Chicago High School for Agricultural Sciences: A case study of an inclusive STEM-focused high school in Chicago, Illinois

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1 INTRODUCTION

In response to a national need to increase the number of high school students prepared for science, technology, engineering, and mathematics (STEM) college majors and careers (President's Council of Advisors on Science and Technology [PCAST], 2010, 2012), there are concerted efforts to broaden opportunities for high school students to develop knowledge and skills in these areas (National Research Council [NRC], 2011, 2012). Historically, these opportunities have been focused on students who excelled in one or more of these content areas prior to high school. In a 2008 survey of U.S. high schools, Means, Confrey, House & Bhanot, (2008) found that there were many high schools with a focus on STEM, including a growing number that admitted students regardless of their prior academic achievement. These high schools are termed *inclusive,* in contrast with selective STEM schools targeting students who have already demonstrated high achievement in science and mathematics.

Inclusive STEM-focused high schools (ISHSs) were featured in a report by the National Research Council (2012) as showing promise for increasing the number of students pursuing STEM careers and college majors. However, there is a paucity of research on what makes these schools effective. Some ISHSs demonstrate consistently high outcomes such as college-going rates and assessment scores when compared to state and school district averages for students with similar demographic characteristics. Because ISHSs seem to be growing in number, there is an immediate need for more information to support scaling up high performing ISHSs all over the U.S. In 2011, NSF funded the Opportunity Structures for Preparation and Inspiration (OSPrI) study to systematically examine a set of "exemplar" ISHSs, those showing strong outcomes for students from diverse backgrounds. Through cross-case analysis, the goal is to develop a theory of action for scaling up ISHSs. This case study is the eighth in the set that will be analyzed to develop such a theory of action.

In a recent report on agricultural preparedness and agricultural research, the President's Council of Advisors on Science and Technology (PCAST, 2012), stressed the need to focus on secondary programs to increase the participation of groups under-represented in agriculture-related bachelor degree programs. The report specifically noted that the program of studies at the Chicago High School for Agricultural Sciences (CHSAS) was exemplary:

First, we must recognize that the talent pipeline, especially for minority and first-generation college students from urban and rural backgrounds, begins well before college admission. A focus on secondary programs, such as the curriculum exemplified at the Chicago High School for Agricultural Science, hold tremendous potential to increase not only the number, but the diversity, of students entering baccalaureate programs, a requisite for the innovation we intend to spur. At the baccalaureate level, a comprehensive array of undergraduate programs relevant to agriculture and the food industry, as well as applied social and natural sciences, must remain strong and well-supported (p 42).

In this case study, we explore not only the unique agriculture science program at CHSAS, but other components of the school's design that we hypothesize are critical to ISHSs in general. In the section that follows, these critical components and the research questions and methodology that guided the study are briefly described. .

1.1 FRAMING THE STUDY

This case study of the Chicago High School for Agricultural Sciences (CHSAS) asked:

1. Is there evidence for each of the candidate critical components (listed in Table 1, detailed in below sections) found in the design of CHSAS?
2. How are the critical components implemented at CHSAS? 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 CHSAS's design, implementation and student outcomes?
4. How do CHSAS student STEM outcomes compare with those of the school district and state (e.g., STEM achievement measures, graduation rates, college acceptance rates)?

This study explored the design, implementation, and student outcomes of CHSAS, focusing on the ten candidate critical components defined in Table 1. The study also captured themes that emerged from the data.

For full treatment of the research design, including the conceptual framework and research literature underlying the ten critical components, the reader is referred to the publication cited in Table 1; for a detailed description of the data collection and data analysis methods, the reader is referred to the Research Framework for Case Studies document on the OSPrI website (ospri.research.gwu.edu), with some additions for CHSAS included in this case study.

Table 1
Definitions of Candidate Critical Components

1. ***STEM-Focused Curriculum***. Strong courses in all 4 STEM areas, or, engineering and technology are explicitly, intentionally integrated into STEM subjects and non-STEM subjects.

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

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

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

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

6. ***Early College-Level Coursework***. School schedule is flexible, and designed to provide opportunities for students to take classes at institutions of higher education or online**.**

7. ***Well-Prepared STEM Teaching Staff***. Teachers are qualified and have advanced STEM content knowledge and/or practical experience in STEM careers.

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

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

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

The citation for the OSPrI study research design, including conceptual framework and candidate critical components is: Lynch, S. J., Behrend, T. S., Peters-Burton, E.E., and Means, B. M. (2012). Multiple instrumental case studies of inclusive STEM-focused high schools: Opportunity structures for preparation and inspiration (OSPrI). Paper presented at the annual meeting of AERA, Vancouver, BC.

1.2 SELECTION OF CHSAS

The goal of the OSPrI study was 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 for such schools. By *exemplar*, we meant that the school has a reputation for success, including some

unusual successes with its student population when compared to the school district or state, given demographically appropriate comparison groups. In addition, the school would be well established within the school district or state, based on thoughtful planning with community support. By *inclusive*, we meant that the school admits a range of students, i.e., the school's admissions criteria did not limit applicants to students who demonstrated that they are gifted and talented in STEM or are very high achievers. By *STEM-focused*, we meant that the school required more, or more rigorous, mathematics and science courses to graduate than district and state requirements; or that its science, technology, engineering and mathematics classes were more integrated than traditional schools. We were primarily interested in STEM-focused high schools that required all their students to complete a college preparatory curriculum, including at least four years of mathematics with the fourth year being Pre-calculus or Calculus; and at least four years of science including core courses in Biology, Chemistry, and Physics. The school may or may not also require technology or engineering courses.

Each school, with its own unique context, governing structure, and academic organization, was chosen as a critical case (Yin, 2009). The school selection process began with an expert nomination process in which we contacted individuals knowledgeable about STEM schools and state STEM networks, reviewed the OSPrI definition of exemplar, inclusive, STEM-focused high schools with these experts, and asked for their nominations of schools that represented particularly good examples.

The Chicago High School for Agricultural Science was nominated by the OSPrI project's External Advisory Board. After verifying through the CHSAS website and publicly available data that the school met our selection criteria of exemplar outcomes, inclusive admissions, and STEM-focus, we contacted the principal with a summary of our intended study. He indicated interest and provided the requisite letter of approval for the research project. He designated himself to fulfill the role of site coordinator, and coordinated with OSPrI project personnel to shape the schedule for the data collection visit.

1.3 DATA COLLECTION

Data collection began before the site visit to the school by using publicly available data and documents found on the school's website in order to begin to understand the school's design and context. Two online questionnaires were completed by school staff prior to the visit: one by the principal, which described the school as a whole; and, one by teachers, which focused on the teachers' individual backgrounds and skills. The final pre-visit data collection used phone interviews with the principal to follow up on questionnaire responses and ask additional questions from a protocol. To understand implementation, the OSPrI study team (comprised of six researchers whose expertise in STEM education and educational research spanned science, mathematics, technology, and engineering) visited the school. Data collection on-site involved focus groups with teachers, students, and parents; classroom observations; and interviews with key staff and community members. In teams of two, researchers collected data using observation instruments and focus group and interview protocols. The data collection activities during the visit are shown in Table 2. Data was then analyzed in the context of the school to answer our research questions.

Table 2
Data Collection Activities during Site Visit at Chicago High School of Agricultural Science

Classroom Observations & Post-observation Interviews	Focus Groups	Other Activities
Biology Chemistry Geometry Pre-calculus U.S. History (for STEM integration) Ag Science Leadership & Careers Animal Science Food Science	Instructional Leadership Team Teachers of Agricultural Sciences Teachers of Mathematics Teachers of Science Teachers on Use of Technology Ninth Grade Students Eleventh Grade Students Students on Use of Technology Students on Informal Learning Parents	Interview with Principal Interview with Counselors Interview with CPS representatives Interviews with College Partners Interviews with Business Partners/Visit to Local Business Student-Led Tour Pathways Facilities Tour Observation of FFA Meeting Interview with FFA teacher mentor

2 CONTEXT

This section contains background information on the locale and school history, its admissions policies and student demographics. Findings are then presented in two major sections, Exploring the Design and Implementation Dimensions, and Exploring the Outcomes Dimension.

2.1 SCHOOL LOCALE AND HISTORY

The Chicago High School for Agricultural Sciences (CHSAS) is a four-year (9^{th} – 12^{th} grade) public high school in the Chicago Public School (CPS) District. At the time of our visit, CHSAS was one of seven magnet high schools in the CPS District. It had an agricultural science theme grounded in the need for adequate college trained professionals in agricultural science and business. Located on a 78-acre campus in the Mount Greenwood neighborhood on the far south side of Chicago, the school site included a classroom building, fields, and a barn as shown in Figures 1 and 2. As one of the 77 well-defined Chicago community areas, Mount Greenwood became part of the city of Chicago in 1927. Development of the area was relatively slow, and it was the home of the last surviving farm in the city of Chicago. CPS owned and leased out this parcel of land for 140 years, including a 110-year lease to one family who farmed the land and lived there until 1980. In the 1980s, the community wanted to maintain the last working farm in Chicago. CPS had used the land for educational purposes since 1954 as a kindergarten center housed in a small five-room building on the edge of the farm. This building became the first site of CHSAS. CHSAS opened its doors to its first cohort of students in 1985. It initially served over 400 students through the use of seven mobile classrooms, until CPS built a modern classroom addition to the original building.

Figure 1. Barn at Chicago High School for Agricultural Sciences

Figure 2. Barn at Chicago High School for Agricultural Sciences

Modern classrooms and lab facilities at CHSAS expanded over the years—one year, the school procured new lab tables, microscopes, scales, and "gently used computers," and another it made improvements to the barn area. The school could sometimes extend the value of its improvement dollars by turning construction projects into student learning experiences. For example, as part of their course work, students who focused their studies on agricultural mechanics built the barn along with new fences and gates. When asked to describe the school facilities at the time of our visit, the principal responded that it was:

> *a 78 acre land laboratory with 30 acres in staple crops of hay (timothy, wheat, and alfalfa), sweet corn and pumpkins; a 3 acre garden; a 300+ tree apple orchard; 8 acres*

of horse pasture (with 12 acres of beef cattle pasture added in spring 2013); and a student-designed and built golf course and athletics fields.

Laboratory facilities at the time of our study were extensive and well equipped, as detailed throughout this case study.

According to the principal, CHSAS, now one of seven or eight agricultural schools in the country, was modeled after Saul High School in Philadelphia, the only other agricultural high school in the country in the early 1980s. Over the years, CHSAS has served as a model agricultural school, hosting school leaders from other areas of the country and educators from other countries, including South Korea and Japan.

CHSAS was originally designed, and continued to function at the time of our visit, as both a college preparatory and a career and technical high school. It served approximately 600 students during the 2012-2013 school year. According to the Principal, Dr. Bill Hook, all students followed the same core curriculum, although they concentrated in the last two years of their studies on one of five Pathways: Animal Science, Food Science, Agricultural Mechanics/Construction, Horticulture/Landscape Design, or Agricultural Economics. CHSAS graduation requirements (28 credits) exceeded those of CPS (24 credits); students took one additional credit each year.

2.2 DEMOGRAPHICS AND TRANSPORTATION

Admission to CHSAS was through an online application and lottery process. Only students who lived within the boundaries of the CPS school district, and whose stanine scores on 7th grade reading, mathematics, and science were at a 5 or above could apply. This corresponded to approximately the top 60% of students academically. We did not consider this requirement too restrictive for our inclusivity criterion.

Transportation was the responsibility of the students; CPS did not provide transportation for high school students choosing to attend magnet schools across the city. This could be a barrier for some students applying. However, a public bus line did serve the school.

Student demographics for the year of our visit are shown in Table 3 and are compared with those of the district and state. The CHSAS student body was ethnically diverse (39% Black/African American, 32% White, 24% Hispanic), and about half of its students were classified as low income. How the CHSAS student body—more heterogeneous than its District demographics—was formed is described in the section on the Inclusive STEM-focused Mission to follow. It should be noted that this is a comparison of a high school's demographics with the school district and state demographics for grades K-12, the only data available. (Ideally, comparisons of high school demographics would supply a more accurate picture.) CHSAS served relatively few students classified as Limited English Proficient; generally, there was a lower percent of Limited English Proficient at the high school level, but these data were not available.

Table 3
2012-2013 Demographics for CHSAS, District (SD 299), and State

	CHSAS	City of Chicago SD 299	State
Students Served	565	395,071	2,054,155
Grade Levels	9-12	PreK-12	PreK-12
American Indian/Alaska Native (%)	<1	<1	<1
Asian (%)	<1	3.4	4.3
Hispanic/Latino (%)	24.1	45.0	24.1
Black/African American (%)	38.9	40.5	17.6
White (%)	31.7	9.1	50.6
Native Hawaiian/Pacific Islander (%)	<1	<1	<1
Two or More Races (%)	4.2	1.5	3.0
Low Income (%) *	48.8	84.9	49.9
Limited English Proficient (%)	<1	17.0	9.5
Students with IEPs (%) **	8.3	13.3	13.6

Note. Data retrieved from Illinois State Board of Education website (http://www.isbe.state.il.us) on December 4, 2013.
* Illinois defines "Low Income" students as pupils age 3 to 17, inclusive, from families receiving public aid, living in institutions for neglected or delinquent children, being supported in foster homes with public funds, or eligible to receive free or reduced-price lunches.
** Illinois defines "Students with IEPs" as those students eligible to receive special education services.

3 EXPLORING THE DESIGN AND IMPLEMENTATION DIMENSIONS

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

3.1 STEM-FOCUSED CURRICULUM (CC 1)

STEM-Focused Curriculum was described in Table 1 to include strong courses in all four STEM areas, or, engineering and technology are explicitly, intentionally integrated into STEM subjects and non-STEM subjects.

3.1.1 Design

The Chicago High School for Agricultural Sciences (CHSAS), a college preparatory high school, had a curriculum blending college level rigor in core humanities, mathematics, and science courses with career and technical education (CTE) coursework in a real-world setting. It was a themed magnet high school focused on agriculture. At the time of our visit, CHSAS offered students a choice of five agricultural pathways for their upper level coursework: Animal Science,

Food Science, Horticulture, Agricultural Business, and Agricultural Mechanics/Technology. The curriculum, particularly during the first two years, was based on the CPS Standards for Learning, which were derived from the Illinois State Standards for Learning. The upper level agricultural science curriculum was co-developed by CHSAS teachers and vertically aligned from the 100 level college coursework down to the high school courses.

A few years prior to our site visit, teachers at CHSAS engaged in a curriculum project aimed at integrating and vertically aligning the curriculum content across grade levels and across subject content areas. Principal Hook described the project in the context of his prior experience leading an elementary school:

You'd talk about the kids and talk about the teaching and how you can connect what you're teaching, so we [CHSAS] started doing that. So, that's how I picked up on this curriculum framework project; they [teachers] try to make these interdisciplinary connections. We all brought down our curriculum maps a few years ago and said…If you're studying the Great Depression in U.S. history and you're reading Grapes of Wrath in English let's do those simultaneously. In our agriculture class, let's cover the impact on soil erosion during the Dust Bowl years. So now, if the connections are there, make them [but] don't spend time making connections where they don't belong, if they're fake.

3.1.1.1 Graduation Requirements

According to the CPS website, the graduation requirements at CHSAS included four units of mathematics at the Algebra level or above, four units of English, three units of social studies, two units of physical education, one unit of art, one unit of music, two units of foreign language, and four units of science (i.e., Biology, Chemistry, Physics, Environmental Science). In addition, CHSAS students were required to complete a total of seven units in agricultural science: three in the first two years, and two each in the last two years in their pathway. Students were required to spend two summers on campus: Freshmen Orientation (0.25 units) prior to ninth grade and a Supervised Agricultural Experience Program (0.25 units) the following summer prior to tenth grade. The principal noted that the graduation requirements exceeded those of CPS schools in general, and this influenced the school to not admit students after freshman year:

We have a four-year science requirement; CPS is three [but it] used to be four. Our math is four, and CPS is three. So our students graduate with more credits and more courses than the typical CPS [school]…. And we don't bring students in, in the sophomore level because they are too far behind. Not many kids leave, the attrition rate is pretty low. Some families move. Maybe 10-15 per class overall.

