to Metro because they knew someone else who had attended the
school. As Principal Kennedy explained, on the one hand this led to an “unintentional reproduction of the first class over and over,” with the same networks of parents continually buying into the school and sending their students to Metro. However, she noted that this had also led to a slight increase in their English language learner (ELL) population. For example, the most concentrated group of ELL students was their Somali student group, which had grown through the years as parents who liked the work done at Metro with their children spread the word to other Somali families, thus increasing their numbers in the lottery.

2.2.8.3.2. Student application process. Students wishing to enter Metro’s lottery completed an admission form, which asked for student contact information, demographics, home school information, and various family-related contact and medical information. Additionally, Metro asked the students for a brief essay, with the following prompt: “In order for us to know a little more about you, please write a 3 paragraph essay explaining why you want to attend Metro Early College High School.” Other background information was requested, including extracurricular interests and plans for the future. As described above, only the home school information was used to ensure that 50 percent of the incoming population came from the Columbus City School District.

Students who were selected through the lottery were then invited to Metro for an informational interview with several teachers, current students, and administrators, providing the students and families an opportunity to learn more about Metro and ask any questions that they may have. There were three 20 minute segments where the students learned about Metro’s curriculum—including the mastery system, course progression, and the early college opportunities; Metro’s advisory system; and various aspects of the school culture such as the dress code and honor code. Principal Kennedy explained that these meetings were opportunities for the incoming students and families to interview the school and decide whether they wanted to attend Metro. According to the principal, a few students and families declined to come to Metro after these interviews, perhaps reflecting a self-selection out of the challenging academic environment characterizing the school. Those spots that opened up after a family declined were filled again through the lottery system.

2.2.8.3.3. Diversity of the student body. With its lottery system and recruiting efforts that extended to every district in Ohio, Metro had a student body that was diverse in terms of its demographics, home cultures, and incoming academic abilities. As Principal Kennedy explained, Metro framed its inclusivity around demographics by comparing itself to Franklin County overall, the county in which Columbus City Schools and Metro were located. Metro’s demographics were representative of that of Franklin County, as shown in more detail in Table 1 in the Context section of this case study. Principal Kennedy elaborated:

*We are 50/50 white/not white, 30 percent free and reduced price lunch eligible, 10 to 15 percent identified special education. We are not selective. When people say, “I wish we had those students,” we can say, “You do have those students.”*

It is worth noting, however, that while the ethnic and racial composition of Metro’s student body closely resembled that of Franklin County, Metro did enroll a noticeably lower proportion of economically disadvantaged, limited English proficient, and special needs students than the
county. In particular, one student group that was not well represented at Metro were students with emotional disorders who required significant behavioral interventions. As shown earlier in Table 1, only 5.1% of Metro’s student body in the 2012-2013 school year were students with identified special needs, compared with 12.9% in Franklin County. An assistant principal explained that Metro did not have the capacity or physical presence that was sometimes needed for students who might have severe outbursts during the school day. Aside from that group, however, those students with special needs who were enrolled at Metro were supported at Metro; at the time of the visit, according to Principal Kennedy, Metro served several blind students, autistic students, and students with brain trauma, supporting them with intervention specialists. Metro did not use pull out strategies or tracking policies for these students, but instead employed inclusion services in the classroom.

Beyond the statistics regarding the student body at Metro, however, what was striking were the comments and observations of the parents and students at Metro around how diverse and inclusive the school was. As one parent reported when explaining why she chose to send her child to Metro:

*When I looked at the information for what they focused on, particularly for our black children, especially for our young black men, that is not a focus they have in the public school system here in central Ohio. I thought that even though he may have some learning challenges, being in a school [such as Metro] where he had the opportunity to be at a level playing field would give him the opportunity to be challenged.*

Similarly, another parent noted:

*There are people from every part of the world here.... There was a student who was Muslim, and she wore a burka.... I wouldn’t see that in the school where I work, but here, it was no problem. No one was making fun. Everyone wants to learn about everyone. They are learning about people and their cultures, which is what high school is about.*

This diversity at Metro was likely a product of the overall diversity in Columbus, Ohio, with its “rich community of immigrants and different nationalities,” according to one parent. The benefits of being a part of such a diverse student body extended beyond the classroom, as described by another parent:

*Clearly there was some design aspects that lent toward it being a very diverse student population, and that was definitely something that my son benefitted from for sure. It created a lot of good conversations at home about the friends he had made, people who had different worldviews and religious perspectives. And I think the diversity and then the challenge to figure out how to be on teams and do presentations was a real world experience that I think they clearly benefitted from.*

Several students also reported that at Metro, there were no cliques, and there was “not a lot of drama at this school,” with everyone getting along. One student noted that “nobody gets picked on here,” especially compared to his previous experience at his private middle school. Similarly, there was a general sense among the students in the focus groups of Metro being a safe school as
well, with one student in particular noting that, “Some kids come here because their home schools are unsafe and poor. Some districts are very unsafe so they come to Metro because they wanted to go anywhere that wasn’t here.” Metro’s teachers and administrators described their efforts in actively fostering this sense of inclusion and safety right from the first day of the school year, when the new students—who came from many different districts and feeder middle schools—participated in an “Amazing Race” type of game. In this scavenger hunt-styled activity, the new 9th graders were teamed up into their advisories of 15 to 20 students. According to one of Metro’s engineering teachers, it was during these initial days that the students began to buy into the culture at Metro and bond with one another.

In addition to the demographic and cultural diversity at Metro, the students came to the school with widely varying levels of academic skills. This past school year, the school administered Measures of Academic Progress (MAP) assessments to incoming freshmen at the beginning of the year to place them in the right mathematics, science, and English courses. According to Principal Kennedy, for the reading assessments, three students came in at the 3rd grade level, ten students assessed beyond the 12th grade level, and the remaining students were spread throughout the grade levels in between. This wide range of academic skills was also seen with the mathematics assessment. An administrator at Metro explained:

*Think about it, we’re open to the entire state. Think about how many interpretations of “passing” there are. Passing 8th grade can look very different depending on where you went. It’s challenging, but doable to differentiate because of the [student-teacher] ratios and the class sizes.*

Additionally, when discussing the students who attended OSU from Metro, the OSU counselor for Metro noted that “it seems that every year, that number of first generation students is getting higher… The first generation kids, a lot of the students by the time they leave Metro have a year or more of college credit finished.”

2.2.8.3.4. STEM-focused mission. Given the school’s mission and status as a stand-alone, regional STEM school in Ohio, it was not surprising that many students did in fact choose to come to Metro for the STEM course offerings and opportunities provided. For example, one student reported during a focus group:

*I was in a lot of lotteries. I did three plus a few others. My last choice was to go to a Catholic school because it was close to my house... Then I got into Metro and came here because I was always interested in math and technology.*

Many of these students quickly gravitated to the robotics team at Metro, which is described in more detail in the Blended Formal/Informal Learning (CC 4) section of the case study. The extremely popular robotics team served as an interesting manifestation of the STEM focus at Metro, with over 15% of the student body participating. As students on the team stated, “The robotics team loves everyone who wants to be there.” Notably, on the day that the research team observed the club meeting, of the 18 students present, nearly half (7) were girls; additionally, the student leaders of the club were two 12th grade female students. This combination of inclusion and STEM interests drove the culture of the team, with students involved who were interested
not only in engineering, but also in the computer sciences and business management aspects of the team. Nevertheless, as one of the student leaders of the team stated, “Our goal is to take everyone and turn them into tiny little engineers.”

Metro emphasized college preparatory level academic work in all of its STEM courses during a student’s Phase I or Core Prep portion of their time at the school. Additionally, as an early college high school, Metro’s system gave students the opportunity to accelerate the pace at which they earned these high school STEM credits and began college-level coursework. Metro incorporated a STEM focus across the learning experience, yet this STEM did not just involve the subject matter content and areas of science, technology, engineering, and mathematics. Instead, Metro viewed STEM as providing the context for a particular process involving problem solving skills, critical thinking skills, and habits of mind that could be extended and used in all realms—STEM and non-STEM, college and careers. This philosophy is covered more comprehensively in the STEM-Focused Curriculum (CC 1) and Reform Instructional Strategies (CC 2) sections of the case study.

According to a variety of metrics and indicators, Metro was successful in providing this STEM content and learning skill to students. The data coordinator noted, “If your predictors are the Ohio Graduation Tests (OGT), attendance, and high school graduate rate, at this point, our graduation rate is 100%, our OGTs are good, our attendance, we’re fighting to keep it decent.” But more important to Metro were other indicators of success around this STEM-related work. One teacher explained that alumni were constantly telling them how well prepared they were for classes at Ohio State University due to the critical thinking and problem solving skills taught at Metro. Metro’s college counselor also described how students who completed Metro’s program were especially prepared for college STEM majors and careers:

*I think if they’ve gone through the program how we’ve laid it out, and they’ve taken advantage of the opportunities and mastered the classes here, and taken opportunities at the college level, they will be really well prepared. A lot of the kids, it blows my mind the kinds of engineering classes and math classes they are taking at OSU. Really, really tough math classes for a senior in college, much less a junior in high school.*

2.2.8.4. Summary
Metro’s mission to be an inclusive, diverse school was realized through its non-selective lottery system and recruiting efforts targeting those student populations that were traditionally under-represented in STEM—low socioeconomic status students, first-generation college goers, and certain minority groups, among others. It is worth noting, however, that despite its recruiting efforts, Metro enrolled lower proportions of students who were economically disadvantaged, limited English proficient, or identified as having special needs, compared to the surrounding district, county, and state. Nevertheless, the ethnic and racial composition of Metro’s student body did closely resemble that of Franklin County, where the vast majority of Metro’s students resided. Also, parents and students noted that the resulting student body was one that was diverse in terms of cultures and interests, and they characterized the school as inclusive and safe for all students. Metro’s STEM focus was evident in how STEM-related processes and skills infused all levels of its curricular and instructional design, with the strength of its robotics team, and in how well prepared their students were for science classes at OSU.
2.2.9. Administrative Structure (CC 9)

2.2.9.1. Definition
This component includes various structures (e.g., school-within-a-school, charter school, magnet school) and is affected by the school’s age and provenance, such as whether the school was converted from another model or was created “from scratch” as a STEM school; it also encompasses various funding structures.

2.2.9.2. Design
The design of Metro’s administrative structure is described below in terms of the school structure, the Governing Board, and the staffing structure at Metro.

2.2.9.2.1. School structure. Metro was started in 2006 by two founding partners, OSU and Battelle. An OSU representative reported that Metro was designed from the start as an innovative STEM-focused school. When it opened its doors, Metro was technically a “programming option,” and as explained by a Battelle representative, students at Metro remained affiliated with their home school. As a result, students who completed their work at Metro did not earn a diploma from “Metro,” but instead received their degree from their home schools. Additionally, student outcome data were not reported by Ohio’s Department of Education for Metro as an entity; rather, all student data went back to each student’s home school. For seed funding, Metro received significant early support from Battelle, OSU, and the Coalition of Essential Schools. Metro was also awarded an Early College Grant through the Bill & Melinda Gates Foundation.

Principal Aimee Kennedy explained that as a STEM “programming option,” Metro’s Governing Board was composed of all 16 superintendents of the school districts in Franklin County. She described the obstacles that this structure presented for Metro’s ability to maintain a consistent student enrollment, an issue that came to a head in 2011:

Each of [the superintendents] could choose to send or not send kids to Metro. We built this program on a model of 100 kids a grade, that’s the cost model that we planned, so some superintendents... might tell us in February, “Hey, we’re not sending kids next year...” So when the district that was supposed to bring five kids every year says, “We’re not bringing everyone,” on the scope of a four year track, we’re now short 20 kids, and out of 400 kids, that’s a lot. So the enrollment piece was really challenging to manage, because we were always under capacity.

As explained by Principal Kennedy, Ohio legislation in 2007, the Amended Substitute House Bill Number 119 (HB 119), had established the stand-alone “STEM school” designation, and Metro had been the impetus for this legislation. HB 119 (available at http://www.legislature.state.oh.us) required proposals to start new STEM schools to provide evidence of partnerships with higher education institutions and business organizations and to also demonstrate a commitment to inclusive admission policies, essentially the Metro blueprint. After a series of conversations and consensus building efforts with the superintendent of Columbus City Schools and other critical stakeholders, Metro officially became a stand-alone regional STEM school, and essentially its own school district, in July 2012, after five years of operation as a STEM “program.” Starting with the 2012-2013 school year, then, Metro students earned diplomas from
Metro, and all Metro student outcome data were officially associated with Metro as a stand-alone entity and reported on the Ohio Department of Education website. Notably, however, students at Metro remained eligible to participate in high school sports and other extra-curricular activities in the home school of their district of residence, a required component under Ohio Revised Code (ORC) 3326, which also was modeled after the Metro blueprint, as explained by Principal Kennedy.

2.2.9.2.2. Governing Board. With its new status as a stand-alone STEM school, Metro’s Governing Board was also redesigned. Principal Kennedy explained that her role was actually more similar to that of a superintendent in that she now reported directly to this Governing Board, rather than to a central office or some other superintendent-level position. This new Governing Board consisted of nine positions, three held by Battelle representatives, three held by OSU representatives, and the remaining three held by representatives from the local school districts. According to a Battelle representative, by design, the three Battelle seats were filled by two executives and one scientist. Two of the three local school district positions were allotted to the Columbus City School District, one of which was held by the Columbus superintendent. The other seat was held by the superintendent of the Bexley City School District at the time of the site visit. The Board’s focus was primarily on financial, fiscal, and budgetary issues, rather than on issues related to academics or educational innovation, according to Principal Kennedy.

2.2.9.2.3. Staffing structure. In addition to reporting to the Governing Board, the chief academic officer (CAO) and principal of Metro served as the academic leader of the school, evaluating teachers, revising curriculum, and overseeing student discipline, according to Principal Kennedy. At the time of OSPrl’s site visit, Metro also had two assistant principals and two co-deans of students supporting this CAO. Each of these administrative staff had partial teaching responsibilities along with their administrative capacities. Principal Kennedy explained that the assistant principals were responsible for ensuring that Metro was running smoothly when the principal was out of the building, evaluating their set of teachers, acting as the “first line of defense” for any discipline or out-of-school suspensions, and being “fully apprised of any information they need to make decisions” affecting the school when the principal was absent.

The deans of students, on the other hand, were not involved in decisions made about teachers, students, or discipline issues, according to Principal Kennedy. Instead, they had specific duties that were “not particularly technical but very time consuming,” such as managing student attendance, and monitoring and meeting with students that were potentially at risk due to falling behind in credits or having some discipline issues. Additionally, each dean of students had separate duties, with one acting as test coordinator for administering state tests and PSATs, among others, and the other dean acting as the data coordinator for Metro.

In addition to these administrators and a staff of 21 teachers, Metro also had a full-time academic advisor from OSU who worked onsite at Metro and was dedicated to supporting its students’ needs in such areas as OSU enrollment and course registration, as well as guidance on how to receive academic support at OSU. The cost of this position was shared between Metro and OSU, with each paying half of the total cost of the contract for this OSU advisor. This position is described in detail in the section on Early College-Level Coursework (CC 6) and was also an important support for students from groups traditionally under-represented in STEM college
majors, including those who would be the first in their families to go to college. Thus, the provision of this full-time academic counselor at Metro is also woven into the section on these supports (CC 10). Finally there were two contractors, one full-time and one part-time, responsible for information technology support. These contractors were housed onsite at Metro. This staff is described in more detail in the Integrated Innovative Technology Use (CC 3) critical component narrative.

2.2.9.3. Implementation
Metro’s implementation of its administrative structure is outlined in the below sections, covering: Metro’s relationship with the local school districts, Metro’s leadership structure, and the data-driven work conducted at the school.

2.2.9.3.1. Relationship with local school districts. Principal Kennedy reported that prior to becoming its own school and district, Metro had a mixed relationship with the local school districts. She explained that this was due to the enrollment and funding issues described in the Design section, with some superintendents more eager than others to partner and share resources with Metro. However, after becoming a stand-alone school, Metro’s relationship with the local districts became more stable, according to the principal.

For example, at the time of this site visit, Metro was in its first year as a stand-alone school district, with the sitting superintendent of Columbus City School District serving on Metro’s Governing Board. With this change, Metro was able to reach its enrollment targets easily. As Principal Kennedy explained, “becoming a stand-alone school allowed families or parents to pick whether they wanted to come or not come, and not superintendents.” Part of Metro’s ability to do this was due to the surrounding Columbus City School District’s willingness to having schools with open enrollment policies, schools of choice, and magnet schools in the district. Principal Kennedy attributed this openness to the supportive attitude of the district’s superintendent.

The principal described the other connections that their school had with the Columbus City School District, connections that ultimately came to benefit both Metro and the district:

*Teacher to teacher, we have a lot of connections with other programs in [the Columbus City School District]. We’ve done some professional development work, through the PAST Foundation, which has hired some of our teachers to do professional development work for the elementary schools. So there have been a lot of connections formally and informally.*

In addition to these professional development-related connections, described in more detail in the STEM-Focused Curriculum (CC 1) and Early College-Level Coursework (CC 6) sections, Metro partnered with a different neighboring high school for each of their themed Learning Centers, which combined OSU courses with high school classes. These partnerships allowed Metro to offer its STEM education innovations to other high schools through collaborative efforts with those schools and to act as a catalyst for advancing STEM education in the local community. Principal Kennedy noted that Metro also benefited from working with strong teachers at other high schools who made substantial contributions to these Learning Center collaborations. These positive relationships with the schools in the Columbus City district were attributable to the
supportive environment fostered by the current superintendent of the district.

2.2.9.3.2. Metro’s leadership structure. In addition to the traditional superintendent- and principal-related duties described in the Design section for this critical component, Principal Kennedy explained that her CAO and principal role included other responsibilities stemming from Metro’s status as an Ohio STEM school:

Some of the things that are more STEM school specific in my school leadership are a recruiting campaign every year, marketing and advertising the school, managing school tours,... working to build partnerships, working with our post-secondary partners,... and making decisions from data.... So even though those are things that generally a principal at a traditional school doesn’t deal with very much, those are things that are very typical for any STEM school principals that I’ve ever met.