3.1.1.2 STEM Course Offerings

CHSAS course offerings by year were published on the CPS website. STEM-related course offerings for the year of our visit are shown in Table 4. Core courses were offered at the honors level for all four years along with five AP courses: AP Calculus and four humanities courses, as further described in the section on Early College Coursework. CHSAS had added a high honors track in 2010 because they had so many students performing at the highest levels. According to the Principal: "*It's a great problem to have; we haven't had a high honors track so we're going*

to do it. Not just an honors or regular [college] prep class, but an actual high honors class, so we're excited about that. We had to increase our AP offerings."

Table 4
CHSAS Course Offerings by Year

Year	Mathematics	Science	Agriculture/Agricultural Science
Ninth	Algebra	Biology	Basic Agricultural Science Agricultural Careers and Leadership
Tenth	Geometry	Biology[1] Chemistry	Introduction to Agricultural Science
Eleventh	Advanced Algebra/ Trigonometry	Chemistry Physics	Agricultural Career Pathway I (2)
Twelfth	Pre-Calculus AP Calculus	Biology Chemistry Environmental Science	Agricultural Career Pathway II (2)

According to the teacher focus group on technology, no technology classes were offered at CHSAS because "*the curriculum was too tight and they couldn't find space for a separate class."* However, technology was integrated into the agricultural science pathways as further described in the section on Innovative Use of Technology. Likewise, there were no engineering courses offered, but practical aspects of engineering content were integrated into the pathways courses, particularly the Agricultural Mechanics/Construction pathway. Students who did not pass required courses took the courses again online through the Illinois VIRTUAL High School program that was also offered by CHSAS.

3.1.1.2.1 Science. CHSAS was in the process of transitioning from a "Physics First" science sequence to a sequence beginning with Biology followed by Chemistry. The teachers found that their students needed to have solid foundations in these content areas to support their learning in upper level pathways courses such as Animal and Food Science. Table 4 explains the typical course sequence after the transition from Physics First. The principal explained the shift away from the Physics First curriculum in terms of ACT preparation as well, in line with their college preparatory mission:

When I got here, we were a Physics First school. Philosophically I don't have an issue with it. But in practical terms, for us, ACT data since 1959 says students who have had Biology, Chemistry, and Physics prior to the ACT do best on the ACT. I mean you can't argue with fifty years of data. Also, we were hearing from our pathways teachers. In Food Science she [the

[1] CHSAS was transitioning from a Physics-first to a Biology, Chemistry, Physics, Environmental Science sequence.

teacher] does a ton of chemistry. Our students weren't getting chemistry until senior year, so she's trying to teach a college food science course with kids who have never had chemistry. . . Same thing with Animal Science, kids were walking in not having had biology. Same thing with Horticulture and Plant Science. So what we do now is biology freshman year, chemistry sophomore year, physics junior year, and then senior year they'll have an elective science.

Beginning with the ninth grade cohort students would take core science classes in the sequence of Biology, Chemistry, Physics, and finally a science elective such as Astronomy in their senior year. However, during the year of our visit, prior cohorts had already had Physics and many students needed to complete Biology, so it was offered to 9th, 10th, and 11th graders.

3.1.1.2.2 Agricultural Science. In line with the urban agriculture theme, freshman took two introductory agriculture classes: Basic Agricultural Science, and Agricultural Careers and Leadership. During their sophomore year, students completed an Introduction to Agricultural Sciences course in which they rotated through the five pathways for eight weeks each: Animal Science, Agricultural Finance, Agricultural Mechanics/Technology, Food Science, and Horticulture/Landscaping Science. The pathways curricula were generated through partnerships with universities, such as University of Illinois and University of Iowa. Pathways teachers also infused knowledge and practices from their prior professional experiences in their academic fields. This curricular development work is described in the two sections on Partnerships and the STEM Teaching Staff.

The principal explained that the sophomore level year-long course, Introduction to Agricultural Science, was intended to equip students not only for making an informed decision, but also to develop agricultural literacy. He described the curriculum development process in the context of adding a sixth pathway, Agriculture Education, in 2013:

Currently students take eight weeks in each of the five pathways… to see what they want to select for their study during the upperclassman years. Next year we are adding a sixth pathway, Agriculture Education. We will have six pathways to attend, so each student is going to be going to a pathway for thirty days. So, we [CHSAS staff including teachers] got down to that level and said 'what are those thirty lessons that they [students] need? What are those things that every kid walking out of the school when they graduate should know about animal science or food science? Not for the next two years, but just from these thirty lessons?' Just to have that sense of agricultural literacy across the board.

At the end of their sophomore year, students, having experienced each pathway and developed awareness of what each offered and what the expectations were, rank-ordered their personal preferences for their upper-level agricultural science coursework. Typically, the sophomores chose somewhat evenly across the five pathways, but if there were more students than spaces in a particular pathway, students with high GPAs were given preference, according to CHSAS administrators.

During their junior and senior years, CHSAS students focused their coursework within their chosen pathway. The Animal Science Pathway courses focused on animal nutrition, physiology, behavior, reproduction, molecular genetics, industry characteristics and management of

individual species. The Agricultural Mechanics Pathway courses focused on personal safety, hand tools, power tools, blueprint reading, surveying, construction skills, agricultural engineering, carpentry, plumbing, electrical, concrete, and stone laying. The Food Science Pathway courses focused on principles of food preservation, food processing, biochemistry, food selection, consumer health, and societal issues concerning food. The Horticulture Landscape Design Pathway focused on using soil and other plant growing media, identifying and propagating horticultural plants, growing horticultural plans in greenhouse and nursery settings, constructing and using plant-growing structures, and operating, repairing and maintaining equipment used in the horticultural field. The Agricultural Finance Pathway focused on a broad view of the food system and the linkage between and among financial institutions, our nation, the world market, government, businesses, and the environment as well as principles of agricultural economics and the accounting cycle.

3.1.1.2.1 Agricultural Finance. This pathway focused on agricultural economics and accounting in the context of a broad view of the food system and the linkage between and among financial institutions, the world market, government, businesses, and the environment. The course covered economics as a decision-making process in the context of limited resources (junior year) and the accounting cycle, financial statements, and context-specific accounting practices (senior year).

3.1.1.2.2 Agricultural Mechanics/Technology. This pathway focused on the knowledge, hands-on skills, and work place skills applicable to construction in the agricultural industry, with the goal of improving workplace and computer skills in the real-world context of learning to read blueprints, surveying, using power tools, and developing construction skills (e.g., carpentry, concrete and stone laying, electrical, plumbing). Targeted careers included agricultural engineering, carpentry, plumbing, electrical, and construction-related occupations.

3.1.1.2.3 Animal Science. This pathway focused on development of a strong biological and natural science background (e.g., nutrition, physiology, behavior, reproduction, molecular genetics) in the context of understanding the principles important to the raising and management of livestock and companion animals. There was an emphasis on new technological applications to animal production.

3.1.1.2.4 Food Science. This pathway focused on examining issues of food science and safety from a scientific and technological perspective (e.g., food preservation, processing, biochemistry, consumer health, societal issues around food development and preservation). The curriculum was aligned with that of the University of Illinois Food Science 101.

3.1.1.2.5. Horticulture/Landscape Design. This pathway focused on developing basic horticultural knowledge and skills in the junior year (e.g., using soil and other plant growing media, identifying and propagating horticultural plants in greenhouse and nursery settings, operating equipment). During the senior year, the courses advanced to the landscape, nursery, and turf segments of the horticulture industry (e.g., identifying landscape plants, designing landscape plans, hardscape construction techniques, and installing landscape plants). Some of the coursework used the on-site greenhouse (Figure 3).

Figure 3. Greenhouse at Chicago High School for Agricultural Sciences.

3.1.2 Implementation

CHSAS staff and teachers were committed to curriculum improvements, including ongoing efforts to integrate learning across STEM and non-STEM content. The current curriculum was the result of a continuous improvement process that began several years earlier with a Curriculum Framework Project.

3.1.2.1 Cross-Curricular Integration

CHSAS teachers continued to collaborate to improve their curriculum after the initial Curriculum Framework Project by integrating across grade levels and across content areas.
The integration took place mostly in the agricultural pathways courses, where the contexts of Food Science, Animal Science, Agricultural Mechanics, Horticulture Science, and Agricultural Finance integrated mathematics, science, history and language arts content in a purposeful way. Thus, the students experienced continuity in their coursework, and by adding the context of agriculture, they were also seeing how what they are learning was related to world events.

Other examples of integration included learning the chemistry behind horticulture in that pathway course, connecting mathematics and psychology principles to commodity prices, writing a business plan for a flower business, and applying human geography to dairy markets in the agricultural finance course. According to the mathematics teachers in a focus group, the agriculture teachers took the lead in integrating the core subjects into their courses using input from the core subject teachers:

The agriculture teachers do more of the application piece…We give them the packets that we create and we do assessments. [For example,] we have been working on reading and writing comprehension where they [the students] have to explain using writing skills. They had to explain how the question was answered as it was.

Partners of CHSAS noted the integration of core subjects in the pathways courses. The former President of Wright College said:

If you go to a typical chemistry or biology class, you see a talking head and some, but not enough, labs. The agriculture school gives an opportunity to tie those things together – brings it together.

3.1.2.2 Continuous Improvement of the Pathway Model

The principal described the school vision and the operationalization of continuous improvement of their pathway model. He explained that CHSAS teachers examined the expectations for University of Illinois (a college partner) agriculture program and used backwards design to plot out the necessary coursework for CHSAS senior year. Then they articulated the junior coursework to get the students to the senior coursework level, and so on.

We kind of did the backwards design, because we were in the process of doing the articulations beyond U of I and so we kind of said okay if we start with this what should the senior pathway look like? Again, the pathways are nice, because it's a double period for juniors and seniors and it's a period of academics and a period of application. So, what should the senior pathway look like? The senior pathway almost looks mirror image of the 101 course the Food Science 101 course, the Animal Science 101, the Horticulture 101, or whatever it is. So, then what does junior year have to look like, because we want the things taught junior [year] to support the kids to be successful senior year. So, we kind of did the full backward [design] and we really made some changes.

The results of aligning the courses to make sure the students were college-ready were seen in CHSAS students' increasing ACT scores in mathematics and science, according to Principal Hook:

I think since the time we started doing this, we have gone up two points on the ACT in math and science. In math, I think a lot of it has to do with having gone to the standards-based curriculum and it's provided great results for them. It's a no-fail policy; they [the students] just have to keep retaking the test until they get it. Different tests, so it's a lot of work on the teacher's part, but it's covering the same content.

3.1.2.3 Recognition of Curriculum Strength by Students and Parents

Parents who were interviewed during a parent focus group explained several different reasons they thought CHSAS was a strong STEM school. For example, one parent said that her son's middle school principal saw that her son was strong in science and mathematics and recommended she consider CHSAS. Another parent mentioned that her co-worker "couldn't say enough about the school and how they teach students how to live a lifetime." Parents all noted that CHSAS taught students the bigger picture of "what life is really about." CHSAS students

who participated in a focus group described their mathematics and science courses as intense, challenging, and as including many connections between mathematics and science.

3.1.3 Summary

CHSAS had a unique curriculum due to its focus on agriculture. The graduation requirements for CHSAS were more rigorous than the district graduation requirements: four units of science, including Biology, Chemistry, and Physics; and four units of mathematics at the Algebra 1 level or above. All core courses were offered at both regular and high honors levels. For the first two years, students attended typical classes in the core subjects along with three agricultural classes, including a survey course in sophomore year that rotated them through each of the five pathways, and a Supervised Agricultural Experience during the summer. Students were assigned to one of the pathways for their junior and senior year agricultural science coursework based on their interest rankings, with preference given to students with higher grade point averages. Students, parents, faculty, administration, and school partners all reported that the curriculum was both cognitively challenging and well integrated across agricultural science, core sciences, and mathematics. The theme of agriculture was pervasive throughout the school with a strong emphasis on the application of all learning to the field of agriculture. Principal Hook advocated replicating the curriculum model but also noted the difficulties of curriculum integration and how having a theme played an important role

We [CPS] would replicate this school 20 times if we could. We're lucky with the circumstances here with the farm and the people who were here to make it a great school, in spite of all the circumstances. If we could replicate it, we would—the integration throughout the school, and the single theme, the agriculture theme, are great…Getting the integration is hard: having the single theme really helps and makes it strong. I would love to see more of these schools [in CPS]—we've talked about how to do it, but with finances so tight, it's hard. We should have done more when we had more money. I would love to see more Agriculture, but in general, the theme-based schools would be great to have more of.

3.2 REFORM INSTRUCTIONAL STRATEGIES AND PROJECT-BASED LEARNING (CC 2)

Reform Instructional Practices are described in Table 1 and include "STEM classes emphasizing active, immersive, and authentic instructional practices/strategies informed by research; opportunities for project-based learning and student production; and performance-based assessment practices that have an authentic fit with STEM disciplines."

3.2.1 Design

On its website, CHSAS described its instructional approach by saying, "We combine an academic learning environment with hands-on practice in a way that maximizes student success." It also self-identified as "a model not only for its innovative curriculum, but also for dropout prevention and exceptional student motivation."

3.2.2 Implementation

3.2.2.1 Mastery Learning

CHSAS had a mastery learning policy in the 9th and 10th grade courses. Students who did not achieve at least a 70% pass rate for homework assignments and for assessments either corrected their mistakes or repeated the assignment. CHSAS adopted mastery learning in the 9th and 10th grades so that when students pursued a pathway as upperclassmen, students would be proficient in the content areas and equipped with the background knowledge to apply to their learning experiences at the upper grade levels. A CHSAS science teacher explained the system used for supporting students' mastery learning:

The students have to have their homework assignments done and do their test corrections. The lunchtime tutors help them fix their assignments. If we feel they are not ready, then we won't give it [the test re-take] to them. We post the homework online every night – it is a resource available – we post every night or the test is Friday or Thursday. . .

A CHSAS science teacher explained how the mastery system has encouraged students to work harder and find success in their science class:

I tell my students that their grade is based on their effort... We don't care when students learn the material as long as they learn the material. I have some students who are failing who are now passing because they get how to work harder. . . When they recognize that they have two tests that they need to do, they face it and go to tutoring. . . That is a fantastic thing—some students take longer than other students—if you don't get it right away—then it isn't the end of the world. If you eventually get it, that is what we care about. In order to be successful at a junior level, you need to know freshman math. It is like building a house—you need a strong foundation.

3.2.2.2 Experiential and Project-based Learning

Although the structure of the 9th and 10th grade classes tended to be more departmentalized and traditional than pathways courses, the teachers at CHSAS strived to build in as many laboratory and hands-on experiences as possible within the curriculum. Project-based learning occurred through extracurricular projects and internship programs over the summer. An agriculture teacher explained,

As far as project based learning outside of career pathways, we get kids to participate in internship programs over the summer, and they receive those opportunities through science fairs, history fairs, or networking with different college representatives, and they know our students, they know what we instill in our students and how well they perform academically, and also the skills they learn in their pathways, so they will seek us out and ask if we have students who are interested and can get them into opportunities outside of the ag pathways.

The 9th and 10th grade teachers made efforts to connect their foundational objectives to future pathways lessons. A biology teacher commented on the differences in her experiences at CHSAS and at her prior school that was not theme-based:

Yes, I have done a lot of labs like this, this year. Even when we learned about microscopes and cells, we did a cell-count through manure. When we talked about bacteria and viruses, we vaccinated our horses and talked about how that helps. At my old school, we did a lot of inquiry

labs, but it wasn't the learning that they're doing here. Same concepts but [the students were] not as invested in it.

A parent speaking during a focus group concurred:

The experiential learning here is great. Everyone will take biology, but learning is hands-on and seeing it makes a huge difference. I'm actually a physician, but learning in textbook versus on the patient is a huge difference. Sometimes learning from a book doesn't make sense, and here you can do it a lot deeper because you experience it hands-on, you see it.

Parents were aware of the student-centered learning that was pervasive through all of the courses—foundational and pathways. During their focus group, parents commented on the ability of the teachers to make learning relevant at CHSAS:

Kids here are front and center, because they're excited about it. It's really very awesome, this place is so kids-centric. Student-centric.

The focus on the application of knowledge created a unique environment that helped students to see the application of their studies When students attempt an inquiry assignment, there was more responsibility for learning, which they were not used to before they came to CHSAS. However, the teachers were flexible in allowing the students to make mistakes and learn from them. A chemistry teacher explained how he recognized that students needed some room to learn how to conduct inquiries:

Some of the things, and I see this idea of look before you leap. Even at the beginning, I asked them if they were ready and they said yes! And then I asked whether they were really, ready and the specific steps they needed to get ready. This idea is conscious thought and reasoning. In a cookbook-lab, the logic is laid out. Inquiry is better, they have trial and error. With inquiry like this, where it's so quick to see them running around, they can go back and review decisions or errors they may have made for next time. If you're doing research in a lab, you don't just do something to figure it out. You talk about it with your team and have a plan in place. You still make mistakes and that's ok.

3.2.2.3 Pathways Courses

The school's agriculture theme provided an easy connection between the science and mathematics taught in the core courses and each of the Pathways courses. CHSAS teachers described how they intentionally wove content into their pathway specialization courses to create a context for the prior learning of the core science:

For the Animal Science pathway, when I teach biology and chemistry, I do it as it relates to the animals that we care for. It makes a really rich project-based learning experience. Tomorrow we are getting 50 chicks. They [the students] have to come up with a plan for how to care for the chick and learn about the physiology and growth of the chick, think about housing and conditions. I talk about these ideas in biology too, like data, setting up an experiment, but they [the students] are way more invested since there is a tiny little chick to care for: they are really, really excited! *For the horses, we look at the vaccination record, to learn about immunology.*

The pathways courses were rich in content and context facilitating teaching through projects rather than lecture. The researchers frequently observed the use of project based learning during the site visit and the teachers proficiently explained how they used projects and authentic activities as much as possible to accomplish the CPS learning objectives. Additionally, the teachers worked together to teach skills that would transfer across the pathways courses so that students would have consistent learning regardless of the pathways strand they followed. An agriculture teacher explained:

All of the students participate in agriculture experience program [with] lots of labs; and one of the major challenges is to get kids to see food science as a science instead of a cooking class. [There is] some lecture [in the courses] too, plus we use technology. We have big entrepreneurship components to our courses. It's a big blend but a lot more project-based. In agricultural finance, I try to set it up as close as I can to a college environment so I do a lot of lecture because I want kids to be ready, so hopefully they would choose a major in the pathway. I use a lot of technology--Excel and accounting software--so they can see data in action. We try to look for ways that we can assist other pathways, to use public speaking and marketing skills.

A business partner explained how he viewed the pathways as an applied science in which the concepts have meaning to students:

Because of its hands-on nature, in food science—basically chemistry—they [the students] make those connections in the farm, in the animal science and the tilapia farm, and the use of the waste from the fish to do the hydroponics.. . . The ag [agriculture] schools give an opportunity to tie those things together, bring it together. The STEM is more hands-on and applied process so that those schools are actively involved in student competitions—FFA [Future Farmers of America} or Science Fair or Robotics.

Participation in the pathways courses helped to prepare CHSAS students for real-world work situations. An agriculture teacher explained,

One thing this school does differently [is] getting the kids out and getting work experience. Every kid does a job shadow. There are a big number of kids doing entrepreneurship… working in labs… [and] all of it comes from the pathways. For example in the Horticulture pathway, the students work together to design, build and operate the only student-run booth in the Chicago Home and Garden Show, which is an extremely prestigious undertaking.

Partners working with CHSAS mentioned this participation and commented that the students' displays were equal to or better than the professional displays at the show.

Teachers at CHSAS were working to institute an authentic capstone project for all students in each pathway that would include what one teacher described as "an exit interview," where students would present on their senior portfolio to people from industry.

3.2.2.4 Integrating Core Content using the Agriculture Theme

The rich context of agriculture in the agricultural science pathways courses presented multiple and ongoing opportunities for the teachers to integrate core content classes into the agricultural topics. It is notoriously difficult to integrate authentic mathematics experiences into other content courses (see for example OSPrI Report 2014-03 on High Tech High School), but CHSAS teachers described finding many opportunities for integration of mathematics content into classes. A food science teacher and a chemistry teacher each described this integration:

Food science works more with proportions because that is math-based and a little bit of science. At the freshman level, when we cover area, we can use this when we are covering sod – anything we can align we discuss – we can use this. Even in agricultural technology – using perimeter and area we use that a lot. Freshman really developed their writing project for the fourth quarter, and they all had to incorporate this writing project in.
(Food Science teacher)

It's really been beneficial with all of our students being able to [integrate] *– food science and animal science overlaps with chemistry. I've already presented material and with the agriscience classes, and have had agriscience teachers talk about connections to biology. It's reinforced in the two classes. So there's collaboration with tying in chemistry, biology, and physics with the agricultural sciences. And the kids are very verbal about it. Students make the connections.*
(Chemistry teacher)

3.2.2.5
The following two classroom vignettes illustrate the instructional practices as implemented during two STEM classes at CHSAS: an 11th grade Animal Science class and an Honors Pre-Calculus class.

3.2.2.5.1. Animal science vignette. When we (researchers) _entered the classroom, which was located in a section of the barn, the students were already at work. They were dressed comfortably—jeans/sweatpants/athletic pants or shorts and T-shirts or sweatshirts. They were in groups of four at separate lab tables on one side of the classroom. On the other side of the room there were two large wooden enclosures (8'x8'x4') on the floor that were custom crafted from thick plywood. A third enclosure the same size was located on a large table next to the wall. These three specially designed chicken pens were for an experiment that students would begin that very day. On a large lab table there were two big corrugated boxes that contained newly hatched chicks, two varieties. Students were excited because today they would get the experimental subjects for a unit on nutrition, using chicken nutrition as a way of learning.

Students had been divided into three groups, one for each of the pens for the chicks. The class began with a review of each group's experimental design for a set of chicks. The object was to systematically change a variable that might improve chick nutrition, three experiments in all. The teacher asked different groups to describe their research questions and variables. Then, the teacher asked student is they were ready to place the chicks in the enclosures. When some said "Yes," she probed their thinking by asking if the conditions in the pens were really ready for the chicks, including whether their water was in place.

Groups began filling water containers marked in milliliters, carefully measuring 1,000 mls then going to the teacher who supervised the addition of an antibiotic to the chick's water. When the first group of students was ready, the box was opened and the students selected chicks from two different breeds. Using two different breeds increased the complexity of the experimental designs.

Next, students in three groups recorded the weight of each of their chicks in a data table that the students had prepared in advance. The first group had one student carefully take a chick out of its enclosure, weigh it, and return it to the enclosure until all were weighed. This was one measurement that the students would take periodically throughout the course of the study. When the first group was done weighing their chicks, the second group began their measurements, improving on the procedure of the first group, having watched some disorganized sequences. Some of students were very large and all the chicks very small. It was good to see the students gently cupping the chicks in their very substantial hands and the careful way they and carried them from box to scale to the enclosure in which the chicks would grow.
Students worked in groups that were mixed in terms of sex and race/ethnicity. The teacher acted as a resource, but did not give orders because the students were well prepared. When all the groups had placed their chicks in their enclosures, the teacher directed the students to observe the behavior of their chicks. Although most of the students were already watching the chicks closely, she reminded them to take careful observation notes. The enclosures were large enough for students to line up around the sides and look over a four-foot high pen fence to observe the chicks. When all the students had their chicks weighed and located in the enclosures, the teacher began offering practical advice: "If a chick doesn't find and drink from the water tray, dip its beak into the water." With this advice, several students began working with the chicks, teaching them to drink. The chicks were fast learners and thirsty. A gate to the enclosure allowed a student to enter the pen very carefully to handle the chicks. While the students were observing their chicks, the teacher showed them how to sex the chicks by looking at differences in their feathers. The students seemed to know about pecking order behavior and the room was buzzing with their talk about what they were observing. At no point did the teacher have to remind her students to be gentle with their chicks, nor was there any off-task behavior. It appeared that all students contributed equally to their group, working seamlessly together. The class ended with students cleaning up their lab table areas and an invitation from the teacher to visit any time to socialize their chicks.

During a post-observation interview, the teacher said that 60 chicks would become replacement pullets for the school's flock of chickens which were older and not yielding many eggs. The farm enterprise used a two-year production cycle for eggs, so these students were raising chickens they would also be responsible for during their senior year. These chickens' eggs would become products for the farm stand and the profits would be used by the school.

3.2.2.5.2 Honors Pre-Calculus Vignette. The class began with several student volunteers putting homework solutions on the whiteboard while other students moved their desks into groups of 2 to 7 students. Students were invited to show alternative solutions to the homework solutions on the Smartboard and several seemed very comfortable and skilled at using the Smartboard features. At one point, students teased a classmate who was putting a solution on the

Smartboard, suggesting that he use the white board because his handwriting was large and sloppy. But the student ignored them and continued using the Smartboard.

We observed this class close to the end of the school year. The homework problems were on the use of trigonometric identities. Examples included finding cos (75) as cos (120-45) using the formula cos (a – b) = cos a ∗ cos b + sin a ∗ sin b. The students were expected to know the trigonometric values from their previous work memorizing sine and cosine values from the Unit Circle. At one point, the teacher said "Before we look at the next one" and waiting until all were silent before continuing with a reminder that they did not need to use the formula if they had already memorized a particular angle's sine or cosine values, citing the example of finding the cosine of pi/2.

The class continued with using trigonometric identities, but using angles measured as radians versus degrees. The teacher instructed students to write the formulas in their notes before working on the new set of problems. Some students were referring to their Unit Circle diagrams as they worked. The teacher later explained that the students had all memorized the first quadrant values but some had not memorized the values for the other quadrants. As the students worked, the teacher walked around and acted as a resource for individual students or groups of students. After about 15 minutes, the teacher wrote a more challenging problem on the Smartboard, tan (7pi/6 – pi/4), and directed the class to "try that one." Then he continued to act as a resource for individual students or groups. The students worked by themselves or with peers in their group. The room buzzed with mathematics talk. After waiting about 8 minutes, the teacher gave one student the go-ahead to put a solution to the tangent problem on the board. The teacher directed the other students to pay attention to the student doing the work on the board and asked questions of the whole class, with some students calling out answers. In his solution, the student left the answer in a form with a radical in the denominator. The teacher says, "It's OK for now," suggesting to the observer that they would work on rationalizing the denominator later. As the teacher continued to walk around and help students, he called out a reminder about cancelling, since he saw a student who had incorrectly cancelled a term in the numerator with one in the denominator (i.e., "freshman cancelling"). Towards the end of class, many students were no longer working on problems or talking about the mathematics work with their peers. The bell rang and they continued to chat while announcements came over the speaker. The teacher closed with the remark that "Tomorrow we will work on simplifying more," referring to the tangent problem on the board where the student had left a radical in the denominator.

3.2.3 Summary

These two vignettes illustrate the range of instructional strategies at CHSAS. Both the Animal Science course and the Pre-Calculus course were rigorous. Students in both classes were clearly used to working with their peers, using the teacher as a resource. In both classes we heard much student discussion about the subject matter they were learning. There was some good-natured teasing in the Pre-Calculus course, but it is seemed that students respected each other and their teachers in the two classes.

The instructional practices at CHSAS were carefully structured so that 9th and 10th graders mastered content knowledge and skills they would need to be successful in upper level courses. The school instituted a mastery learning system that required students to persist in their efforts to

master the material, re-taking tests until they met the benchmark of 70% or higher. This was not to the exclusion of other instructional practices, however. There was an emphasis on integrating subject matter across the curriculum, capitalizing on the agriculture theme to build real world connections. There were also carefully planned projects to help students build the group work skills that they would need in the pathways courses in 11th and 12th grades. Experiential learning in their agriculture survey course in 10th grade helped students who were rotating through different pathways to make informed decisions of which pathway to "major in" for 11th and 12th grades.

In 11th and 12th grades, CHSAS students took a double period of their chosen pathway. This allowed ample time to pursue longer-term projects and experiments, such as the experiment we observed in the Animal Science class that would span several weeks. It would teach students to learn the underlying science and how to work in groups on the experimental design and experiment. Each pathway had its own specialized technologies and particular connections to other STEM coursework, including mathematics, biology, and chemistry.

3.3 INTEGRATED, INNOVATIVE USE OF TECHNOLOGY (CC 3)

In Table 1, integrated, innovative use of technology was defined broadly to include uses to connect to "information systems, models, databases, STEM research resources, teachers, mentors [and] social networking resources for STEM ideas." This component includes both laboratory technology and information technology.

3.3.1 Design

3.3.1.1 Laboratory Technology

Laboratories were well-equipped with the technologies needed to facilitate the curriculum. Upper level students used specialized agricultural science technology specific to their pathway. In response to the school description questionnaire, the Principal identified the following laboratory facilities: (1) for the Horticulture/Plant Science pathway, two greenhouses and a plant-soil lab; (2) for the Food Science pathway, a fully equipped production lab in addition to the Food Science lab; (3) for the Animal Science pathway, a biological science lab and a well-equipped animal barn; (4) for the Agricultural Economics pathway, a computer lab; and (5) for the Agricultural Mechanics/Construction pathway, a wood shop, a metal shop, and an auto shop. In addition, CHSAS had a large, well-equipped hydroponics lab (Figure 4) with its own backup generator; and there were biology, chemistry, and physics lab classrooms.

Figure 4. Hydroponics Lab at Chicago High School for Agricultural Sciences

Information Technology. Each classroom had a teacher desktop computer and projector, Smartboard, and speaker systems. The school had its own website, managed by a teacher, and most teachers also maintained individual sites for posting homework and materials. Students and their parents could use the website to access resources such as the calendar of events, and to check grades. The Agricultural Business pathway used primarily information technology. Besides using Excel software, this pathway lab had a stock market ticker to track commodity and stock prices in addition to specialized economic analysis software. CHSAS had four full computer labs and a classroom set of thirty iPads.

As a district high school, CHSAS was subject to the technology policy set by the Chicago Public Schools. No cell phones were allowed, and students could only use school-issued laptops or other school computers. There was no identified formal process for allocating technology funds. There was no dedicated information technology staff person at CHSAS, nor was there a centralized repair or maintenance service for the school's information technology. There were no technology courses offered at CHSAS; technology was integrated into the curriculum, as described in the next section on Implementation.

CHSAS students had access to online classes. These ranged from remedial courses for students who failed to master a course during the school year to rigorous courses associated with upper level pathways. For example, students in the Horticulture pathway could take the Introduction to Horticulture online course offered by Wilbur Wright College and taught by University of Illinois professors, opening opportunities to take challenging courses taught by university faculty. CHSAS students were required to use the resources available on the college and career counseling website "What's Next Illinois?" This website included a career test, an ACT preparation resource, and information on scholarships and internships. Finally, CHSAS students had access to Kahn Academy videos to supplement classroom instruction.

As described in CC1, in junior and senior years, students took a double period of their pathway courses each semester, with at least half of the time spent on a practicum in the labs. In at least 3

out of 4 years, students also took classes in the biology, chemistry, or physics labs. Thus, CHSAS students were immersed in the use of lab technology ranging from core science lab classrooms to highly specialized technology labs, including, if the student was in the Animal Science or Horticulture pathways, a state-of-the-art hydroponics lab. As described in CC1, all students were required to complete an independent science project, and to use research and production technology on other occasions such as major projects for the Flower and Garden show display and booth. These learning experiences provided opportunities for students to employ scientific reasoning in real-world contexts. More detail on the richness of instruction at CHSAS is discussed in the prior instructional strategies section of this case study.

Some CHSAS students also participated in research projects with mentors at the United Stated Department of Agriculture (USDA), or the University of Illinois through its Research Apprentice Program. These students had opportunities to use more advanced technology in innovative research applications.

3.3.2 Implementation

Teachers, students, district representatives, and family members described the specialized lab technology at CHSAS in a consistent way, namely that the school was adequately supplied in f hardware and specialized equipment for the pathways (i.e., Animal Science, Food Science, Horticulture/Landscaping, Agricultural Mechanics, and Agricultural Business/Economics). Food Science had a laboratory room that far exceeded the needs of the Home Economics courses of the past. The Food Science teacher had been a professional food scientist and the lab was equipped with a walk-in cooler, commercial mixers, and ovens, and a honey extractor. A science teacher described this room as:

...like a science lab. She [the food science teacher] has the extractor for the honey. She has different ovens [where] you can control the rising levels. She was a food scientist, so she has those things. When the kids go to their labs they are using all of those different technologies available.