In light of these many responsibilities, Principal Kennedy reported that the Governing Board encouraged her to think through and put in place strong preparations for leadership development and succession planning. This was why she had two members of her teaching staff who had reduced teaching loads in order to take on the assistant principal and deans of students responsibilities. For the assistant principals in particular, “the reason why we have two people on board at any time is because the goal is that the assistant principals are really learning about what it means to be a STEM school principal.” One assistant principal said:

In [the principal’s] absence, it’s my job to sure make sure the building functions. If we have visitors in the building, I host the visitors and let them know what our school is actually doing, as well as the outreach we do for the different partnerships we have. This means it’s both inside and outside of the building.

Additionally, one of the deans of students reported that taking on administrative duties has allowed her to “learn a lot from observing. It’s been giving [me] a different perspective in terms of how you respond to different situations.” As a side benefit, she also appreciated the opportunity to see if she enjoyed administrative work without having to leave the teaching role altogether.

This leadership structure of having administrators retain partial teaching loads also helped Metro to be cost effective with its budget while building out a strong, high-capacity administrative team. Principal Kennedy explained that previously when she was the assistant principal, Metro had a full-time principal and a full-time assistant principal who did not teach. Her current model was actually less expensive than this earlier model due to the combination of teaching and administrative tasks covered by the current administrative arrangement, while also adding an assistant principal for succession preparations.

2.2.9.3.3. Data-driven work. When asked what student outcomes were considered to be most important to Metro, the data coordinator described the school’s continuing efforts in defining “success”:

I think in terms of graduating [from college], even though that’s not our focus, it’s still a great
indicator of the work we’re doing. We thought initially we’d have kids graduating at a crazy fast pace, but what is actually happening is they are just having a rich experience, studying abroad and such. We’re still kind of new at figuring out what are the outcomes that indicate success, that’s something we’re learning as we’re going.

With its transition from a “programming option” to a stand-alone STEM school for the 2012-2013 school year, Metro’s student outcome data were reported on Ohio’s Department of Education website for the first time as a separate entity. The academic performance of the school was accordingly described through categories of data such as “Achievement” on the state assessments, “Gap Closing” for every student regardless of income, race, culture, or disability, and “Graduation Rate” (http://reportcard.education.ohio.gov). Even before this transition and resulting state-led compilation of outcome data, however, Metro collected and analyzed its own student data, including demographic and socioeconomic data, Ohio Graduation Test (OGT) scores, and other assessment scores such as the PSAT and ACT, according to their data coordinator. Metro also partnered with the National Student Clearinghouse to examine and monitor the college enrollment, persistence, and completion outcomes for each of its students. These data, along with the outcomes collected and reported on the Ohio Department of Education website, are explored in more detail in the Student Outcomes portion of this case study.

Additionally, as described in more detail in the STEM-Focused Curriculum (CC 1) and Early College-Level Coursework (CC 6) sections of the case study, Metro worked closely with OSU to track students’ credits, grade point averages, and any successes or challenges faced in the college courses taken while at Metro, both to support students and to inform the level of rigor of their curriculum. The data coordinator reported that the OSU-related data were managed by the OSU advisor who was on Metro’s campus full time. Principal Kennedy also stated that Metro worked closely with Battelle for Kids, a non-profit organization founded in 2001 through a partnership with the Ohio Business Roundtable and supported by a grant from Battelle (http://www.battelleforkids.org), around data analyses, “trying to make decisions based on data all the time, [such as] if kids are failing a certain class, [understanding] what might be going on, and what is the profile of the student who isn’t performing well.” These analyses involved student growth data sets from Battelle for Kids based on student scores on end-of-course exams, among other data.

2.2.9.4. Summary
Metro transitioned from a “programming option” to a stand-alone STEM school in July 2012, which provided a much-needed context for sustaining the size of the student body at capacity. Along the way, the structure of Metro’s Governing Board also changed, with three seats filled by Battelle and three others by OSU, the two founding partners of the school. The remaining three were held by representatives from the local school districts, which provided a structure for building stronger relationships with those districts, particularly with the Columbus City School District. Through all of these changes, Metro’s leadership structure remained intact, with a chief academic officer supported by two assistant principals and two deans of students. The efficiency and effectiveness of this lean, highly capable administrative team allowed Metro to provide the full range of administrative supports for its students, maximize the value of its student outcome data to guide its instructional work, and have strong leadership development opportunities in
place for its staff.

2.2.10. Supports for Under-Represented Students (CC 10)

2.2.10.1. Definition
This component comprises bridge programs, tutoring programs, extended school day, extended school year, or looping to strengthen student transitions to STEM-focused curriculum; it also includes altered, improved opportunity structures, including helping students be better positioned for STEM college majors, careers, and jobs.

2.2.10.2. Design
Metro’s central mission as stated on its website was to turn students’ college aspirations into reality through the new 3R’s: “personal relevance, academic rigor, and transformative relationships.” This was accomplished through a focus on STEM education, although students were not required to pursue STEM college majors, jobs, or careers. Rather the expectation was that Metro students would use their STEM knowledge to become good citizens. Metro’s “Habits of Mind” (Effective Communicator, Inquiring Learner, Active and Responsible Decision Maker, Effective Collaborator, Critical Thinker, and Engaged Learner) were crucial to understanding “the Metro Way.” As described in their Family Handbook, the support system was designed to develop these soft skills (see, for example, Tough, 2012) and 21st Century Skills (Partnership for 21st Century Skills, 2012) through a rigorous program in STEM.

Upon entering 9th grade, a student was assigned to a multi-grade advisory group of 15 to 20 students led by a staff advisor who was usually a lead teacher at Metro. “Advisory” was treated as a class and met twice weekly during the regular school day; it was required to be completed satisfactorily in order to earn credit each year. As detailed in the Metro Family Handbook, Advisory was intended to provide time for the teacher to support and facilitate students around several aspects of their work at Metro: academic work such as completing the electronic portfolios showcasing their work and personal growth; completing their “Gateway” exhibitions required for demonstrating the Metro Habits; internship and service learning requirements; and other advisory-related required assignments throughout the year. The Family Handbook also described the “Advisory Week” that took place during the first week of school and was used for team building and for familiarizing new students with the Metro Habits of Heart and Mind, the Taskstream and PowerSchool platforms, and school procedures.

Tutoring was offered every Tuesday, Wednesday, and Thursday from 2:30 to 4:00 pm. Choose Ohio First college scholars and Metro teachers were on hand to assist with questions for mathematics, science, and engineering courses. The Metro staff also included tutors and intervention specialists for students with disabilities. The principal of Metro explained that the only disability category that Metro staff felt unable to adequately serve was “highly emotionally disturbed” students who required major behavioral interventions. The school did not have the staffing for this category of special needs.

2.2.10.3. Implementation
Myriad comprehensive and innovative student supports were evident during the site visit. In order to realize the Metro mission, it was important to have OSU involved with planning the
structure of the academic program, and to continually provide feedback about the supports that would be needed for Metro students to learn and flourish on the college campus. Given Metro’s goal of early college success in STEM subjects, these student supports were crucial. Equally important, however, was Metro’s commitment to creating a school climate that was supportive of all students learning rigorous content and founded on the principles of Coalition for Essential Schools and the three R’s: rigor, relevance, and relationships (NRC, 2004).

2.2.10.3.1. School choice and early expectations. Students who considered applying to Metro were helped to understand the school’s expectations as they embarked on the journey to early college admission and a STEM focus. The typical student course of study at Metro (for about 75% of students) was to complete the basic requirements for a high school degree in the first two or two-and-a-half years, and then begin their early college coursework in themed STEM-focused Learning Centers that included an OSU course combined with high school courses, described in further detail in the Early College Coursework (CC 6) narrative. This demanding program required extensive student supports. However, it appeared that for every challenge posed, there was a web of supports that were not only directly instrumental, but that also provided social and emotional backing.

The first support structure was to supply ample information to prospective students and their families who visited the school after the lottery admissions process to see whether they were up for the challenge of enrolling at Metro. As one parent said:

*I’m a principal [at an area school]. When I visited Metro, I knew this was the perfect place for my son and that he’d fit in so well. I like the fact they have high expectations for all students. It seems like everyone is treated as a gifted student and they have the support to go along with those high expectations.*

Another parent of a son with disabilities was less certain that her son could succeed at Metro. But she was so dissatisfied with his prognosis for success at his middle school, that she enrolled him at Metro, despite her fears:

*The middle school he attended had an 80% failure rate with what they called disabled children and 72% of those were minorities.... They had expectations for the child and parent, but not for the school.... That’s why I was looking for another school system. He was resistant, the same as all freshman who come here because of the culture shock with the work. But the school system that he was in, he was being swept under the rug, and it was so clear.... But here, you’re held accountable. I think that that is real life and that’s what these kids are going to experience in college or the workforce, but not what they’re being taught in [regular] public schools.*

The information and orientation systems provided to parents and students who were applying to Metro were thus the first supports encountered; students and families needed to know if they were up for the challenge. Notably, the assistant principal pointed out that in the prior year, 120 freshmen began at Metro, and only four of those students left Metro:

*Whenever you’re going to ask some group of kids to change their academic culture, you’re going to get friction, and they’re either going to mold and you’re going to help them graciously mold to
our system, or they’re going to leave. We try to keep them where they’re working with us…
because we know they’ll come around, and we’ll support them to do it. We don’t lose that many.

2.2.10.3.2. The Metro Way. Because Metro was intentionally a small school with a special mission and set of opportunities, a unique sense of the high school had evolved, sometimes referred to by students and staff as “the Metro Way.” This was nurtured by team building activities at the beginning of each year. Because students came long distances from schools all over the county, bonding and making new friends at the school were important. One teacher pointed out that after school, “kids don’t leave or go home, but stay here and hang out. They will not leave. So I don’t know how many times I’ve gotten to just sit with a student after school and just talk and really learn little bits here and there….” A student similarly explained that it was not a typical high school experience at Metro because in two years they would attend the university. They had to work hard to achieve that goal; one student calculated that he had completed on average 5.8 assignments per day over the last year.

The rigorous, accelerated academic work required dedication, and some students and parents reported that the unique culture or context at Metro was one of things they would have changed about their time at Metro. For example, one parent in a focus group opined that Metro perhaps “fell a little short in the extracurricular” offerings, with “not a whole lot to do [aside from] the robotics team.” A student alumnus similarly reported that Metro was not a traditional high school experience:

I went to two high school games my entire high school career. We didn’t have sports teams. When you’re going into a large university with kids who did have these experiences, it’s just different. I guess that’s my only thing about it. It was definitely hard for us because we were the first year going in. I feel the first years we spent disliking it; now we appreciate it, but going through it was difficult because you were told to change something and just had to go with it.

Another parent did concede, though, that “this was one of the things that was inevitable about how the school was designed,” due to having students come from so many different school districts. In particular, this parent stated:

A lot of community schools become a hub, and the community and parents and kids all go to the schools, and logistically, it’s easier to [have extracurriculars and sports], but here, by virtue of its design, they made that pretty much impossible.

However, despite these challenges, it appeared that Metro’s structure also served to bring their students together, through their shared experiences. One student alumnus during a focus group stated, “I think [our experiences at Metro] brought us together a lot more though.” This student elaborated:

In our first year, we were on like 9 field trips and became so close… I mean, we did have the problems that we all had in common that brought us together, but we did spend so much time together that it brought us together more.

Similarly, another student pointed out that students created their own support system, saying,
“You are bombarded by assignments and expectations, so we get through it together. It’s hard to go at it alone, and we have to do group assignments anyway.” An assistant principal recognized the challenges and noted that at its core, Metro was a small school, allowing relationships to solve a lot of issues: “It’d be hard for me to make as much difference in as many kids’ lives and experiences if I didn’t know them well.”

2.2.10.3.3. **Advisories.** When students entered Metro, they were assigned to teacher advisors with a mixed age group of students. They stayed with the same advisory groups until graduation, getting to know the teacher and other students in the group well in a deliberately planned and supportive environment. A student pointed out:

Advisors are always there to help solve any problems with classes, schedule, a teacher. They know what they are doing, and they try to know us pretty well. Advisors do a lot of activities exploring what kind of student you are. They say it is about group advisory bonding, but it is good for the teacher also to know how you work.

A parent saw it as every student belonging to a teacher who was in charge. She felt that advisors were valuable in pushing the students, checking on them, and monitoring them to make sure that they were doing well. She remarked on the number of emails that went back and forth between the advisors and families and how the administration took certain students under their wings and watched over those special cases. An engineering teacher confirmed the parent’s sentiments as he talked about the way he approached his advisory:

The advisor frequently checks up on our students, [saying] “Here are your grades, why are you doing well, what got you all those A’s this semester versus last semester....” Every two weeks, I started giving them all a Metro Habits reflection. It has all six habits, and it has a question or comment for them to rate themselves based on the habit... They share that with me, then we talk about what they can do to be a better active, responsible decision maker, or whether they are using their computer to make reminders on [assignments] or whether they need to talk to a teacher, et cetera.

2.2.10.3.4. **Mastery learning system.** An unusual and particularly challenging aspect of Metro’s instructional program was its mastery-based learning (Bloom, 1968; 1971) approach that required that students pass the Metro high school courses with grades of 90% or more, earning an A. An additional challenge for students was that these courses were compressed into a single semester. If they did not attain the 90% level, then they repeated the course. Such a circumstance was not regarded as a failure; rather, it was seen as a challenge and learning opportunity, and many students regularly had to re-take courses.

Mastery learning requires extremely well-structured curricula and formative and summative assessments linked to each learning goal, as well as a fair and open system of accounting. At Metro, this was aided by a software program, Taskstream, accessible to teachers, students, and their families. Taskstream helped students to know their progress at any moment. With the help of the supports at Metro, the mastery learning system seemed to aid students in becoming better prepared in the required course concepts and skills, avoiding any troublesome gaps in knowledge and skills. One teacher described the system:
Since Metro has a range of students, this means that students who might ordinarily get B’s or C’s must work to mastery - A’s. If they do not achieve mastery the first time through a course, they must repeat it. However, because they take a one-year course in a single semester, repeating the course does not feel so onerous because they would normally take that long.

Parents had to adjust their expectations as well, as shown by one parent’s remarks:

My son had an 88 in two of his classes when he came here. But he didn’t have mastery. So he has to either do a recovery class or summer school. It was frustrating. Ms. Kennedy said, “Think about this, he has four years to master this. Let him come in and do three days in summer school.” I had to change my mindset to say he does have four years. He has time to master, and he’s lacking in something whether it’s doing homework or being organized. So once I changed my mindset, I put more responsibility on him.

But most students did achieve mastery in their courses with A’s most of the time, despite the initial challenge. This supported students in developing “soft” or non-cognitive skills to self-regulate, be reflective, and seek out supports as they were needed. Metro taught the value of such skills and explicitly helped students to make progress in the skills through advisories, tutoring, and other supports.

2.2.10.3.5. Tutoring and technology.
There were formal tutoring sessions three days per week after school until 4:00 PM. They were usually staffed by OSU mathematics and science students. In addition, OSU provided students who helped out as Teaching Assistants (TAs) in the Metro classes; these TAs helped to prepare labs, do presentations, and work with students in class. Teachers also had office hours and met with students before school, after school, and during lunch. One teacher said, “We had a student last year who came to tutoring 3 days a week and did really well in biology, and he was a great model for other students for success to show that tutoring works well.” The school also provided quiet places for work, to go over what was covered that day, or to catch up on homework. Students seemed to enjoy the contact with the OSU tutors and TAs. One student remarked, “We don’t even think of it as tutoring, you just ask them questions. Some classes are more intense about tutoring – physics, math lab.”

The school’s Taskstream learning system allowed teachers to post lectures, assignments, and homework on the platform so that students could find what they needed in one place. One parent remarked that because of these systems and supports, even when there were snow days, the learning did not stop.

[My son] can get into Adobe Connect and there’s no problem. Seeing it here, the way they are using it is really nice. My son can do anything he needs to do on that computer. When he goes into the workforce, I don’t see there being too many tasks he’s not going to be able to do. He has no fear of the technology.

2.2.10.3.6. Internship supports. Every student at Metro completed an internship requirement, typically during their junior or senior year. These students received substantial supports from
Metro’s internship coordinator, who spent over half of every day visiting students and mentors at each of the various internship sites. Additionally, through seminars conducted at the beginning of each semester, the internship coordinator met with each student who was about to embark on an internship for approximately a week in order to get them “resume ready.” During this time, he helped those students find internship placements. As explained by the CAO, Metro had a list of sites that were always looking to host their students, but some students wanted to find a different location for their particular interests. The internship coordinator provided as much support as possible for these students, helping connect them to potential mentors. During this team’s site visit at Metro, for example, he was actively on his cell phone, successfully working to get a student placed at a new internship site.

After the students began their internship work for the semester, the internship coordinator met with all of them together once a week in their weekly seminar. This class allowed him to provide continuous supports and monitoring to the students as they completed their internships.

2.2.10.3.7. College transition. Most of the students at Metro took college classes at OSU before they graduated, and Metro helped these students learn to use support services to make a good transition and find success. Teachers met with OSU faculty to find out how Metro students were doing in their first full-time college classes and if they needed to be prepared differently. One parent with two children at Metro described the transition and supports:

My daughter has had a lot of college courses. Not all of them have been successful. She just withdrew from one yesterday. But it’s better to learn to crash and burn now when your mom and dad are here and your teachers are here. My son is taking his first year of classes and is tearing it up. I like the Learning Center model because they get to take college classes and still get access to her teachers here [through advisories]. I like that they ramp up the difficulty level within the Learning Center so they are ready to start to take the college classes.