Because CHSAS blended career and technical education with college preparatory curricula, and because it was a working farm as well as a learning environment, Animal Science and the Agricultural Mechanics pathways had all the technology needed to run a working farm (e.g., animal enclosures, tractors and specialized equipment for planting, fertilizing, harvesting vegetable crops, construction tools). For example, we observed an Animal Science class during which students were conducting an experiment using sensitive metric scales to weigh chicks. Animal Science had both standard lab equipment such as microscopes, and specialized equipment such as incubators. Agricultural Mechanics students learned to use specialized construction tools to build improvements and additions to the farm facilities, such as cattle chutes, and research apparatuses for other pathways. The Horticulture/Landscaping Pathway had equipment to care for both indoor and outdoor plants, including golf club turf. CHSAS had an impressive hydroponics facility with a tilapia tank and backup generator to enhance the hydroponics productivity. Students from both Animal Science and Horticulture Pathways learned to maintain the hydroponics facility using specialized equipment. Students in each CHSAS pathway had many opportunities to learn to use specialized real-world technology, and received immediate feedback from the health of the living creatures under their care.

As noted in the Design section, CHSAS did not have technology courses. Use of information technology was integrated, as discussed in the next section.

3.3.2.1 Integration of Information Technology

3.3.2.1.1 Using Technology to Learn. Teachers reported use of information technology in the classroom primarily for students to conduct data analysis and create visual displays of data or information (81%), and other learning products such as visual presentations (79%) or written text documents (70%). In addition, teachers reported using information technology to support personalized instruction, with 70% reporting use to support individualized learning, 63% to compensate for a disability or limitation, and 49% for remediation for basic skills. Only 51% of teachers reported using technology in the classroom for collecting data and performing measurements, or for data analysis. Use of technology to create models or simulations was reported by 30% of the teachers. An example of the latter was students using the classroom set of iPads to work with a farmer on a school project to "plug in the soil and [design] how many rows we need to plant [and] figure out how many seeds to plant."

In focus groups, students described using information technology to do research and to learn. CHSAS students could access Kahn Academy learning resources. CHSAS more recently started using YouTube videos to enhance classroom instruction. A student described the example of a teacher showing videos to support discussion of comparisons of living in North and South Korea and differences when visiting each country. All students in the focus group on use of technology said they had experienced YouTube for classroom instruction, noting that some teachers used it more than others. Other examples cited included short, interesting educational videos in AP Calculus, economics and policy making, and animal science, as well as English classes. Animal Science also used PowerPoint presentations and videos created by a University of Illinois instructor who teaches an introductory college-level course.

Students in an 11th grade focus group described using Kahn Academy to support learning rigorous mathematics and science coursework. One noted that students in AP Calculus had to complete 300 Kahn Academy competencies, and that he found the Kahn Academy videos, particularly the chemistry videos, "awesome." Another noted that her US History teacher recommended using a website called Hippocampus for topics in US History: "It can help us learn a specific topic for the AP test." One student summarized well how helpful these opportunities were in expanding resources for individual learning:

What's good about using technology in schools is, if a student doesn't understand a certain topic, there's always a website available that will help me understand it. It opened my eyes to different possibilities. It gives a different viewpoint to learn different things from different people, shortening the distance between people. They can be on Skype, or making a video or a website. Not everyone learns the same way, so if I can't learn it from my teacher maybe I can find a video of someone else teaching it that will help me learn it.

Students also reported using information technology for communication, research, and collaborative analysis. For example, students described using Google drive to store Excel files of

their group's data, with "everyone working on their graphs together." Another student described an example from English class:

In English class we were reading a book as a class. Every 5 chapters, we had to do a class blog post on Google. We had different groups. Learning about everyone's thoughts and feelings. Instead of just listening to everyone talk about this in class. We all have Google email addresses. We use these accounts to not only send our assignments to each teacher, they allow us to use [Google] Drive; we can use Google share features to complete assignments.

Teachers also posted worksheets and other course resources for students to access online.

Based on student and teacher comments, the use of technology by students appeared to have led to a flattening of the hierarchy between knowledge, teachers, and students. In a teacher focus group on use of technology, one teacher commented:

Kids are fast on the web. They [the websites] are these very complex sites that they can access and use." Another noted that "Some [of CHSAS] students are good at programming—a couple of kids—like Adobe Flash. One kid is trying to develop an app. Some kids are way out there. It would be more of a hobby type of thing. Some have hobbies of using software or playing around until they are proficient.

In post-observation interviews, some teachers also described how their students could teach them practical aspects of working with technology in learning activities, sometimes as a result of prior experiences or research that they did online.

3.3.2.1.2 Using Technology for Career and College Self-Advising. All CHSAS students were required to prepare for the ACT, explore career options, and investigate scholarships and internships independently using the "What's Next Illinois?" website resources. One student in a focus group explained:

Our counselor has us use "What's Next Illinois?" and take a career test to find out what job would be perfect for us. We can browse the jobs and find out what jobs are out there and what the pathways are to that job. Maybe the suggestions through this website are a little too vague, not as specific or accurate. [One student seemed to think it was pretty worthwhile, at least it gave information about things he didn't know about before.] They also have scholarship and internship information on that site. Students are required to do these surveys.

Students in the focus group varied in the degree to which they thought this feature of the website was worthwhile, but agreed that it at least gave them access to information they had not known before. Thus, students were given the technological resources as well as the personal responsibility for using the college and career resources to meet their individual needs. Students, rather than a counselor or advisor, were positioned as experts for career and college choices.

3.3.2.1.3 Using Information Technology for Communication. Students in focus groups reported feeling comfortable with emailing or even texting teachers when they needed help outside of the

school day. They confirmed that when they emailed teachers on weekends or in the evenings, the teachers emailed them back.

In both the focus group with parents and the student focus groups, students and parents referred to using the school's website to learn about events and news, in addition to checking grades and accessing homework. One parent reported learning about a student's award via the web site before the student even came home from school that day. Another parent shared the story of watching the live webcam feed of a pregnant horse that was due to give birth shortly. According to the Principal, it was a teacher and a few students who set up the webcam to show the birth: "In the Animal Science pathway, we had a pregnant mare and set up a webcam in her stall so she could be monitored 24 hours a day. And when she delivered it could be watched by everyone. The teacher and a few students set this up." In this and other ways, such as posting event notices, the web site reinforced the sense of community and connection that parents valued about the school.

There was also evidence that the students at CHSAS had opportunities to communicate with professionals through use of communication technology. One teacher described using videoconferencing via Skype, and said that this outside communication "really energizes them [the students]. Instead of physically going to another school, kids can be interviewed by Skype." Students used Skype for job interviews.

3.3.2.2 Information Technology Professional Development for Teachers

Teachers responding to the Teacher Survey had positive reports of ongoing professional development relating to technology. Approximately 50% of CHSAS teachers responding to the survey noted that learning how to identify, locate, and evaluate technology resources to be used with their students had caused them to change their teaching practices; and one-third reported a similar impact from professional development on technology for differentiating instruction and collecting and analyzing student assessment data. Despite the generally high level of technology integration we observed during our site visit, several teachers felt the school could be doing more. One teacher commented on the survey that:

More and [more] targeted professional development opportunities would be helpful. Not just workshops, but where you're actually coming with material and everyone in the group has the same goal. And they're learning how to incorporate one technology in their discipline. And then whoever the presenter is—a co-teacher or [another person who comes out to help teachers] — actually implements new ideas and technologies. [It would be good] if we are shown how to actually do this, or get help from someone once we're trying to get something done in class. A lot of us [individually] use things in the classroom that, if we could share with others, that would be good.

3.3.2.3 Technology Acquisition

Teachers made individual requests when a piece of technology was needed. Comments from teachers and administrators indicated that the administration would always find a way to meet these teacher requests. Teachers also brought technology to the school that they had acquired during prior professional experience in their field of specialization.

According to the district representative, planning for technology integration was challenging: "old thinking was that the old shop programs—auto, HVAC, carpentry, they would bring industry people in, but we're in the 21st century, and we're out in the stratosphere in technology—it's sort of a new phenomenon, because we are really looking for people with strong industry experience to teach our IT programs and our health programs. It's very challenging."

The principal conveyed that there were additional technologies he wished they could improve or replace: "Maybe we'd like to update the tilapia tanks. Vertical hydroponics is a big improvement. Some of those ideas came from our sister schools in South Korea; theirs is a lot more efficient. Aeroponics would be better."

The unique focus of the school requires specialized technologies in each pathway. When asked about the technologies used in their classes, pathways teachers gave a very wide range of responses:

In Food Science, we have our walk-in cooler, honey extractor, kitchen aid mixers large and small…. Horticulture must be certified to use pesticides. Release vents. Turn things on and off. Setting timers. Animal Science – we have standard lab equipment, microscopes, water baths, incubators, also help out with aquaponics. Cleaning out the clarifier, checking the heater. Other types of equipment, cow chutes.

The Agriculture Finance pathway teacher indicated a desire to expand the types of technology used in his classroom:

For Ag Finance, the only technology we have is computers. In the past for the flower and garden show, our job was to sell most of the food that the other Ag sciences make. We used Excel, but we want to get a class iPad set so we can have an interactive lesson. Also want to buy a credit card reader. But with all the CPS restrictions, we're not sure we are going to be able to do this. All of the reports on the sales for the Flower and Garden show were done in Excel.

3.3.2.4 Information Technology Limitations

The Technology policy was set by the Chicago Public Schools. A CPS policy against any iPhone use limited some creative uses of the technology in classrooms. No cell phones were allowed, and students could only use the school issued laptops or other computers, which could be slow. There was no centralized repair or maintenance program for the technology. Two teachers [who were not IT specialists, but regular classroom teachers who were interested in technology] seemed to be responsible for anything that needed to be fixed. One teacher commented on the distinct lack of a dedicated technology professional:

To improve things, we could really use a dedicated technology person with a curriculum focus. When we hear about other initiatives in the other districts, we're embarrassed by what we do. But we just don't have someone who can bring new ideas to the teachers. It's just getting people to have the vision, and the understanding of what else is going on.

In an observation of one class, the teacher had intended for the students to complete an online survey of agriculture careers to help them understand what kinds of careers they might be best suited for, but the internet was not working well enough for her to be able to use the classroom set of iPads that would have enabled the students to complete the surveys. This situation required the teacher to adapt her lesson where students selected agricultural careers from a large set of career cards to read and learn about what was involved in a variety of agricultural careers. A student focus group suggested that this was not an uncommon experience.

3.3.3 Summary

The school was able to be innovative in its uses of technology, even within the constraints that were inherent in the CPS environment. These innovations were part of the learning experience; students built and maintained the technology and were intimately involved in its use. Students used technology to connect with resources and students in remote locations; to acquire new skills; and to communicate. Pathways classes had advanced equipment similar to what one would find in a college lab or in agricultural industry, although administrators and teachers were always looking for ways to innovate further.

3.4 INFORMAL OR OUTSIDE-OF-THE-CLASSROOM LEARNING (CC 4)

This critical component, defined in Table 1, includes "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."

3.4.1 Design

CHSAS designed its programs with a heavy focus on informal learning that occurred outside of the classroom. In response to school description questions about opportunities for students to engage in outside-of-the-classroom learning experiences, the Principal explained that CHSAS required all of students to perform a minimum of two job-shadowing experiences in their chosen pathway. Additionally, every student at CHSAS was required to be a member of the local Future Farmers of America (FFA) organization. He also noted that CHSAS hosted the annual Illinois Job Shadow Kick-Off Event, in which high school students, including CHSAS students, could learn about job shadowing opportunities.

CHSAS also required its students to complete at least one supervised agricultural experience outside of school. Principal Hook noted that many students performed paid or unpaid internships with organizations as a result of job shadowing experiences, and that many students participated in research projects with the United States Department of Agriculture (USDA), or with the University of Illinois through the Research Apprentice Program. The school's website included the following two statements related to informal or outside-of-school learning opportunities:

Summer employment opportunities are available for any student interested in exploring various jobs in agribusiness and agriscience. Summer internships at the University of Illinois and Michigan State University are another important feature of our program. These experiences help students discover their interests, aptitudes and abilities, while at the same time teaching them proper work habits and attitudes.

Participation in the FFA student leadership organization activities and Supervised Agricultural Experience (SAE) projects is an integral component of all agricultural courses for leadership development, career exploration and reinforcement of academic concepts.

3.4.2 Implementation

CHSAS put forth a very conscious effort to ensure that all students were substantially involved in a variety of informal learning opportunities during their time at the school. The subsections that follow provide descriptions of the many avenues that were available to CHSAS students in the agricultural and science fields.

3.4.2.1 Participation in the FFA

The FFA is a nationwide organization founded in 1928 with the mission of preparing "future generations for the challenges of feeding a growing population" (http://www.ffa.org). Both then and now, the FFA promoted agriculture as a multifaceted industry that extended beyond just planting and harvesting, and comprising the full spectrum of science disciplines (e.g., biology, chemistry, engineering, animal sciences, etc.), as well as entrepreneurial business fields.

As explained on its national website, the FFA is structured on three levels: local, state, and national. The local FFA chapter at CHSAS was a major presence at the school, providing wide-ranging learning opportunities and experiences. Every student at CHSAS was required to be a member of the FFA during enrollment at the school. However, a student in a focus group explained that they could each decide how active of a participant in the FFA they wanted to be. Students had the opportunity to serve as elected officers of their FFA, in such positions as president, vice-president, secretary, treasurer, historian, and student advisor. Students also could serve on the Courtesy Corp of the FFA, which one student described as the "volunteer hands" of the FFA, helping to set up projects and events.

The bulk of the learning and development opportunities for students in the FFA came through the variety of Career Development Events (CDE) that took place throughout the year. These CDE competitions progressed through a series of levels, starting with sectional competitions—CHSAS was in a section with five other schools—and moving on to district, state, and national competitions. CHSAS students competed in a variety of FFA disciplines. During a focus group, a student described participating on the school's horticulture CDE team, with competitions involving a variety of tasks such as plant and plant disease identification, landscape design, and plant grading. Other FFA competitions that occurred at various times throughout the school year included Parliamentary Procedures (i.e., public speaking), Forestry, and Agronomy (the science and technology of producing and using plants for food, fuel, fiber, and reclamation).

These competitions required substantial preparation by participating students. As an example, for the horticulture CDE, the CHSAS team of five students prepared twice a week for four months with the school's horticulture teacher. According to a district representative who was heavily involved with the school, CHSAS's FFA chapter was quite successful in these competitions. He explained that the school had the third largest FFA chapter in the United States and was a major participant in state- and national-level competitions.

Students also had opportunities to go on several FFA-related trips, with two annual conventions that most students attended. The first was the state convention for all of the Illinois districts, and the other was the national convention for all of the states and Puerto Rico. The national convention was usually held in Indianapolis, and the school chartered a coach bus for student transportation. A student explained that the school raised money for transportation to the convention through fundraising activities throughout the school year, but students were responsible for covering lodging and food.

Students, parents, and staff universally expressed the importance of participating in these conventions for the students. One student, for example, reported that conventions taught them how to network and meet other people, exposed them to other people's ideals and beliefs, and helped them appreciate different perspectives. Another student described the sessions on leadership and various agricultural sciences at the conventions, and how valuable it was to interact with students from other areas of the country. In a focus group, several parents expressed a deep appreciation for the learning experiences their children had through the FFA. One parent listed the leadership skills, discipline, and opportunities to meet students from all over the world as major benefits, and another parent noted the connections that his child developed with college recruiters. Finally, teachers reported that the FFA events were an important avenue for students to further apply the knowledge and skills they learned in their classes at CHSAS. An agriculture teacher explained that students could take what they learned in horticulture classes and use it in the various competitions. Additionally, a counselor at CHSAS described how participation in the FFA events helped one of their special education students "blossom" and was a critical factor in preparing him "for when school is no longer there [after graduating]… be as independent as possible and learn how to self-travel, as they become adults."