Students were also coached by an OSU college and academic advisor who was housed full-time at Metro. OSU and Metro shared the cost for this advisor, with each paying half of her salary. This advisor helped students with paperwork, registration, and navigating the college campus, and she kept track of the progress of each Metro student at OSU. Additionally, because of the emphasis in developing Metro habits, students were encouraged to seek help at OSU if they needed it and access OSU tutoring or meet with a professor during office hours.

Because Metro was a school with open enrollment and all levels of ability, not all students could succeed immediately in the rigorous STEM Learning Centers. Some students were encouraged to take an OSU study skills course, and they had done so well in that course that they developed the confidence to access a variety of OSU college courses for full credit independently of the Learning Centers, as reported by Principal Kennedy. Another group of students took courses at the community college instead of OSU. The community college allowed for an easy transfer of course credits to OSU, so if the students wanted to continue their studies at OSU, they were able to do so. Principal Kennedy felt that it was important for the students to know that every student had a personalized approach to early college attendance and that someone at Metro was carefully watching each step of the way.
Taking college credits, essentially at no cost to the students or their families, appeared to be a valuable financial support as well. Many Metro families were of limited means, and this support represented a substantial savings on tuition costs. One parent pointed out that if her daughter continued at OSU after graduating from Metro at 18 years of age, she could complete her undergraduate degree at age 20 while living at home, and then be positioned to start graduate school at a university somewhere else in the United States.

Metro required students to participate in college planning beyond OSU and had a college advising program developed by the Metro guidance and college access counselor. As Principal Kennedy explained, she helped students develop their college plans to decide which colleges were reach schools, appropriate schools, or safe schools for them, openly involving the families in these conversations as well. This occurred in a required, graded course (called Senior Communications) for all seniors at Metro that met one day every other week. Principal Kennedy felt that this course provided a way to “systematize the college application and college going process,” helping students and families to make educational and financial choices:

*Even if you think you’re going somewhere, you don’t necessarily know for sure if you’re going there, you don’t know if you’re making the best decision for you financially. You may not have explored specific college opportunities, and we really want kids to have a lot of choice, so it’s important that you apply to schools that you might not get into and schools you are pretty sure you can get into.*

In this same vein, an administrator at Metro indicated that a lot of students can “get stuck in this one mindset” of focusing only on OSU as their postsecondary option, thus making it important for Metro to help students “explore outside of OSU and open up to possibilities that might be a better fit for them.”

**2.2.10.3.8. Disability services.** At Metro, 5.1% of its student body of approximately 400 students were identified with special needs. Because Metro was a school of choice, they and their families knew at the outset that this was a challenging STEM school with early college enrollment as a goal. One might have speculated that this would have discouraged students with learning challenges from enrolling after being selected in the open lottery system, but Metro had students with disabilities representing nearly the full range of disability categories. Most of the supports for students with disabilities were provided before or after school or during pull-out times. An intervention specialist at Metro responded to students who came in with problems with assignments and designed interventions when necessary. There were two specialists in the building. The assistant principal also noted:

*The expectation is that every teacher in this building is an intervention specialist. Teachers are making accommodations for kids who don’t have IEPs [Individualized Education Programs], and that’s what we’d expect them to do. So with that, when you are already doing that for a child who is in the general population, it’s very easy to extend that to a child who has an IEP.*

Some students with disabilities could take longer to achieve mastery in a course, but the mastery system allowed them to show that they had learned the material in a variety of ways. Some students with disabilities could also take longer to transition into the OSU program which
required a successful Gateway Portfolio to demonstrate mastery. The school provided a means for students with disabilities to go more slowly, and many ultimately made the transition to OSU courses. When there, they were expected to sign up for accommodations and seek the help that would help them to be successful, as with any student with identified needs. In addition, they could return to Metro for advisories and for discussions with an intervention specialist. Students with disabilities were thus supported at Metro, aided greatly by the personalized approach to teaching and learning that aligned with “the Metro Way.”

2.2.10.4. Summary
Metro was very purposeful in building many facets of student supports into the design of the school. As challenging an inclusive STEM school that Metro was, the supports that were in place were thoughtfully and strategically developed, aligned with Metro’s mission and its academic program. They worked in harmony to meet the needs of the students without overburdening the teaching staff. These supports began even before new students enrolled, through an informational application, lottery, and interview process that ensured that prospective students and parents were prepared for the work at Metro. These supports were provided throughout the students’ time at Metro, particularly for first generation college-going students and other underrepresented students, through the Advisory system, tutoring for academic classes, supports for internships, and early college advisors. The common thread throughout all of these supports was the relationship building that was such an integral part of Metro’s mission and “the Metro Way.” Also noteworthy was Metro’s mastery learning program, which provided a means for students to learn deeply and well, thus creating learners who knew the material and were confident in their ability to perform as they sought supports as necessary. Metro students also received a great deal of support from OSU which supplied an in-house advisor, close links with college faculty teaching Metro students, and tutors and teaching assistants. There was also a range of financial supports for Metro families, both direct and indirect.

This integrated support system was one of many aspects of the partnership between Metro and OSU, without which the students’ experiences at the large university likely would have been quite different. Metro took regular students who were ready to take on a STEM challenge, and coached them into the world of academe. This was done not only on the basis of social capital received from parents, but by helping first generation students and their families build and earn new social capital through hard work (rigor), relevance (in the range of early college experiences) and relationships with Metro educators, OSU educators, and others in the community.

2.3. STUDENT OUTCOMES
Having explored the design and implementation dimensions in the above sections, this study now examines the student outcomes produced at Metro. There is overall agreement that ISHSs should improve underrepresented students’ preparation in STEM in ways that inspire and provide requisite background knowledge and skills, instilling confidence and desire to seek more STEM education, jobs, and careers (Means et al., 2008; NRC, 2004). To capture this student outcome information for Metro, OSpRI compiled near-term outcome data such as student demographic data, attendance rates, student scores on state assessments, and ACT scores. The study also gathered information on longer-term outcomes such as high school cohort graduation rates and
postsecondary-related outcomes from Metro.

2.3.1. Inclusive Demographics: Who are the students that Metro is serving?

Table 14 presents demographic data for high school students (grades 9 to 12) from the 2012-2013 school year, comparing Metro with the district it was physically located in, its surrounding county, and state. Additionally, this table compares Metro’s demographics with Columbus Alternative High School (CAHS), a public high school that is part of the Columbus City School District (CCSD) and located five miles from Metro. CAHS is a magnet school for college-bound students in Columbus, offering both Advanced Placement (AP) and International Baccalaureate (IB) programs for its students. In contrast with most of the schools in the district, which guarantee admission to residents of their respective neighborhoods, admission to CAHS is fully determined through the district’s lottery system. CAHS accordingly pulls students from all areas of CCSD and represents an informative comparison point as a high-performing school with a diverse student body.

Metro was open to all students across Central Ohio, and the overwhelming majority of Metro’s students came from Franklin County, which encompasses 17 school districts. For example, in the 2012-2013 school year, over 96% of Metro’s students came from a district in Franklin County, and 53% came specifically from CCSD. Overall, a total of 25 school districts were represented in Metro’s student body, with seven districts contributing 15 or more students. Given that nearly all of Metro’s students came from Franklin County, it is notable that Metro’s demographics closely resemble that of the county, with very similar proportions of Black, Hispanic, and White students. Metro does, however, have a lower proportion of economically disadvantaged students and students with special needs than the county.

Table 14
2012-2013 High School Demographics for Metro, Columbus Alternative High School (CAHS), District, County, and State

<table>
<thead>
<tr>
<th></th>
<th>Metro</th>
<th>CAHS</th>
<th>Columbus City School District</th>
<th>Franklin County *</th>
<th>Ohio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students Served in Grades 9-12</td>
<td>394</td>
<td>699</td>
<td>12,890</td>
<td>46,454</td>
<td>495,088</td>
</tr>
<tr>
<td>Female (%)</td>
<td>50.2</td>
<td>59.5</td>
<td>49.4</td>
<td>48.9</td>
<td>49.2</td>
</tr>
<tr>
<td>Male (%)</td>
<td>49.8</td>
<td>40.5</td>
<td>50.6</td>
<td>51.1</td>
<td>50.8</td>
</tr>
<tr>
<td>Asian (%)</td>
<td>7.6</td>
<td>3.9</td>
<td>2.7</td>
<td>4.1</td>
<td>1.8</td>
</tr>
<tr>
<td>Black, Non-Hispanic (%)</td>
<td>28.3</td>
<td>61.1</td>
<td>65.3</td>
<td>28.5</td>
<td>16.3</td>
</tr>
<tr>
<td>Hispanic (%)</td>
<td>3.8</td>
<td>3.7</td>
<td>6.1</td>
<td>5.0</td>
<td>3.4</td>
</tr>
<tr>
<td>American Indian/Alaska Native (%)</td>
<td>--</td>
<td>--</td>
<td>0.1</td>
<td>0.3</td>
<td>0.1</td>
</tr>
<tr>
<td>Multiracial (%)</td>
<td>5.9</td>
<td>1.7</td>
<td>2.2</td>
<td>3.4</td>
<td>3.6</td>
</tr>
<tr>
<td>Pacific Islander (%)</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>White, Non-Hispanic (%)</td>
<td>54.3</td>
<td>29.0</td>
<td>23.4</td>
<td>57.8</td>
<td>74.7</td>
</tr>
<tr>
<td>Economically Disadvantaged (%)</td>
<td>29.4</td>
<td>55.0</td>
<td>75.6</td>
<td>41.4</td>
<td>41.2</td>
</tr>
<tr>
<td>Limited English Proficient (%)</td>
<td>--</td>
<td>5.5</td>
<td>9.9</td>
<td>5.4</td>
<td>1.3</td>
</tr>
<tr>
<td>Students with Special Needs (%)</td>
<td>5.1</td>
<td>6.4</td>
<td>17.6</td>
<td>12.9</td>
<td>14.1</td>
</tr>
</tbody>
</table>