A representative from the University of Illinois who worked closely with CHSAS summed up the value of the FFA for the school's students:

The [impact of the] FFA cannot be underestimated. It creates a framework for the application of STEM and for leadership development. If you want to know what makes this place different, the FFA has a remarkable impact on these students and their future… This is the biggest FFA chapter around; there is a real difference in the students who are active in FFA. Students who are good in STEM but go nowhere because they have no vision…the FFA gives them that vision.

3.4.2.2 Fieldwork and Supervised Agricultural Experiences

Students at CHSAS were required to complete some form of agricultural fieldwork, primarily through the Supervised Agricultural Experiences (SAE), which typically lasted two weeks. As a student explained, in their freshman year, students had to choose between the fall, spring, and summer semesters to complete their SAE. Many of the students completed their SAE through fieldwork on the CHSAS campus. One student described her SAE work:

It was like a normal school day. I got here at 8:00, you worked in the field, cleaned up in the barn with the animals, took care of the greenhouse. I chose the barn; basically they teach you and show you more things about the school than you knew before. They give you the agricultural experience… and opportunities to learn about the practical side of the [agricultural career] pathways.

Students in a focus group described other SAE options such as: landscaping work on the school campus, such as planting orchards or revamping the school golf course; food production, which involved harvesting and selling the crops grown on campus; and, agricultural tourism, which had students leading tours through the school for large groups of elementary school children, giving them a hayride outside the school, and describing the various plants that were housed on campus. Students could create their own SAE program rather than taking on a school-given task. For example, students explained that they could set up their own mini-businesses selling food or cutting lawns, with part of the profits returning to the school if the student used some of the school's equipment such as ovens or lawnmowers. Students who pursued this avenue were required to write up their business plans and present those plans along with a description of their product and their sales results at an FFA section fair, in order to receive their SAE credit.

Students completed their SAEs for credit both during and outside normal school hours. Additionally, students were required to complete 12 Applied Agricultural Activities (AAA) hours each semester. One student reported that these activities were a way for the school to get them more involved in agricultural activities at the school and after school hours. An agricultural teacher said that she was initially unsure of the value of this level of fieldwork for the students, but eventually came to see the value of these experiences for her students:

I thought it would be bad to take out class time to do chores. But they learn to take constructive criticism because they can see their own inefficiency. It builds work ethic to have the opportunity to fail. There is a lot of learning that goes on during that time, plus they bond and learn to work together as a team. There are no slackers because they are interdependent.

3.4.2.3 The Research Apprenticeship Program at the University of Illinois

As described in more detail in the Partnerships narrative of this case study, CHSAS had a relationship with the University of Illinois. Through this partnership, CHSAS students had the opportunity to participate in the university's Research Apprenticeship Program (RAP), which a representative from the University of Illinois described as a twenty-five year old program aimed at preparing underserved students for college and work in agriculture-related careers. This university representative further explained that students had to apply for a spot in the RAP, and approximately four hundred applications were submitted for sixty-five spots. Students who were accepted spent three consecutive summers living on the university campus and working in teams sponsored by a science industry stakeholder. Half of every day was spent working in a laboratory with university faculty, and the other half of the day involved working on life skills and career preparation. Through the program, the students received exposure to agriculture-related career pathways and invaluable college preparation. The university representative stated that all of the students who came to RAP went on to college, with 70% of them attending the University of Illinois, and 50% going to the university's College of Agricultural, Consumer, and Environmental Sciences (ACES). Principal Hook also described the value of the experience for the students:

They actually do research, and they're on the research findings. Then a lot of them end up down there at the University of Illinois, because they get a great experience, they like the campus, and

meet the teachers. Actually, we have ten kids going, twelve kids accepted, but ten going to the University of Illinois this year.

A student in one of the focus groups who participated in the RAP program confirmed the value of the experiences for her. She completed her first summer living on campus for four weeks and she would be returning for the next two summers to continue her work on the project:

I worked for Kraft Foods; I had to create a product for the market and had to create a business plan. I had to figure out all the costs, pitch it to Kraft, and we had a big final unveiling of everyone's product [at] the lab we were working at… They bring kids from different schools [and] they're doing different projects. I worked for Kraft, but Pepsi Co. had kids work with candy bars… They were different from our program but they lived with us, and I was friends with them. While we were at U of I, we worked in conference rooms or worked in one lab [or] the main food science hall at U of I. This year I'll be working with a professor. Last year I worked with a grad student who was there that summer.

These research experiences helped to develop important skills for students to bring back to their classrooms after the summer work. A science teacher elaborated during a focus group:

These students work at universities in scientific research over the summer. When they come back to the classroom doing peer collaboration, they get a better approach to things. They understand what needs to be done at the collegiate level, all of those components that are involved with the final project—all aspects of the science project that are required. They have a better understanding of what peer collaboration looks like, through doing this experimentation at the college level, then coming back to the classroom and participating, collaborating with their own peers showing what is acceptable.

3.4.2.4 Job Shadowing and Internships

Principal Hook explained that CHSAS placed a high level of importance in getting students out into the agricultural field, and experiencing career options through job shadowing and internship opportunities. A teacher in a focus group also stated that the school offers the students "so many opportunities to go out into internships and job experiences… If they are not getting experiences in the classroom, they are reaching out into the community to see what else they can learn." An agriculture teacher pointed out:

One thing this school does differently: getting the kids out and getting work experience. Every kid does a job shadow. There are a big number of kids doing entrepreneurship. There were kids working in labs, there are jobs, all of it comes from the pathways.

Every year, CHSAS held a "Job Shadow Day" kickoff event, a major event attended by 200 juniors and seniors. Every junior and senior was required to complete at least one job shadow, and most students did between two and four job shadows. Each job shadow entailed a company hosting CHSAS students for a full day to give them a real sense of the career opportunities and experiences in their respective fields, according to Principal Hook. Students thus had the opportunity to explore a particular career pathway and build connections. Principal Hook explained that some of the most important lessons for students came when they shadowed a job

they thought they were interested in, but then realized through the shadowing experience that they were in fact not interested. The principal noted, "It's a better lesson learned at seventeen than twenty-four. I think parents will attest to that."

Most students shadowed one of CHSAS' business and industry partners, with Eli's Cheesecake, Kraft Food, and Sara Lee serving as regular hosts. Students were also able to venture out and find their own job shadowing opportunity. Several students in a focus group reported working an internship with local businesses. One student, for example, worked with the Museum of Science and Industry, working for the robotics program and helping to develop a new exhibit on the history of robotics. Another student had an internship with the school during the summer between his sophomore and junior years; this paid internship involved maintaining the landscaping on campus, harvesting the crops, and managing the on-campus farm stand.

3.4.3 Summary

Through a rich variety of informal learning opportunities, CHSAS provided its students with multiple avenues for exploring career options, preparing for college, and developing expertise in the agricultural sciences and strong leadership and networking skills. The local FFA chapter at CHSAS was a major presence and unifying experience at the school. Through their participation in FFA competitions and conventions, CHSAS students applied their agricultural knowledge and developed critical skills that prepared them for future work in the field. CHSAS also fostered a strong level of involvement in the agricultural and field work on the school campus through the SAEs and other responsibilities. Students had the opportunity to participate in a rigorous college-level research program at the University of Illinois. In sum, CHSAS provided multiple opportunities for their students to directly experience a variety of career pathways in agriculture, opportunities that helped students get a true sense of the work and preparation needed to enter those fields.

3.5 PARTNERSHIPS (CC 5)

This critical component, defined in Table 1, includes "Students connecting to business/ industry/world of work via mentorships, internships, or projects that occur within or outside the normal school day/year."

We get so much help from our partners, community partners, business partners, to let them [CHSAS students] know that you don't have to be on a tractor in Mattoon, Illinois to be involved in agriculture. It's not just farmers; you can be in food science here at Hillshire brand. You can be in food science at Eli's Cheesecake. You can be in animal science at McDonald's. We had a job share last year with their vice president of American operations, but he took students from all pathways—from ag finance, from food science, from animal science--and he says, 'Listen, there's opportunities at McDonald's from all of these pathways' and they [the students] get an understanding that agriculture isn't just farming. (Principal Hook)

3.5.1 Design

CHSAS had a robust system of business and internship partnerships, formally organized into a Business Advisory Council of some 60 members. Additionally, CHSAS had a strong relationship with the University of Illinois, described by the Principal as the school's "oldest and strongest partner." The school's academic partnerships with the University of Illinois and other

universities with agricultural programs are described in the section on Early College-Level coursework, but University of Illinois stood out also for the research apprentice program through which many CHSAS students participated in research internships during the summer. Other university summer programs that CHSAS students attended included the California Polytechnic University at San Luis Obispo (Cal Poly), the University of Colorado at Boulder, as well as several Midwestern universities with agricultural programs.

3.5.2 Implementation

3.5.2.1 Business Partners

The Business Advisory Council was founded and co-chaired by two staunch supporters of the school, the president of Eli's Cheesecake Company and the Chicago Parks Commissioner. The Council met twice each year, once at the school and once at the Garden and Flower Show, where members toured the exhibits of CHSAS students and held a meeting. These meetings, besides functioning as meetings to raise financial support, also provided opportunities for the businesses to request job shadows or interns as well as to make donations to the school. For example, business partners had donated horses, tractors, and mulch in the past. Many of the business partners hosted CHSAS students for job shadowing or internships, and some provided college scholarships. The Parks Commissioner used the Garden and Flower Show as an opportunity to publicize and obtain resources for the school from local businesses. The extra resources raised during this event enriched the school beyond the normal funding provided by CPS which accounted for the majority of the school's funding. As a working farm, CHSAS also benefited by money raised from selling farm products. Eli Cheesecake was involved in some aspects of this entrepreneurial activity, which is described in the emergent themes section titled World of Work.

Community support in the form of donation and funding was not the primary focus according to Principal Hook who explained that CHSAS instead sought direct interaction with students:

I don't need their [partners'] money. We'll make do with what we have. We'll sell our produce in the farm stand and we'll use that money. We want their time. We want their expertise. We want the students to benefit from their experience. We want the job share. We want the internships. We want that kind of thing.

Specific business internships mentioned by the Principal included mainstays such as Eli Cheesecake, the Chicago Park District, Sara Lee, and the Brookfield Zoo, as well as new opportunities with McDonalds in Animal and Food Sciences, and with veterinarians for Animal Science pathway students.

The Principal was very clear in distinguishing between the support its business partners provided and their impact on the academic program:

It's not the case that this is an industry mouthpiece; multiple people have reinforced the fact that they [students] hear all sides of issues. They are hearing the consumer side. They are thinking about the social implications of some of these things like the ethical implications of urban agriculture and organic farming. So, it's not like Kraft U at all. It really could be like that, so it's noteworthy that it's not.

3.5.2.2 University Partners

CHSAS had developed relationships with a number of universities that had agriculture programs. The University of Illinois was one university partner where some CHSAS students had the opportunity to participate in the Research Apprenticeship Program. Iowa State was another university partner that accepted approximately 40 CHSAS students a year to participate in their summer program. The school's academic partnerships with the University of Illinois and other universities with agricultural programs are described in more detail in the section titled Early College-Level Coursework (CC 6).

3.5.2.3 Career Exploration

Career days occurred frequently at CHSAS. Pathway teachers organized these events in their areas of specialization and brought in speakers from partners and others they knew to inform students about career opportunities and answer their questions. As described by the Instructional Leadership Team at CHSAS, agricultural majors are one of the most sought after majors at colleges and universities:

We try to make them aware of all of the careers out there for them. We always try to tell the students that, no matter what kind of career you decide you want to go into, it can always apply to agriculture. We have a student graduating Friday from medical school. When she left here she went into food science, but she knew she always wanted to be a doctor.

The principal stated in the questionnaire before the site visit that there is a need for qualified workers in agriculture and a shortage of underrepresented populations in agricultural careers. He noted that industry interest is based on this realization and businesses look to agricultural schools as an approach to meeting that need.

The University of Illinois also provided strong support for CHSAS students to explore careers and college majors. Each year CHSAS took busloads of students to the University of Illinois to spend half a day looking at each of two pathways they might be deciding between, to see what each would look like at the college level and in careers, so that the students could make informed decisions.

3.5.2.4 Staff Professional Development

Business partnerships also extended to teacher professional development. Each year a different company hosted all of the CHSAS teachers for a professional development session. Teacher professional development is connected to industry. According to the instructional leadership team:

At the beginning of school, we have three days of professional development [and] teacher preparation… We spend a day on [a university] campus and then [another day] at an agricultural business so the teachers have an idea of how it all integrates together.

Individual teachers also maintained strong connections with industry, especially pathways teachers who mostly came from industry. The University of Illinois was especially strongly

connected with the food science program. As the food science teacher noted, "I really go by what they do at U of I—I work closely with them and have lots of access to their materials." A University of Illinois representative confirmed their strong relationship, which had even led to publications for the *Journal of Food Science Education*.

3.5.3 Summary

The school was intimately tied to agricultural industry, and this was reflected in the nature and number of industry partners listed by the school. A large and active business advisory council served as a source of academic enrichment, funds, and career opportunity for students. The political and sometimes controversial nature of these partnerships (e.g., genetically modified foods) is discussed in classes and the school puts a great deal of effort into remaining balanced. Teachers maintained active ties with industry and in the case of pathways teachers, come from the industry they teach about. They drew from this experience in developing the curriculum, giving examples, and forming connections for students. Teachers worked actively with college partners to align curricula and formulate joint programs that made sense.

3.6 EARLY COLLEGE-LEVEL COURSEWORK (CC 6)

This critical component, defined in Table 1, encompasses opportunities for students to take college-level coursework and earn college credits. It includes AP coursework, online college courses, and college classes at institutions of higher education (IHE). An aspect that is also considered is the flexibility of the school schedule to accommodate students taking courses at an IHE.

3.6.1 Design

CHSAS offered its students several avenues for earning college credits during high school: Advanced Placement (AP) courses/exams; articulation agreements/exams with universities for specific courses; and community college courses.

3.6.1.1 Community College Dual Enrollment Coursework

As members of the CPS district, CHSAS students had the same access as other CPS students to community college courses for dual credit, either at a community college campus or online, outside of school hours. According to an interview with a CPS district representative, there had been a recent centralized effort to strengthen the early college opportunities for high school students through the City Colleges of Chicago:

The mayor [of Chicago] is spearheading that. We have almost tripled the number of students in dual enrollment in English and math…. Right now City Colleges offer 700 free seats and students have to meet the college readiness benchmarks that we have: a 21 on the Math ACT, or, for English, students have to qualify via ACT and the writing exam, or COMPASS. If you meet those benchmarks, you [a high school student] can be dual enrollment and go to a City College campus; there are seven across the city. Or a student can do dual credit, where the class is actually taught in the high school and taught by a high school teacher who qualifies as an adjunct faculty at City College. Those are introductory math and English courses, like AP and IB. For example, you can take a calculus class dual enrollment, and you get dual credit for it.

The district representative shared that about one in four of CPS graduates who enrolled in college went to City Colleges of Chicago. To address the problem of low graduation rates at these two-year colleges and the high percentage of these students who had to be placed in remediation courses, the intent of this early college program was not only to help high school students accumulate college credits, but also to help them be more prepared for college.

3.6.1.2 Articulated College Coursework

CHSAS had articulation agreements with the University of Illinois and other Midwestern universities with agricultural programs (e.g., Michigan, Iowa). These agreements offered CHSAS students thoughtfully planned opportunities to accumulate college credits in Animal Science or Food Science. An agriculture teacher noted that CHSAS was working on developing an articulation agreement for Horticulture as well. The district representative noted that articulated courses offered a tuition-free option to earn credits should a student attend a university that had an articulation agreement with CHSAS.

The University of Illinois was a major CHSAS college partner. In an interview, the CPS district representative characterized the partnership as "a very deep relationship." In fact, the University of Illinois maintained an office at CHSAS that was run by a CHSAS alumnus. Although this University of Illinois office served anyone in the community, its presence at CHSAS made it easily accessible to CHSAS students. The partnership between University of Illinois and CHSAS is discussed further in the section titled Partnerships (CC5). Another major college partner was Wilbur Wright College (WWC), located about a mile north of CHSAS. WWC offered online college courses aligned with specific University of Illinois courses that would be accepted by University of Illinois if the student later enrolled there.