*Note. Data retrieved from the Ohio Department of Education school report cards website (http://reportcard.education.ohio.gov) on September 12, 2013. “--“ indicates no data reported for that particular student group since
2.3.2. Attendance Rates: Attendance as an Indicator of Student Engagement

The important role that student attendance plays in promoting academic success is widely acknowledged and accepted (see, for example, Bryk, Sebring, Allensworth, Luppescu, & Easton, 2010). Table 15 presents the attendance rates for Metro, CAHS, CCSD, and the state for 2012-2013. (County-level data is not reported and could not be aggregated from the separate district-level reports.) Metro displayed very high attendance rates both overall and across four student groups that are traditionally underrepresented in STEM fields: females, African American students, Hispanic students, and students from low socioeconomic backgrounds. In addition, Metro’s attendance numbers compared favorably to those from CAHS, CCSD, and the state, which was notable given CAHS’s status as a magnet school.

Table 15
2012-2013 High School Attendance Rates Comparing Metro, CAHS, District, and State

<table>
<thead>
<tr>
<th>Attendance Rates for all students in grades 9-12 (%)</th>
<th>Metro</th>
<th>CAHS</th>
<th>Columbus City School District</th>
<th>Ohio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>&gt; 95</td>
<td>94.4</td>
<td>89.3 *</td>
<td>92.6 *</td>
</tr>
<tr>
<td>Female</td>
<td>&gt; 95</td>
<td>94.1</td>
<td>89.2 *</td>
<td>92.4 *</td>
</tr>
<tr>
<td>Black, Non-Hispanic</td>
<td>&gt; 95</td>
<td>94.0</td>
<td>89.5 *</td>
<td>88.4 *</td>
</tr>
<tr>
<td>Hispanic</td>
<td>&gt; 95</td>
<td>90.8</td>
<td>87.3 *</td>
<td>90.3 *</td>
</tr>
<tr>
<td>Economic Disadvantaged</td>
<td>&gt; 95</td>
<td>93.5</td>
<td>88.5 *</td>
<td>89.6 *</td>
</tr>
</tbody>
</table>

* The high school attendance rates for the district and state were estimated by taking the averages of the rates for grades 9, 10, 11, and 12.

2.3.3. Assessment Scores: How are Metro Students Progressing and Achieving Academically?

Metro relied on the ACT Quality Core and End of Course content standards to design their courses and serve as benchmarks for their instructional outcomes. As such, given that the Ohio state assessments were aligned to Ohio’s academic content standards, although their students were required to take these state-mandated assessments for NCLB accountability purposes, direct test preparation for the Ohio assessments was not as much of an explicit focus for Metro’s instruction as the ACT exams. Beginning with the 2012-2013 school year, however, Metro became its own district, with its student test scores reported on the Ohio Department of Education website for the first time. Accordingly, Metro did pay close attention to their results on the Ohio assessments, due to the role those test scores were now playing regarding school accountability and public perception purposes.

2.3.3.1. The Ohio Graduation Tests (OGT): Background

The Ohio Department of Education website provides detailed background information on the OGTs (http://education.ohio.gov). The OGTs were aligned to Ohio’s academic content standards, which were adopted by the Ohio State Board of Education in English language arts,
metropolitan, science, and social studies. Students were required to pass all five parts of the OGTs (the four subjects above plus writing) in order to receive their high school diplomas. High school students took the OGTs for the first time in the spring of their 10th grade year. If they passed all five tests, they completed their OGT requirements and were not required to take any additional OGT assessments. If they did not pass all five assessments, they then had the opportunity to re-take those tests that they did not pass in the fall and spring of their 11th and 12th grade years, until they passed them.

There were five performance levels that students could achieve on the OGTs: Limited, Basic, Proficient, Accelerated, and Advanced (Ohio Department of Education, 2006). In order to pass the OGT assessments, students had to achieve at least at a “Proficient” level on all five tests. The Ohio Department of Education provided descriptors for each of these performance levels for all five subjects. For Science and Mathematics, the descriptors for “Proficient” level performance were:

Science: Students typically recognize and provide descriptions or explanations showing understanding of scientific concepts and relationships underlying natural phenomena, structures, processes in living, physical, and Earth and space systems and cycles (e.g., food webs, electric circuits, water cycle). Given investigative scenarios, they demonstrate a working ability to design scientific investigations. They organize, represent and analyze data in various forms, and detect and summarize data trends. They use information to provide explanations and to draw reasonable conclusions. They demonstrate understanding of physical and conceptual models. They recognize some inputs and outputs, causes and effects, and interactions and relationships within a system. They recognize factors impacting rate of change (e.g., effects of forces on motion). They recognize the practical application of scientific concepts and principles to problems in the real world and show a developmental understanding of technological applications.

Mathematics: Students performing at the Proficient level apply mathematical concepts, terms and properties to problem situations. Most times, students can solve problems with two or more steps or decision points. They usually make appropriate decisions about what to do and can use informal reasoning and problem-solving strategies. Students typically can interpret or provide a visual or symbolic representation to match a problem situation and purpose. Students communicate mathematical thinking and solutions using a combination of informal and mathematical language.

2.3.3.2. OGT: Student Outcomes

Figure 2 presents the percentages of Metro students that achieved at or above the “Proficient” level on each of the five OGT assessments on their first attempts at passing those tests as 10th graders, with comparisons made to the corresponding results for CAHS, CCSD, Franklin County, and the state. Metro outperformed the district, county, and state across all five subjects and was comparable to CAHS, a magnet school in the Columbus City School District. As Figure 3 shows, by the time Metro students completed their 11th grade year, nearly all of their students passed all five OGTs, on par with CAHS’s results and again outperforming the district, county, and state.
Figure 2
Spring 2013 OGT Results for Metro, CAHS, District, County, and State (Percent of all 10th graders at Proficient, Accelerated, or Advanced Level)

Note. Data retrieved from the Ohio Department of Education school report cards website (http://reportcard.education.ohio.gov) on September 12, 2013.

Figure 3
Spring 2013 OGT Results for Metro, CAHS, District, County, and State (Percent of all 11th graders at Proficient, Accelerated, or Advanced Level)

Note. Data retrieved from the Ohio Department of Education school report cards website (http://reportcard.education.ohio.gov) on September 12, 2013. 11th grade figures represent cumulative results for students who took the tests as 10th or 11th graders.

Some may argue that “academic excellence” reflects more than achieving at “proficient” levels, instead defining such excellence as performing at an “advanced” level, the highest level of achievement recognized by the Ohio Department of Education. By way of comparison for Science and Mathematics specifically, the descriptors for “Advanced” level performance are:
Science: Students consistently demonstrate superior knowledge and the ability to integrate understanding of scientific principles. Students use complex reasoning skills to predict and to design investigations that answer questions about real-world situations. They integrate, interpolate and extrapolate embedded information to draw well formulated explanations and conclusions. They describe the inherent strengths and limitations of models and revise models based on new information. They recognize relationships within systems and use this knowledge to make reasonable predictions. They describe and explain constant, exponential, or irregular patterns and apply this recognition to make predictions. They evaluate technological solutions for given problems.

Mathematics: Students performing at the Advanced level routinely identify and connect fundamental mathematical concepts, properties and procedures to more complex and novel problem situations. Students typically demonstrate more abstract and sophisticated thinking in their analysis of, approach to and solutions for problems. They provide a formal mathematical justification using precise mathematical language and notations. Students consistently demonstrate deep knowledge and skills across the standards.

Accordingly, Figures 4 and 5 address this distinction and display the percentages of 10th grade and 11th grade students achieving at the “Advanced” level on the OGTs for Science and Mathematics, for Metro, CAHS, CCSD, and the state. (County-level test results are not disaggregated by performance level.) It is notable that when looking at this particular metric, Metro outperformed not only the district and state, but also CAHS, potentially reflecting greater success at providing high-level STEM instruction.

**Figure 4**
Spring 2013 OGT Results for Metro, CAHS, District, and State (Percent of 10th graders at Advanced Level Only)

![Bar Chart]

Note. Data retrieved from the Ohio Department of Education school report cards website (http://reportcard.education.ohio.gov) on September 12, 2013.