Additionally, some CHSAS students were accepted into agricultural summer programs for high school students hosted by IHEs, providing additional opportunities for students to earn college credits and experience campus life. CHSAS had an agreement with WWC for students interested in hydroponics to earn college credit during a summer workshop taught at the college's hydroponics facility. Select students also were accepted to participate in University of Illinois' summer apprenticeship program, for which they earned college credits; this program is discussed in more depth in the section titled Informal or Outside of the Classroom Learning (CC4). Other examples included summer programs at the University of Colorado at Boulder and the California Polytechnic State University at San Luis Obispo (Cal Poly).

3.6.1.3 Advanced Placement Coursework

With a student body of about 600 students, CHSAS also offered a solid program of AP coursework in mathematics and humanities which included: Calculus AB, English Language, English Literature, US Government and Politics, Human Geography, and US History. CHSAS also offered a senior Honors Chemistry class and students who took the AP Chemistry exam could earn college credit, based on their performance.

3.6.2 Implementation

3.6.2.1 Community College Coursework

A CHSAS mathematics teacher said that most CHSAS students took General Education requirements "to get a jump start on college," and this included some who took community college mathematics courses. Up to about ten CHSAS students earned college credits during the summer participating in University of Illinois' research apprentice program or the WCC hydroponics program. In addition, WCC was involved with the delivery of online University of Illinois courses for CHSAS students outside of school hours. CHSAS did not have a special school schedule to allow its students to leave campus and take community college courses.

A number of students also earned college credit by participating in an agricultural entrepreneurship course that blended required work at the CHSAS farm with specific entrepreneurship activities at the location of a local business partner.

3.6.2.3 Advanced Placement Coursework

About 20% of CHSAS students took AP Calculus, and other small groups of students earned college credits through participation in summer programs at IHEs. These opportunities were available through partnerships with the University of Illinois, WWC, or other universities with agriculture programs. CHSAS offered a solid program of AP coursework in the humanities and a senior honors chemistry course, affording additional opportunities for its students to earn college credits through examination.

3.6 Summary

Students at CHSAS had ample opportunities to experience college-level coursework through their agricultural science pathways and approximately 20% of its students took AP Calculus. CHSAS also offered AP courses in English Language, English Literature, US History, US Government and Politics, and Human Geography. Students taking Senior Honors Chemistry might also earn AP credit by taking the AP Chemistry exam. Not all CHSAS students earned college credits; articulated credits were limited to the Animal Science and Food Science pathways, although efforts were underway to implement an articulation agreement for the Horticulture pathway. CHSAS had articulation agreements with the University of Illinois and another five or six Midwestern universities with agricultural programs. Some CHSAS students took community college courses outside of school hours to fulfill IHE general education requirements, but tuition-free opportunities were extremely limited. Although CHSAS did not have a special schedule to allow students to attend community college courses during the school day, it did link some of its students to agricultural science-related summer programs at IHEs, affording them opportunities to experience campus life and college-level rigor as well as earn college credits. Finally, students at CHSAS could earn dual credits through the City Colleges of Chicago, although the number of tuition-free slots was limited to 700 for the entire Chicago area. Some CHSAS students took general education courses at these community colleges, including mathematics, to meet those college requirements before graduating from high school.

3.7 WELL-PREPARED STEM TEACHING STAFF (CC 7)

This critical component, as described in Table 1, is defined by a teaching staff that is qualified and has advanced STEM content knowledge and/or practical experience in STEM careers.

3.5.1 Design

CHSAS was a magnet school within the CPS system and as such followed teachers union rules and regulations. However, according to a CPS representative, the principals in each school had the autonomy to select and hire teachers. Once teachers were tenured, the union rules became significant.

According to the school website, the vision for CHSAS was "to create a positive learning environment that will support the integration of our academic and agricultural programs" with the goal of creating "competent and literate citizens." The implementation section shows how this vision affected the motivations and interests of the school, administration, and teaching staff.

Teachers at CHSAS belonged to one of the nine departments identified in Table 5. In keeping with the theme of the school, the agriculture department supported the largest number of teachers and collectively offered the most classes in the school. There were 19 teachers of STEM courses (agriculture, mathematics, and science), 15 teachers of non-STEM courses, and 12 special education teachers. The high number of special education teachers related to CHSAS serving as a special education cluster site. Low incidence special education students from the cluster site attended some classes with other students at CHSAS, such as electives and physical education. They also participated in field trips, dances, and other events whenever possible. The focus of this discussion of the teaching staff is on STEM teachers and non-STEM teachers with respect to integration of STEM into their curricula.

Table 5

Academic Departments, Number of Classes, and Size of Teaching Staff.

Academic Department	# Classes	Staff Size
STEM Courses		
Agriculture	22	10
Mathematics	14	5
Science	11	4
Non-STEM Core Courses		
English	14	5
Social Studies	8	3
Foreign Language	5	3
Non-STEM Other Courses		
Fine Arts	3	2
PE	3	2
Special Education	0	12

3.7.2 Implementation

This section describes how a "Well-prepared Teaching Staff" was implemented at CHSAS. Included are six subsections: hiring the teaching staff; teacher demographics and qualifications; integration across the disciplines; university connections and CHSAS; teacher support; and school teacher culture.

3.7.2.1 Hiring the teaching staff

Bill Hook, the principal at CHSAS, had the flexibility to hire teachers with the qualifications and motivation to teach in an agriculturally focused high school. Teachers in academic disciplines had to be certified by the state of Illinois to teach in their subject areas, and teachers in the Agriculture pathways program were held to Career and Technical Education Enhanced Teacher Credential Requirements, which in part required additional industry experience.

Hook sought to hire teachers who demonstrated both a deep knowledge of their academic content and a solid understanding of how to help others learn that content. Hook described his teachers as a "blend between specialist and . . . [those who] know how to teach." He also sought teachers who were motivated to be team players, explaining: "I don't want you to be here till five o'clock just to be here until five o'clock, but if we need you to be here until five o'clock I need you to be here without asking you."

According to Hook and teachers' responses on the Teacher Survey, teachers typically arrived at CHSAS through one of three different ways. Several teachers were already teaching in the school when it became an agricultural school; about 20% of the faculty was recruited; and, the majority of the teachers actively sought out teaching positions at the school. Most of the general education teachers came from the Chicago area, but according to Hook, the agriculture teachers applied from around the nation to work at CHSAS.

3.7.2.2 Teacher Demographics and Qualifications

3.7.2.2.1 CHSAS all teaching staff demographics. A total of 43 teachers, including 16 STEM teachers, completed the Teacher Survey which was administered before the site visit began. Fifty-nine percent of the respondents identified as female and 39% as male. Seventy-four percent of the teachers identified as White, 7% as Latino or Hispanic, and 19% as Black or African American. The age range for this group of teachers was from 25 to over 55, with a mean age in the 40-44 year age range. Nine percent of the teachers were under 29 years old, and 23% were over 55 years of age. The average teacher had taught for almost 15 years, and had been at CHSAS for about 9 years.

3.7.2.2.2 STEM teacher demographics. The 16 STEM teachers responding to the survey included seven agriculture teachers, five mathematics teachers, and four science teachers. Seventy-one percent identified as female and 29% as male. Sixty-nine percent of the STEM teaching staff identified as White, 6% percent as Hispanic or Latino, and 25% as Black or African American. The STEM teachers had a larger percentage of teachers under 29 years of age (25%) and a smaller percentage over 55 years of age (6%) than the general teaching staff at CHSAS. These STEM teachers had about 15 years of teaching experience overall but had been teaching at CHSAS for an average of 10.5 years. The majority of the STEM teachers had teaching experience at the high school level, with a couple of teachers having had additional experiences with other age groups including elementary and post-secondary grades.

3.7.2.2.3 Educational background. All teachers at CHSAS responding to the teacher survey held at least bachelor's degrees, and 65% of the teachers also held master's degrees. The majority of the teachers had attended universities in Illinois or in other nearby states; a few teachers had studied further afield in states such as Connecticut, North Carolina, and New Mexico.

All of the science and mathematics teachers responding to the survey held at least a bachelor's degree in either mathematics or a science discipline. Eighty-one percent of the STEM teachers held at least a master's degree, the majority of which were in an education field. The STEM teachers held active certifications appropriate for the subjects they were teaching. The agriculture teachers held bachelor's degrees, the majority of which were in some field of agriculture with 71% of the agriculture teachers holding master's degrees, the majority in education, often Agricultural Education. The agriculture teachers held teaching certifications in agriculture.

3.7.2.2.4 Teacher preparation in the agricultural fields. Industry experience was a significant requirement for all teachers teaching in the Agricultural Science pathways programs. In a focus group, agriculture teachers described the fairly stringent process of agriculture professionals becoming agriculture teachers. Some of them began at CHSAS with temporary provisional teaching certificates, which they described as requiring significant number of hours of industry work (8,000) in addition to affidavits from former employers. The CPS website for teaching credentials for Career and Technical Educators described establishing requirements for the credentialing of CTE teachers "in collaboration with industry and college partners" as being "above and beyond the Illinois State Board of Education CTE teacher credential requirements." This site described new requirements that, as of October 2011, applied to all new CTE hires. These included both college degrees and significant industry work experience as "expected upon hire" ("Enhanced Teacher Credential Requirements," 2011).

A representative from the CPS district explained that since the program at CHSAS is "not your typical teaching program… Illinois allows us to bring industry people into teaching if they meet minimum requirement under certifications." He provided an example of one of the teachers: "the animal science program teacher has a regular science background, but she could teach animal science because of her experience in the industry," and went on to explain that teachers "can teach [a] content area if they have a minimum of 60 hours of college credit and 2,000 hours of experience in the industry." In addition, for some areas, "Chicago raises that bar to bachelor's and 2 to 4 years of experience in the industry."

In describing teacher certifications, the CPS district representative also spoke about possible changes to the credentialing process for teachers at the district's STEM schools to enable teachers to teach courses designed for both high school and community college credit. He explained:

We are looking at increasing minimum requirements for teachers at our STEM schools to make them also eligible to teach for dual credit, able to teach for community college credit so they can be dual teachers. At least on the IT piece, we are trying to make those matches, which increases beyond the state minimum to get credentials in IT.

3.7.2.2.5 Agriculture teachers. Agriculture teachers came to their teaching positions with significant prior industry experience. Hook explained "everyone in our Ag department pretty much brings a vast experience from industry to the classroom." Several of the agriculture teachers noted that "all of us have industry experience, so we can act as our own litmus test; we stay current with the trends in our field." They provided some examples: "I worked as a

landscape architect for four years;" "I worked in food science;" "I was a buyer for [a large retail company];" "I was a teacher at another high school and trained horses;" "I worked on several ranches through college." "Quality assurance—microbiology—I was a manager." Beyond the experiential requirements for certification, many of the agriculture teachers described the distinct advantages of having the "perspective of the workplace" on their abilities to guide students toward a future in agriculture—having contacts in the field and being able to expose students to the real applications to future jobs.

3.7.2.3 Integration Across the Disciplines

As mentioned in the Design section for this component, the school's vision played an important role in the ways that teachers and others thought about the relationships among the courses offered at CHSAS. The vision expressly identified "the integration of our academic and agricultural programs" as significant. Teachers and administrators spoke both about how the integration of course content was successful and also where they struggled to meet their own expectations. The integration of course content was broadly discussed within the different academic departments in the school, within teams of single grade-level teachers, and across the academic/agriculture divide. While most teachers said that the success was less than perfect, most seemed to agree that it was emphasized, discussed, and thoughtfully considered throughout the school.

3.7.2.3.1 Structures that facilitate integration. Natural collaboration occurred within the academic departments, as one science teacher explained, "chemistry and biology talk with each other to align that way [but it's] harder outside of the department". Within the Agricultural pathways there was open and easy collaboration. A sophomore teacher compared opportunities for communication with a school where she previously worked and explained, "Here we get to talk," and went on to describe some of the opportunities, "we get to meet once a week . . . we have the same lunch period . . . we have a prep together."

An agriculture teacher commented, "We have these planned school-wide staff meetings by grade and department so we can do horizontal integration." One of the challenges identified by the agriculture teachers was that they taught grades 10-12 and couldn't always make all of the grade level meetings because of scheduling conflicts, explaining, "We can't get to every meeting, we spend so much time in the classroom."

These open lines of communication facilitated teachers from one grade level checking on content that students had previously studied in other classes, enabling the gradual building of aligning learning opportunities across grades. One teacher explained that she used the teachers of freshmen as a resource to help her understand what her sophomore level students should have previously learned that she could build upon: "When I have them [the students] as sophomores I go to the freshmen teachers and find out how they were doing as freshman."

3.7.2.3.2 Integration examples. Teachers described how they sought cross-disciplinary integration. A science teacher explained, "[I] sat down with the junior math teacher [to] figure out what they can handle and what to expect." One agriculture teacher expressed being "encouraged to integrate science concepts into my agriculture classes" as well as to "provide

problem based learning activities for my students that are highlighted in the science fair and portfolio project."

Academic teachers saw the natural application of their course content within the Agricultural pathways classes. A mathematics teacher explained that the "ag teachers do more of the application piece" and are able to "integrate math into their projects." A science teacher said "I have dialogued with the food science instructor . . . It works really well that way—agricultural and the disciplinary subjects" and proceeded to describe collaborations between the agriculture and science teachers saying, "I've already presented material with the agriscience classes, and have had agriscience teachers talk about connections to biology." The science teacher explained the advantages of this cooperative experience: when there is "collaboration with tying in chemistry, biology, and physics with the agricultural sciences . . . [the] students make the connections."

A math teacher described talking with a food science teacher about the use of proportions and with a horticulture teacher about constants. Another freshman-level teacher explained "anything we can align, we discuss" and described using the concepts of area and perimeter while exploring the laying of sod in Horticulture/Landscape Design and various topics in the Agricultural Mechanics pathways.

Another agriculture teacher explained that integration was facilitated by the open communication pathways between teachers: "If you ever need to reach out, you can. I saw some math skills that were a little soft so I asked the teacher to focus on those skills."

3.7.2.3.3 Challenges to curricular integration. Many teachers, however, expressed concern about doing as much as they would have liked to ensure that academic and agriculture content were dovetailed. The most significant concern was time. Despite some time being scheduled into the school day, teachers described not having enough. A couple of science teachers explained, "Every year you find new connections and find overlap," but lamented that "you almost need an entire summer to be able to plan it out." A new first year agriculture teacher felt encouraged to collaborate but was challenged by time and proximity, "We do try to do collaboration; this is my first year in this school and I unfortunately think it has been a little separated."

Some of the science teachers expressed interest in working collaboratively, but identified challenges with the sequence and timing of topics in courses. Once concern was that, "we don't have the time to really sit down and plan out things like that." In addition, the different agricultural pathways addressed different content at different times of the year making it difficult for an academic teacher to align curriculum across all of the pathways. One teacher suggested instead, "maybe we could pick one and align with that one pathway, but making it all work, it might be difficult."

There also seemed to be a split between the agriculture teachers and the other STEM teachers when it came to the familiarity with each others' curriculum. One agricultural pathways teacher shared this perspective of the gap in understanding:

One of biggest challenges with [agriculture] *program is to let the core* [teachers] *understand that we're teaching what we're teaching. They don't know what we're doing… if I could show them our labs, that would be great. But they're so focused on the tests and preparing for that, so they don't have time to look at what we're doing. But we're doing a lot with conversions, equations, molarity work,* [etc.] *so it's interesting to me to see how kids* [not taking Food Science at the same time] *place in science as opposed to those not in Food Science… because I think I cover a lot of the science here.*

A CTE representative from the CPS district identified both Hook's level of support for the integration of course content and the faculty's desires to make it happen, but reiterated some of the challenges saying:

Within the faculty, another strength—I talked before about the integration. That's also a weakness though, because Bill has to constantly work at that, because if you slack off a bit, [the teachers] *tend to get back into their silos—CTE and academics. I'd love to see those groups interact even more—I think there still is some separation between those groups. When I come here, I interact the most with the CTE teachers, it's who I serve, but I don't interact as much if at all with English, math, science, and I should, but I don't know them as well…In CTE, nationally, it's just an issue that everyone has across the board, integrating CTE or anything is a challenge for any group.*

3.7.2.4 University Connections and CHSAS

The University of Illinois had a "historic connection" with CHSAS to provide support for the agriculture programs. A representative from the university explained that the goal of the interaction was to "get everything aligned [and] on track," noting that the level of interaction between the University of Illinois and CHSAS depended on the pathway, with the strongest connections being with the Animal Science and Food Science pathways. She explained that the Food Science program followed a syllabus and outline that was very similar to those at the university, and that the teachers collaborate regularly, "come and visit… and make arrangements to swap equipment, share ideas, etc."