For Figure 5, the data for 11th graders represent the cumulative results for students who took the tests as 10th or 11th graders, as reported on the Ohio Department of Education website.
Figure 5

Spring 2013 OGT Results for Metro, CAHS, District, and State (Percent of 11th graders at Advanced Level Only)

![Bar Chart]

Note. Data retrieved from the Ohio Department of Education school report cards website (http://reportcard.education.ohio.gov) on September 12, 2013. 11th grade figures represent cumulative results for students who took the tests as 10th or 11th graders.

Additionally, it is informative to examine Metro’s outcomes in getting their students to the “Advanced” performance level on the Science and Mathematics OGT assessments when looking specifically at three student groups that are traditionally under-represented in STEM fields: female students, African American students, and socioeconomically disadvantaged students. (Metro did not have sufficient numbers of tested Hispanic students to have reported data on the state website.) Figures 6, 7, and 8 present the percentages of students achieving the “Advanced” level on the Science and Mathematics assessments, disaggregated for those specific groups respectively. Across the board, Metro either outperformed or closely matched the results for CAHS, a magnet school, and outperformed the district and state for all metrics, perhaps indicating Metro’s success in supporting these under-represented students with rigorous instruction as they pursue STEM interests. In these Figures, the data for 11th graders represent the cumulative results for students who took the tests as 10th or 11th graders, as reported on the Ohio Department of Education website.

Figure 6

Spring 2013 OGT Results for Metro, CAHS, District, and State (Percent of 11th grade Female Students at Advanced Level Only)

![Bar Chart]
education.ohio.gov) on September 12, 2013. 11th grade figures represent cumulative results for students who took the tests as 10th or 11th graders.

**Figure 7**
*Spring 2013 OGT Results for Metro, CAHS, District, and State (Percent of 11th grade Black, Non-Hispanic Students at Advanced Level Only)*

![Bar chart showing OGT results for Metro, CAHS, District, and State.](chart1.png)

*Note.* Data retrieved from the Ohio Department of Education school report cards website (http://reportcard.education.ohio.gov) on September 12, 2013. 11th grade figures represent cumulative results for students who took the tests as 10th or 11th graders.

**Figure 8**
*Spring 2013 OGT Results for Metro, CAHS, District, and State (Percent of 11th grade Economically Disadvantaged Students at Advanced Level Only)*

![Bar chart showing OGT results for Metro, CAHS, District, and State.](chart2.png)

*Note.* Data retrieved from the Ohio Department of Education school report cards website (http://reportcard.education.ohio.gov) on September 12, 2013. 11th grade figures represent cumulative results for students who took the tests as 10th or 11th graders.

### 2.3.3.3. ACT Benchmarks and Student Outcomes
Metro placed a priority on using ACT Quality Core Curriculum and College Readiness Benchmarks to design their courses and measure the achievement outcomes for their students. ACT provided Metro with annual detailed data profiles and college readiness reports for their students, including overall outcomes for their students and comparisons with their surrounding state and national averages. In general, Metro performed very well with respect to these comparables. Figure 9 provides the percentages of Metro students who “met ACT college readiness benchmarks” and compares those percentages with the state and national averages. As
the ACT report explains:

A *benchmark score* is *the minimum score needed on an ACT subject-area test to indicate a 50% chance of obtaining a B or higher or about a 75% chance of obtaining a C or higher in the corresponding credit-bearing college courses.* (ACT College Readiness Letter for Metro)

For the 2012-2013 school year, the corresponding ACT college readiness benchmark scores for each of the subjects tested is listed in Table 16. Student scores that matched or exceeded these benchmark scores indicated that the students were “college ready.”

**Table 16**

*2012-2013 ACT College Readiness Benchmark Scores*

<table>
<thead>
<tr>
<th>Designated College Course</th>
<th>Corresponding ACT Subject Test</th>
<th>Benchmark Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>College English Composition</td>
<td>ACT English</td>
<td>18</td>
</tr>
<tr>
<td>College Algebra</td>
<td>ACT Mathematics</td>
<td>22</td>
</tr>
<tr>
<td>College Social Science</td>
<td>ACT Reading</td>
<td>22</td>
</tr>
<tr>
<td>College Biology</td>
<td>ACT Science</td>
<td>23</td>
</tr>
</tbody>
</table>

*Note. ACT College Readiness Letter for Metro provided by Metro on September 6, 2013.*

Given those benchmarks, Figure 9 displays the percentages of Metro students who met the respective ACT college readiness benchmarks, compared with the state and the nation. Similarly, Figure 10 provides the average ACT scores for Metro, the state, and the nation, for all four subject tests and the composite score. Metro outperformed both the state and the nation across all subject areas.

**Figure 9**

*2013 Percent of Students Who Met ACT College Readiness Benchmarks for Metro, State, and Nation, for all students tested*
The ACT report also provides some disaggregated data for the test scores across specific demographic categories. Figures 11, 12, and 13 provide the average Mathematics, Science, and Composite ACT scores for Metro and the state for three traditionally under-represented student groups: African American, Hispanic, and female students (the ACT report does not include socioeconomically disadvantaged students as a separate group). Overall, Metro compares favorably with the state, although it does slightly underperform relative to the state averages with respect to Hispanic students for the Mathematics and Science tests. However, for the Composite scores, Metro’s outcomes for their Hispanic students match the state averages.

Figure 11
2013 Average Mathematics ACT scores, disaggregated by demographic categories, for Metro and State

Note. 2013 ACT Profile Report, provided by Metro Early College High School on September 6, 2013.
Figure 12
2013 Average Science ACT scores, disaggregated by demographic categories, for Metro and State

Note. 2013 ACT Profile Report, provided by Metro Early College High School on September 6, 2013.

Figure 13
2013 Average Composite ACT scores, disaggregated by demographic categories, for Metro and State

Note. 2013 ACT Profile Report, provided by Metro Early College High School on September 6, 2013.

2.3.4. Longer-Term Outcomes: Cohort Graduation Rates and Postsecondary Outcomes
Metro has shown high levels of success around their high school graduation rates. Table 17 compares Metro’s four-year cohort graduation rates with those of CAHS, CCSD, and the state. (County-level data is not reported.) For the classes of 2011 and 2012, Metro had a 100% graduation rate, which outpaced the nearby magnet school CAHS and the surrounding district and state. It should be noted, of course, that Metro was a smaller entity than any of its comparables, but nevertheless, its success in supporting students to graduate on time, particularly in light of their demanding mastery assessment system, was noteworthy and positive.
Table 17
Four-Year Cohort High School Graduation Rates of Classes of 2011 and 2012 for Metro, CAHS, District, and State

<table>
<thead>
<tr>
<th></th>
<th>Metro</th>
<th>CAHS</th>
<th>Columbus City School District</th>
<th>Ohio</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Class of 2011</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Graduates (N)</td>
<td>94</td>
<td>158</td>
<td>2,650</td>
<td>117,889</td>
</tr>
<tr>
<td>Graduation Rates (%)</td>
<td>100</td>
<td>98.1</td>
<td>75.8</td>
<td>79.7</td>
</tr>
<tr>
<td><strong>Class of 2012</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Graduates (N)</td>
<td>68</td>
<td>112</td>
<td>2,576</td>
<td>116,894</td>
</tr>
<tr>
<td>Graduation Rates (%)</td>
<td>100</td>
<td>91.8</td>
<td>79.2</td>
<td>81.3</td>
</tr>
</tbody>
</table>

Note. Data obtained from Metro and retrieved from the Ohio Department of Education school report cards website (http://reportcard.education.ohio.gov) on September 12, 2013.

Metro demonstrated similarly positive results for college acceptance and enrollment rates. Data provided by Metro indicated that 100% of their students were accepted to college for the classes of 2011 and 2012, with 92% gaining acceptance to four-year colleges in 2011 and 94% in 2012. The remaining students in those years were accepted into two-year colleges or joined the armed forces.

Metro also partnered with the National Student Clearinghouse to examine and monitor the college enrollment, persistence, and completion outcomes for each of its students. Table 18 displays postsecondary-related data for the Classes of 2010 and 2011, comparing Metro’s outcomes with national data published by the National Center for Education Statistics (NCES). The comparison is necessarily inexact, as the closest approximation for a national sample available through NCES is that of “recent high school completers,” defined by NCES as “individuals ages 16 to 24 who graduated from high school or completed a GED during the preceding 12 months” (NCES, 2012b). This rough comparison, however, serves to provide at least some context around Metro’s enrollment rates and indicates that after graduating from high school, Metro students have proceeded to enroll in college at a relatively high rate.