One of the challenges reiterated by a representative from the University of Illinois was a perceived "bifurcation between ag teachers and regular teachers." She went on to note her perception that while the mission of the school was clear—to integrate academic and agricultural programs—there was "a lot of variation in buy-in," among some of the general education teachers, and she suggested that the conversation "has to go beyond the pathways." Another representative described the university's approach to helping all teachers understand the philosophy: "we've tried to help with that, we tried bringing in ALL the teachers to talk to them; had former students talk to the teachers to explain how math and science could have been better [at CHSAS] in preparing them."

Describing other connections between the university and CHSAS, the representative noted that University of Illinois had placed student teachers at CHSAS, had students from their Agricultural Education programs visit CHSAS for observations, and had many of the CHSAS teachers enrolled in the online Agricultural Education program. The university also hosted teachers on campus for professional development experiences such as conversations about curriculum.

3.7.2.5 Teacher Support

The teachers at CHSAS described several support structures that helped them do their jobs well. The underlying foundation was Hook's belief in his teachers. Hook described his role at the school as being responsible for the big picture: to hire the best teachers possible to teach, to ensure that teachers had time in their schedules to communicate and collaborate with others in their subject areas and on their grade levels, and to make sure they had the resources they needed to carry out their jobs. Hook described: "My strength is . . . the budget. You know we're tight there and you can talk to teachers over the years—they've cut our budget by two million dollars—you could ask the teachers and they wouldn't feel it." Teachers concurred. One teacher explained, "the school administration does have a good rapport with its teachers and does make resources and support available;" another in the math department said, "the administration is very supportive—it is done and no questions … [if] we want to meet, he gives us time, and if we want to do retakes on the weekend, they help; they do as much as they can;" and continued saying "When we ask for something, we come up with a plan and it gets supported; we are very lucky to have him."

In general, teachers were positive about their opportunities for professional development within CHSAS, although there had been some changes from the previous year as a result of a teacher strike and union negotiations. Hook explained that the CPS school system sought to give students more instructional time, which required restructuring the school day to remove teachers' common planning time that was built into every Friday afternoon. In addition, they lost their school improvement days because of the days the teachers were out on strike. Hook explained,

We [used to, last year] *average one school improvement day a month. Teachers could sign up for things outside of school at other schools in the district because we all had teacher improvement days on the same days each month, or we did some really great things in-house here.*

However, Hook continued,

The problem is we had this built in time for teachers to work together, and now all of it is gone. It's been a rough go this year. Instead we send multiple emails back and forth, and don't have the time to sit down and figure things out.

Even with the challenges, teachers expressed feeling well supported. Teachers explained that they had adequate classroom facilities and funding for lab equipment and the technology necessary for their programs in STEM education. The teachers also described having professional development opportunities and designated time throughout the school day for interaction and planning with others. One teacher stated:

S*upport is given … through professional development. There is also cross-curricular planning and implementation* [time]. *When we do level and department planning, we* [engage in] *cross-curricular programs that incorporate all courses. We have in-services on all areas of education. We talk and share information through email, media and face to face.*

3.7.2.5.1 Teacher opportunities to learn. On the teacher survey and in teacher focus groups, several teachers described their opportunities for on-going learning at CHSAS, both within the school day and the school district, and beyond. Teachers highly valued the time they had to collaborate with other teachers in the school, citing departments that were "very hard-working and cohesive" with colleagues who were "helpful and [had] strong content-knowledge."

All of the STEM teachers responding to the Teacher Survey indicated that they had observed other teachers as part of professional development within the past year. A significant majority of the STEM teachers had also had opportunities during the current school year to meet regularly with a local group of teachers to discuss STEM teaching issues (77%), had collaborated with STEM teachers to integrate content (77%) and had collaborated with non-STEM teachers to integrate content across the disciplines (86%). STEM teachers were much more likely to have attended a STEM teaching workshop within the past three years (65%) than to have attended a state or national STEM teacher meeting of any kind (15%) within that same time period.

In general, teachers felt that professional development experiences offered specifically by CHSAS better suited their needs than the general professional development offered by the CPS district. Teachers described having "in-services on all areas of education" as part of their professional development experiences as CHSAS staff, especially those targeting such needs as the use of inquiry-based and problem-based learning. Other teachers said they had had opportunities to go outside of the district for professional development, and had occasionally attended teachers' conferences. Several teachers had participated in the National Board for Professional Teaching Standards (NBPTS). One science teacher described a particular summer experience working with a farmer where he noted the value of working "with someone from another discipline all summer long" in helping to make some real-world connections with his science course such as the chemistry involved with fertilizers, pesticides, and herbicides, and the details of irrigation.

Teachers suggested ways that their professional development experiences could be improved. Several mentioned that increased time for targeted professional development to meet particular needs of their classrooms would have been beneficial. Individual teachers described being interested in taking college level courses in mathematics education, attending a STEM specific modeling conference, and having more opportunities to engage in lab-based learning or project-based learning courses. Others identified a need for professional development on general learning, such as how to help students with reading the text, developing their writing skills, the use of peer review in the writing process, and the applications of the Common Core State Standards. Other teachers expressed an interest in having more time to interact with other teachers to facilitate learning from their peers. One teacher explained:

I have gone out of CPS system to do my own professional development and I have participated in a professional development group that was a group that worked together to work on lesson plans. Usually the professional development was "experts" but they weren't teachers, and I find it more useful to have best practices from other teachers.

Another teacher said:

More and targeted professional development opportunities would be helpful. Not just workshops, but where you're actually coming with material and everyone in the group has the same goal. And they're learning how to incorporate one technology in their discipline. And then whoever the presenter is, is a co-teacher, or comes out to help teachers actually implement new ideas and technologies. [It would be helpful] *if we are shown how to actually do this, or get help from someone once we're trying to get something done in class.*

3.7.2.5.2 Teacher level of confidence with reform practices. According to the Teacher Survey, teachers generally agreed or strongly agreed that they were well prepared to use a variety of reform-based practices in the classroom including inquiry-based and project-based work. They were less confident on average with their abilities to involve parents in their students' education (see Table 6).

Table 6

STEM Teacher Data for Pedagogical Strategies

Question - I am confident in my ability to:	Scale 1-5*
Lead a class of students using investigative strategies	4.1
Manage a class of students engaged in hands-on/project-based work	4.2
Help students take responsibility for their own learning	4.2
Recognize and respond to student diversity	4.4
Encourage students' interest in science	4.2
Use strategies that specifically encourage participation of females and minorities in STEM	4.0
Involve parents in the STEM education of their students	3.4

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

3.7.2.5.3 Teachers' professional development and effects on classroom practices. Regarding professional development experiences, the majority of all teachers responding to the survey indicated that, if they had had professional development on one of these topics, the experiences were more likely to confirm what they were already doing in class than to cause changes in their teaching practices. The responses for STEM teachers were similar overall to all teachers. (See Table 7.)

Table 7

Effects of Teacher Professional Development on Teaching

Question: Considering all of your professional development, how would you rate the impact in each of the following areas?	All Teachers Scale 1-3	STEM Teachers Scale 1-3*
Deepening my own STEM content knowledge	2.2	2.2
Understanding student thinking in STEM	2.2	2.4
Learning how to use inquiry/investigation-oriented teaching strategies	2.3	2.3
Learning how to implement problem-based or project-based learning	2.4	2.2
Learning how to integrate the different disciplines of STEM into my course	2.3	2.1
Learning how to teach STEM across the high school curriculum	2.2	2.0
Learning how to help students perform STEM research	2.2	2.3
Learning how to teach engineering or design concepts or activities	2.1	2.0

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

3.7.2.5 School Teacher Culture

According to Hook, the CHSAS teachers were committed to the school, and in general they "want to see themselves in that ten year plan" and "if they're going to remain teaching, they want to remain here."

3.7.2.5.1 Determining course content. Teachers recognized and respected their autonomy to make decisions in the classroom and were invested in making the best decisions they could for student learning. One teacher described: "the hardest part of this job is deciding what learning opportunities out of all of them you're going to do. Instead of thinking about how you're going to teach various [pre-determined] concepts."

The teachers described using the ACT as a guide for their course content in the academic courses. A teacher explained that the goal is to "push [the students] as best we can" to be prepared, and since most colleges use the ACT as their entrance exam, this standard is in line with the school's expectations of college preparation and pushing the students "beyond senior year." Some teachers described creating "our own assessments and problem packets."

Some teachers also explained that they had to be flexible in the courses that they taught, that their preps could change from year to year. They could be teaching different levels of courses or different courses altogether. In addition, they needed to be able to adjust their teaching within a single course to meet students where they were. In describing his teachers and their willingness and abilities to adjust and adapt, Hook explained, "You know you may have to do it differently next year; you may have to do it differently for fifth period. You just have the understanding you need to adjust and have the ability to do that."

A math teacher described this process saying:

It is a hard start up to create the materials. The workload is harder than 'open the book and give the problem set.' And you can't go to the test generator and you have to create the three versions by hand. Even this year we change the questions and check to see if we are asking enough or asking too much. We work on the materials as much as we can.

In describing his experience with one class on one day, a biology teacher explained:

I adjusted throughout the day. My intention was to go further, and there is a more complex pedigree and in the morning I was showing it. But it had sex-linked traits, and it was confusing to them. By the time I got to 9th period, I made it simpler. I didn't get to assess it, so tomorrow I will give them a written assessment of how they understand the pedigree.

3.7.2.5.2 Teachers and technology. The teachers responsible for coordinating technology at CHSAS were regular classroom teachers who volunteered to work in this capacity. They explained that the principal was extremely supportive of the use of technology at CHSAS and was willing to purchase materials that teachers perceived as necessary. These teachers expressed concerns, however, about a lack of a school-wide strategic plan for technology implementation and a well-informed designated staff member who could focus on the integration of new technologies into the curriculum.

These teachers explained: "Our principal will purchase anything we want him to, and for example, Smartboards, he will buy them if someone wants them. It's that we don't really know what to ask for." They described their concerns relating to teachers' opportunities to stay current with technological change and teaching technologies and being knowledgeable about the usefulness of technology in the classroom. They asked, "How do you get teachers who have been teaching for a long time to embrace change? Our . . . science department, those teachers have been there 12+ years—teachers who have done it one way for so many years." They went on to explain: "We just don't have someone who can bring new ideas [in teaching technologies] to the teachers. It's just getting people to have the vision, and the understanding of what else is going on."

3.7.2.5.3 Teacher commitment. Parents and students recognized teachers' commitments to the school and to their students. Parents explained that teachers stayed late, after 5:30 p.m. to help students retake assessments and to tutor students, "spending their time to make sure the kid really gets it." Eleventh graders in a focus group articulated teachers' commitments saying "they spend a lot of time here after school," they are "accessible" and "a resource," adding "some students have a very strong relation with particular teachers." Ninth grade students in a focus group said, the teachers "are always there to help you," explaining that they could email teachers on nights and weekends and expect a response. These students went on to explain that the school "supports each and every student; it's like a big family—they want everyone to do their best." One student described a personal experience: "I thought I was going to be quiet and I grew a strong bond with my teachers and that was unusual—I really trust my teacher." A representative from the CPS district concurred, explaining that teachers "treat students as people, not just kids who don't know anything."

3.7.3 Summary

The agricultural theme at CHSAS permeated all aspects of the school. It expanded into conversations about teacher hiring, teacher collaboration, and ongoing teacher education. This single-minded focus helped to create common ground connecting administration, teachers, students, parents, and the larger community. Students and parents felt a sense of community through the teachers' attentiveness and concern, and teachers and administrators perceived they were part of a greater whole, and operated with collective movement.

The teachers at CHSAS were selected for their abilities, skills, and motivation to teach in an agriculturally focused high school. They were interested in being part of a team that saw the value in integrating content across the discipline with particular attention to finding and elucidating the connections with content and careers in the agriculture fields. The principal worked hard to provide teachers the time and resources to do their jobs well. Teachers found time to communicate amongst themselves and were given opportunities for professional development through the CPS school system, within CHSAS, in conjunction with University of Illinois, and beyond the school day and year. Teachers' opportunities to collaborate and to learn helped them to feel competent in the implementation of effective reform-based education.

3.8 INCLUSIVE STEM-FOCUSED MISSION (CC 8)

This critical component, defined in Table 1, is comprised of two subcomponents: inclusiveness and STEM-focus. The implementation findings are presented in two corresponding subsections.

3.8.1 Design

The mission statement published on the school's website at the time of our study read as follows:

The Chicago High School for Agricultural Sciences is a college preparatory high school that provides opportunities for diverse students from across the city to study agriculture with the goal of developing marketable skills as well as college level competencies. We will produce technologically proficient graduates who will have the power to change the image of urban agriculture.

CHSAS self-identified as a college preparatory high school focused on agriculture with three developmental goals for its students: college level competencies, marketable skills and technological proficiency. The statement specifically included an inclusive aspect, "opportunities for diverse students from across the city."

The mission statement targets agriculture, and as the school's name suggests, the focus was on agricultural sciences. Similarly the CHSAS vision statement, also published on the school's website, targeted agricultural programs but in the context of integration with its academic programs:

Our vision at Chicago High School for Agricultural Sciences is to create a positive learning environment that will support the integration of our academic and agricultural programs. Our goal is to create competent and literate citizens.

One of the distinguishing characteristics of the school, according to the principal, was that the curriculum integrated career and technical education with its college preparatory curriculum. Furthermore, the vision statement specifically identified a school-level goal to "create a positive learning environment" to support this integration. This is described in greater detail in sections on instructional strategies and supports for students. Finally, the vision statement also adds another developmental goal "to create competent and literate citizens."

3.8.2 Implementation

This subsection focuses the school's implementation of its mission and vision, specifically the inclusiveness and STEM focus.

3.8.2.1 Inclusive Mission

CHSAS used a lottery system to determine admission to the school. According to a counselor, the lottery was tiered with preference first to siblings, then to those in the proximity area of the CPS boundaries, and then those within the CPS boundaries but outside the proximity area. According to a district representative, 40% of CHSAS students were from the neighborhood.

Student demographics for the year of our research visit can be found in Table 3.
More females attended CHSAS than males. The counselor provided the information that the ninth grade class included more female students, 80 compared to 70 male students. The student body at the time of our visit was racially/ethnically diverse: 39% Black/African American, 24% Hispanic/Latino, 32% White, 4% Two or More Races, with Asian, Pacific Islanders, and Native Americans accounting for the remaining 1% (Table 3). About half the students were from low income families (Table 3).

As noted in the Context section, admission to CHSAS was somewhat selective. Students needed to score at or above the fifth stanine on their seventh grade mathematics, reading, and science achievement tests, meaning students scored better than 40% of students taking the test. CPS magnet schools typically required that students score in the fifth stanine in mathematics and reading, so CHSAS, as a CPS magnet school, was somewhat more restrictive in also requiring that level for science. A CPS administrator explained that there were CPS magnet schools that were much more restrictive, requiring stanine scores of 7 or above (top 23%). He also commented that a student in the fifth stanine "is considered an average student."

Some allowance was made for students with individual education plans. By submitting their IEP with their lottery application, applicants could be considered if their combined mathematics and reading scores were a combined total of 10. About 40 CHSAS students were students with IEPs taking the prescribed curriculum. CHSAS also housed a large CPS cluster-site program for 65 low incidence special needs students with autism or cognitive delays ranging from moderate to profound, who did not follow the same curriculum.