Table 18
College Enrollment and Persistence Rates for Metro and Nation, Classes of 2010-2011

<table>
<thead>
<tr>
<th></th>
<th>Class of 2010</th>
<th>Class of 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Metro</td>
<td>Nation</td>
</tr>
<tr>
<td>Total Number of Students (#)</td>
<td>74*</td>
<td>3,160,000**</td>
</tr>
<tr>
<td>Total Enrolled in College Immediately after High School (%) ^</td>
<td>85.1</td>
<td>n/a</td>
</tr>
<tr>
<td>Total Enrolled in 4-Year College (%)</td>
<td>75.7</td>
<td>n/a</td>
</tr>
<tr>
<td>Total Enrolled in 2-Year College (%)</td>
<td>9.5</td>
<td>n/a</td>
</tr>
<tr>
<td>Total Enrolled in College Any Time During the First Year after High School (%) ^^</td>
<td>91.9</td>
<td>68.1</td>
</tr>
<tr>
<td>Total Enrolled in 4-Year College (%)</td>
<td>79.7</td>
<td>41.4</td>
</tr>
<tr>
<td>Total Enrolled in 2-Year College (%)</td>
<td>12.2</td>
<td>26.7</td>
</tr>
<tr>
<td>Percentage of Enrolled Freshmen Enrolled in a</td>
<td>88.2</td>
<td>n/a</td>
</tr>
</tbody>
</table>
College for their Second Year (%)

<table>
<thead>
<tr>
<th></th>
<th>4-Year College</th>
<th>2-Year College</th>
</tr>
</thead>
<tbody>
<tr>
<td>In 4-Year College</td>
<td>91.5</td>
<td>n/a</td>
</tr>
<tr>
<td>In 2-Year College</td>
<td>66.7</td>
<td>n/a</td>
</tr>
</tbody>
</table>


* These figures represent the total number of Metro alumni/ae who were registered with the National Student Clearinghouse.

** These figures represent the approximate number of “recent high school completers” as defined by NCES.

^ The National Student Clearinghouse defines “Immediately after High School” as the fall semester immediately following graduation. The fall semester is any enrollment that occurs between August 15 and October 31.

^^ The National Student Clearinghouse defines the “First Year after High School” as including any enrollment that occurs between August 15 of the graduation year and August 14 of the following year. NCES data reflects those students who graduated from high school or earned their GED during the preceding 12 months.

2.3.5. STEM Interests
Metro also administers the ACT PLAN tests to its students; PLAN serves as the midpoint measure of academic progress in ACT's College and Career Readiness System. In addition to containing four curriculum-based assessments (English, Mathematics, Reading, and Science) PLAN asks students to report on their career preferences and plans. In the 2012-13 administration of the PLAN tests, students could indicate their interest in attending a two-year or four-year college in pursuit of career interests in the fields of Science/Technology, Administration/Sales, Business Operations, Technical, Arts, or Social Service. Based on those choices, 65% of Metro students indicated an interest in pursuing a four-year college degree in Science/Technology. By way of comparison, according to the National Center for Education Statistics, in 2011, 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 (NCES, 2012a).

2.3.6. Summary
According to the student outcome measures considered in this case study, Metro substantially outperformed their surrounding district, county, and state. Additionally, Metro compared very favorably with the nearby CAHS, a selective magnet school offering AP and IB programs for its students. Not only did nearly all of Metro’s students, for example, pass all five subjects in the state OGT assessments by the end of their 11th grade, matching the results for CAHS, but also higher percentages of Metro students achieved at the “Advanced” level on the mathematics and science OGT assessments than CAHS. Metro’s focus on ACT’s Quality Core Curriculum and College Readiness Benchmarks in designing their STEM courses was also seemingly evident in its student results on the ACT tests. Across all four subjects in the ACT assessments, Metro substantially outperformed the state and the national averages.

Beyond these test scores, Metro’s outcomes based upon student indicators such as attendance rates, high school graduation rates, and college enrollment and persistence rates were also quite strong, exceeding the results for their comparison points. However, Metro did enroll smaller percentages of economically disadvantaged students, English language learners, and special education students than these comparison entities. In light of the fact that Metro pulled its students from 25 different school districts across Central Ohio, with the vast majority of their student body coming from Franklin County, it was notable that Metro’s student demographics
around race and ethnicities closely matched those of Franklin County. Metro did still enroll a lower percentage of economically disadvantaged students than Franklin County, however.

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

This case study on Metro is the sixth in a series of cases that OSPri is conducting on inclusive STEM-focused high schools. During our research team’s site visit at this school, we observed an intricate network of opportunity structures built at Metro providing unique and integrated schooling experiences for its students (Roberts, 1968). In particular, Metro’s STEM-focused and early college educational program provided the crucial opportunity structures needed to support success in STEM during high school, college, and careers for all of their students and especially for their low-income, female, African American, and Hispanic students, groups that have traditionally been underrepresented in STEM fields. Not only did 100% of Metro’s students graduate, many with two years of college credits already earned, but through the educational experiences and supports they received, Metro students also entered full-time college enrollment better prepared to succeed at advanced college-level work and an increased academic workload.

Such opportunity structures were likely not feasible at the classroom level alone, and Metro was an excellent example of a school that possessed a cohesive alignment across its classroom practices, school-level initiatives, and partnerships with the university and other industry stakeholders in the state. This alignment provided a far more ambitious and extensive platform for innovation than typically seen in high schools in the United States. Similarly, the work done at Metro to foster positive student outcomes that extended beyond mere test scores made this an interesting and valuable case study of a successful ISHS and of innovative STEM education. By fostering the Metro Habits of Heart and Mind, emphasizing the development of critical thinking skills, and providing experiential opportunities that allow students to access and succeed in early-college coursework and STEM-related experiences, Metro enabled its students to experience a genuine academic growth, with college and careers becoming feasible and attainable due to the purposeful linking of instructional programs and learning opportunities.

Perhaps not surprisingly, then, all ten critical components proposed by this OSPri study and supported by the research literature (see Table 2) were actively observed by the study team at Metro. Notably, though, our findings based on the data collected and analyzed suggest that five critical components were especially salient in characterizing the educational program at Metro:

- STEM-Focused Curriculum (CC 1);
- Real-World STEM Partnerships (CC 5);
- Early College-Level Coursework (CC 6);
- Administrative Structure (CC 9); and
- Supports for Underrepresented Students (CC 10).

Additionally, while further analysis of these data revealed no additional emergent themes that were not already extensively covered within the critical components, it became evident that three facets of Metro’s educational program which crossed multiple critical components were insightful in defining the sources of Metro’s strengths and distinguishing it from other schools:

1. Learning Centers. The advanced work that Metro students had the opportunity to engage with in the Learning Centers after completing their high school requirements provided a unique combination of themed STEM coursework at the high school and college levels,
purposefully planned interdisciplinary connections with humanities courses, and a great deal of self-directed, but supported, experiential learning with local businesses and educational partners in the community. These learning experiences represented not just an especially strong STEM-focused curriculum or reform-based instructional practices for Metro’s students, but they also provided invaluable access for these students to real-world STEM industries and STEM-related careers. Additionally, the early exposure and “on ramping” to college-level work within a supportive academic structure afforded Metro’s students an opportunity to have their first experiences with college coursework scaffolded with access to safety nets and dedicated academic counseling not typically given to high school students or full-time college freshmen.

2. *Focus on Habits of Mind.* Metro grounded its educational philosophy in the Metro Habits of Heart and Mind, which served as a framework for designing the instructional strategies across all classes and guiding high expectations for students in academic work and professional internships. For Metro, STEM education did not just cover subject matter content; it was also about the responsible decision making, effective communication and collaboration, and application of critical thinking skills that their students could employ no matter the class, no matter the situation, and no matter the career that they ultimately pursued. As such, these habits were not just present in the instructional strategies used at Metro, but they also represented a central facet of Metro’s mission statement, the expectations placed on Metro’s well-prepared teaching staff, and the supports provided to all students as they progressed through the high school. Ultimately, Metro’s students, teachers, and administrators all reported that students who graduated from Metro have developed the self-efficacy, responsibility, and critical thinking skills that would serve them well in their college work and their careers.

3. *STEM Learning Networks.* Metro’s connections in the world of STEM education were not just limited to neighboring high school partners for Learning Centers or to the local universities such as OSU and Columbus State. Through its partnership with Battelle, Metro had access to and was in fact a leader in both statewide and national STEM learning networks, including the Ohio STEM Learning Network and the multi-state STEMx network. Metro’s involvement with these networks provided an extensive level of resources to Metro for STEM education innovations, teacher and administrator professional development, and collaborative opportunities with other STEM schools. As a consequence, Metro’s STEM focus was not just an insular, internal focus confined to its four walls, but extended throughout Ohio and the United States.

While certain critical components and themes were particularly salient in characterizing this school’s educational program, Metro was notable for the cohesiveness of its design and implementation of all ten critical components. The result was a whole school commitment to providing a strong network of opportunity structures to all of its students. Not only were teachers and administrators dedicated to a rigorous STEM curriculum and a rich variety of instructional strategies in the classroom, but the learning experiences provided by Metro extended beyond the four walls of the school through the internships, networks of STEM partners, and early college experiences. Students at Metro were immersed in STEM, both in terms of the content and knowledge that they were learning, but also with the practices, habits, and skills that Metro
emphasized throughout its program. This included Engineering classes, robotics clubs, Design Challenges, and Gateway requirements. As a result of this work, Metro developed a track record of strong student outcomes for students underrepresented in STEM, with high state assessment scores, consistently high ACT results, a 100% high school graduation rate, and excellent college enrollment and persistence rates. Metro is thus an insightful case study of a successful ISHS that cohesively aligns its classroom instructional practices and experiential learning opportunities to provide an exciting new model for inclusive STEM education.
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