Students and their parents chose to apply to the lottery for CHSAS. Some chose the school for its focus on agricultural sciences, but focus groups with students and parents revealed that the school's facilities, safe environment, and opportunities to earn scholarships and participate in internships, were what attracted others to the school. For example, one parent commented that, as someone in the neighborhood, she was attracted by the facility itself: "We live nearby and it's a

great facility—the concept of the last farm in Chicago. They do real things; it's a bigger picture of what life is really about."

Students, parents, and teachers in separate focus groups agreed that the school's culture was inclusive. Parents in the focus group agreed with other parents' comments that "These kids get along great. I've never seen so much diversity come together so well…I've seen all kinds of students work together with no problems." Eleventh graders agreed that all students were friends and worked together seamlessly. They appreciated the benefits of learning to work with students from diverse backgrounds: "You learn to interact with all kinds of people." These older students recognized and embraced the demographic diversity of the student body, and in fact were proud of being the "most diverse FFA [Future Farmers of America] chapter." All CHSAS students belonged to the FFA and CHSAS sent a large contingent of their FFA to the organization's conferences, as further described in the section on Informal and Outside the Classroom Learning (CC 4).

When asked about how inclusive the school was, ninth graders agreed with one student's statement that "I really like this school because it supports each and every student. It is like a big family; they want everyone to do their best….There are so many races and religions here. It is really diverse. The school feels inclusive." School administrators in a focus group described CHSAS as a "very accepting school" with no racial conflicts between groups. They attributed this to the students accepting and supporting each other. As one administrator related, "Not long ago they had a day of silence for those who are gay/lesbian, so straight students were wearing tape over their mouths in support. There is a lot of support for each other; it's the culture of the school."

This culture of supportive acceptance extended to the special education cluster site students as well. As noted by the district representative we interviewed, and confirmed during focus groups,

They [CHSAS] give the (low incidence) special education kids a lot of opportunities in the areas they teach in Agriculture. The [special education students] go out into the barn, participate in the farm stand, they make dog treats for sale: they are really involved here….They are really integrated here.

Students with low incidence disabilities were partnered with other CHSAS students in a buddy system and they interacted socially (e.g., school dances) and academically (e.g. field trips, school-wide projects).

Teachers agreed that the school's student body was inclusive in terms of not only demographics and student interactions, but also academic ability. For example, in a focus group of mathematics teachers, the group agreed with a statement by one teacher who described the inclusiveness of the school:

I would say it is very inclusive. We have a wide range of students, not only with their abilities and levels [but also] we get every type of student from all over the city. All [the students] have different backgrounds…and different needs, from reading to writing to language to math. There are a few kids who are homeless…The curriculum we have in place won't shut out any students;

we grab their hand and drag them to the higher level… Many of the students are coming from families who have not gone to college.

Science teachers agreed that the CHSAS student body was diverse and that students varied in their prior science classroom experiences:

In [CPS] grammar school, they have really focused on reading and math at the expense of science. I think we have 70 feeder schools, so a great diversity of schools, backgrounds, and abilities in science. Some have had great instruction [but] one kid said he hadn't had science instruction since fifth grade.

Similarly, the technology teachers described the range of technological access of CHSAS students and how they helped close the gap:

With the economy, a lot of people are losing their jobs. Students might say, 'my parents can't afford to have Internet at home.' I told the kids I'll open up the lab at lunch time if you can work then. We [also] try to dedicate some of our class time to doing an assignment that is using the Internet or requires the use of technology. We try to do the majority of [that] work in house [in the classroom].

Teachers at CHSAS differentiated their instruction and provided tutoring at lunch and after school to support individual student learning, as described in the section on Reform Instructional Strategies and Project Based Learning (CC 2) and Supports for Students Under-represented in STEM (CC 10).

3.8.2.2. STEM-Focused Mission

Teachers and students, as well as business partners we interviewed, agreed that CHSAS was STEM-focused. In the online survey completed by the teachers, responses indicated that they perceived that the school was STEM-focused and that the agricultural focus was on science:

We as a school all place importance on the teaching of STEM courses.

Our administration is very supportive of STEM initiatives as are most teachers. The agriculture department is very supportive because most of the agriculture courses are based in science. I am encouraged to integrate science concepts into my agriculture classes and provide problem-based learning activities for my students that are highlighted in the science fair and portfolio project.

The administration encouraged participation in a STEM program by speaking with a select group of teachers, asking them to consider participating. My department tries to provide support (technology and funding) for STEM programs.

STEM is encouraged by the school and the community through the push for agricultural science classes. Many [agricultural] businesses partner with us, and tours to colleges with agricultural programs are available to students.

The school is constantly focused on encouraging students to pursue STEM careers.

Ninth graders in a focus group varied in their responses about why they applied or decided to attend CHSAS. A few indicated that they were drawn by the STEM focus based on their interests in careers in agricultural science, such as animal or food science; others were drawn by the opportunities available at CHSAS, such as scholarships to the University of Illinois, the robust Future Farmers of America program, weekend trips, and apprenticeships with University of Illinois, FFA, and Kraft. One female ninth grader remarked that she had not originally wanted to attend CHSAS but by the end of her first year, she did, and now wanted to go to veterinarian school. In a focus group with 11th graders, two female students indicated that they hadn't even known there was an agricultural focus, that their parents had entered them in the application lottery to attend. One of these students shared that her parents both had agriculture backgrounds and were "thrilled" that she would have the opportunity to study urban agriculture. Another 11th grader said he was on the waiting list for CHSAS and was planning to go to another STEM school in the Chicago area, but changed his plans when he received a notice during the summer that CHSAS had an opening for him: "I wanted to come here because it had a lot of opportunities for animal science. I always wanted to be a veterinarian and it will let me know what is going on before college."

Responses from a parent focus group similarly varied, with some interested in their children attending CHSAS because of its focus on agriculture and others because of its proximity to where they lived and overall quality compared to other public school options. Development of life skills and a focus on hands-on learning also played a role in some parents' decisions, as well as the safe learning environment and location. One parent who was a police officer stated that, "Hands down this is the safest school on the south side of Chicago." Word of mouth played a role in some parents' decisions to apply for the admissions lottery with one parent mentioning that it was recommended by her son's [middle school] principal because he was strong in science and mathematics. Another heard from a co-worker that "they teach them how to live a lifetime; they don't just teach them regular math and science."

Although safety, location, and a learning environment focused on development of life skills was mentioned by most of the parents in the focus group, preparation for college was also identified by most suggesting that parents recognized that CHSAS had a college preparatory mission. All but one seemed to be really sure that their children would pursue college majors in their "pathway." Students at CHSAS concentrated their studies in the last two years on Animal Science, Food Science, Agricultural Economics, Horticulture, or Agricultural Mechanics. One noted that her daughter was interested in pursuing studies related to international crop science, another that her daughter wanted to study to become a veterinarian. One parent summed up this understanding in these words: "The skills they learn here are practical [and] they can work towards degrees in college. I knew this would be a wonderful thing for them."

A connection between agricultural career opportunities and the vibrant agribusiness in the Chicago area was noted in several interviews including one with a CPS district representative, a business partner who had also been involved as a parent, and a college representative, . The district representative stated that the goal was to prepare students enough to go on to college if they so choose, and further commented that, "We try to provide all students with ability to be

pre-college but also giving them the skills to work if they do not go to college right away, and skills to transition from work to college further out." Finally, he noted that, although students who attended CHSAS did not all come because of the agriculture, that the school "does lay a really great foundation for those students to go into what they want to study in college and to make really good choices for what they want to go into," noting that many of the teaching staff had graduated from CHSAS, gone to college and then come back."

Responses from stakeholders also aligned with the explicit college readiness goals of CHSAS:

The mission of the school [is] to prepare kids for college and careers. We're preparing them for careers and the vast majority of them will have a stop at college on the way, and that's really the mission. If they go into Ag [Agriculture], that's great, and a lot of them do; and a lot of them don't, and that's fine. It's just the vehicle, the means, by which we get them there.

The principal believed the academic rigor of CHSAS was characteristic of a school with a college preparatory mission. He also believed what made CHSAS unique was its integration of the academic program with an applied agriculture program, "I think you have that rigor of academics here and I think we also have rigor of application and I think that's kind of what's missing [from other college preparatory programs]."

3.8.3 Summary

CHSAS' mission was to provide opportunities for "diverse students from all over the city" of Chicago to become "competent and literate citizens," and to develop college-level competencies and marketable skills, including technological proficiency. This was accomplished through an integration of academic and agricultural programs supported by a positive learning environment. Interviews and focus groups with stakeholders (e.g., students, parents, teachers, and school district) indicated that these various aspects of the mission and vision were being enacted, and there was overall agreement that the inclusive school culture was based on acceptance and support. Teachers recognized that, with students coming from 70 feeder middle schools across Chicago, each student had a unique background in terms of prior educational experiences. The teachers spoke of adapting their instruction to meet individual student needs. All students were required to complete a college preparatory curriculum integrated with agricultural science practicums, as described in the next section.

3.9 ADMINISTRATIVE STRUCTURE (CC 9)

Administrative structures were broadly defined in Table 1 at the school level, but this component includes within-school structures as well as structures CHSAS was a part of, specifically the district, CPS. This section focuses on school administrative staffing, funding, and teacher hiring and support.

3.9.1 Design

CHSAS was a themed magnet high school in the CPS district. It had an agricultural science theme, and the student body consisted of students who, together with their parents, chose to enter a lottery for open seats. CPS did not provide transportation for its students attending magnet schools such as CHSAS. With students coming from all over the Chicago area, this meant that

CHSAS students not living within walking distance needed to use public transportation, carpooling, or their own cars. CHSAS also served as a CPS special education cluster site.

CHSAS, as a CPS high school, received funding from CPS. As the CPS representative described, the property that the school was located on had been owned by the city of Chicago since the 1800s. CPS was going to sell the property, but the surrounding community pushed CPS to continue to use the property for educational purposes, as described in the Context section. An agreement was brokered, with the state legislature providing funding for a high school to be established on the land. As part of this agreement, the student enrollment at CHSAS had a legislated cap, originally set at 600 students and recently raised to 720 students. This was the only school in Illinois where the enrollment was legislated in this way.

CPS received federal Perkins Grant funding through the state of Illinois and provided substantial funding through this grant to CHSAS. As the principal explained, the Perkins Grant provided funding for career and technical education programs (CTE) serving student groups such as special education, and academically and economically disadvantaged students. As a school serving a large number of students from special populations through a combined CTE and college preparatory curriculum, CHSAS received grant funding that could be used for laboratory resources, tutoring services, and teacher professional development.

CHSAS served almost 600 students, including approximately 40 to 50 students with individual education plans (IEPs) but few English language learners. Students took both college preparatory and career and technical education courses.

Principal Hook led the school and was supported by an instructional leadership team that included two assistant principals, two counselors, and two special education teachers. There was also a librarian on the professional staff.

3.9.2 Implementation

The principal and a CPS representative who was interviewed agreed that CHSAS had enjoyed a positive relationship with the CPS district since its opening in 1985. However, as the CPS representative noted, the 20% increase in the enrollment limit for CHSAS was not accompanied by a corresponding increase in funding from the state legislature. He explained that the central district office understood the school's additional financial needs and provided certain funding amounts that were more than what their other schools received, in order to ensure that the school had enough farm supplies. CHSAS supplemented this funding with an enterprise model, in which the school sold agricultural products through a farm stand, plant sale, and participation in the Chicago Flower and Garden show with associated marketing efforts. Additionally, the Principal related how CHSAS leveraged available funding for school facility improvement through the use of student labor. For example, improvements to fencing and the barn were completed by students specializing in the Agriculture Mechanics pathway, such that available funds were used only for purchasing materials. CHSAS had an arrangement with CPS that allowed the CHSAS principal to have considerable autonomy in hiring teachers.

According to the CPS School Report Card, CHSAS was given an overall Level 1 rating, with average student growth and student performance, and described as *Organized for Improvement*,

meaning that the school has a strong culture and climate with only a few areas in need of improvement. Results were based on student and teacher responses to the *My Voice, My School 5Essentials* survey (http://iirc.niu.edu). In particular, the survey responses indicated strong agreement with two survey items: that the school partners with families and communities, and that there is a strong focus by the leadership on results and school improvement. Survey results also indicated very strongly that students feel safe and that the school supports positive behavior. Survey responses indicated average agreement with the statements that the school has high expectations and is instruction focused, challenging, and engaging; and that the teachers work well together and strive for excellence.

The subsections below explore the implementation of the administrative structure at CHSAS in greater detail.

3.9.2.1 Administrative Stability and Capacity

At the time of the site visit, CHSAS had been in operation for over 25 years, having first enrolled students in September, 1985, according to the school website (http://www.chicagoagr.org). During that time, CHSAS has had only three principals, which a CPS representative noted as "saying a lot" about the stability of the school's administration. The current principal, Dr. Hook, had been at the school for six years as of the site visit, and he was explicit in describing his plans to stay in that role for many years to come. The sense of stability at the top was reflected in the stability of the teaching staff and partnerships, as well. According to Principal Hook:

It really is kind of empowering to think that I can develop a ten year plan and see it out… I think the partners kind of buy into that. I'm not just one and done and then let me pad my resume with this experience. I'm going to retire from this position… I think the teachers have that sense too. Unless they have other plans to do other things, if they're going to remain teaching, they want to remain here. It's nice for them too. They buy into that ten year plan, and they want to see themselves in that ten year plan, which is a nice thing.

Perhaps because of this stability, one of the key strengths for CHSAS was the cohesiveness and level of collaboration among the leadership and staff, as described by a CPS representative who worked closely with the school. The effectiveness of the administrative staff was also enhanced by having certain types of personnel that most schools in CPS did not have. For example, the teachers from the Agriculture department described the "luxury" of having a person on the school's administrative staff dedicated to outreach and coordination with partners. As they described, most schools in CPS had to rely on someone from the district central office to perform this role. In their view, it was important that this role be performed by someone who "knows about the school and what is going on there. [The administrator] knows the kids and knows us, so it ends up being really valuable [to have her on the administrative team]."

3.9.2.2 Administrator–Teacher Relationships and Supports

When asked what he prioritized in order to offer a strong, quality STEM program at CHSAS, Principal Hook focused on the work being done by the teachers at the school. Notably, as a CPS representative explained, "the principal has total autonomy in selecting teachers… It's ultimately the principal's choice." This policy applied to all schools in the district. Once teachers were hired and attained tenure, they were protected by the terms of the Chicago Teacher's Union contract.

Principal Hook also stressed the administrative team's push to be "constantly learning and constantly trying to improve. We're constantly trying to get to the next level." This vision translated to a school administrative team that was seen and appreciated by multiple stakeholders as very supportive of the teachers. Business and industry partners recognized that the staff at the school was committed to improvement, with one partner explaining that the school "is constantly improving, and the administration and faculty is always making it better." Teachers agreed that they were well supported. One of the mathematics teachers in a focus group described how the administration, particularly the principal, supported their work:

The administration is very supportive. [If] *we want to meet,* [Principal Hook] *gives us time, and if we want to do retakes* [of tests] *on the weekend, they [administrative staff] help. They do as much as they can… When we ask for something, we come up with a plan, and it gets supported. We are very lucky to have him.*

In an interview, a chemistry teacher echoed this sentiment that, for her, getting resources she needed for her class was simply "a matter of saying to the principal, 'this is what I need.' Whenever I go to the principal to support my teaching, that has never been a problem."
This support of teachers extended to professional development opportunities. In a focus group of science teachers, one teacher commented on the administration's willingness to send teachers to professional development opportunities that they found, even when outside the Chicago school district, such as a National Science Teacher Association (NSTA) conference in Seattle, Washington. Other teachers in the focus group explained it was particularly helpful to be able to access targeted, relevant professional development given that CHSAS was a unique school with its agricultural focus; typically, professional development opportunities offered by the district were not fully relevant.

In another focus group, a teacher even identified the administration as the "magical ingredient" accounting for the school's positive outcomes. As she elaborated, "When you work for someone who truly supports you and loves their job, then that atmosphere gets passed on to everyone else. And that gets passed on to the students…. The key ingredient is our administration." When asked to describe all of the ways that they experienced support for the teaching of STEM courses by their school and administration, many teachers responding to a survey cited the support of the administration as a key factor in their work. A sampling of their comments demonstrates the many facets of the support that the administrative team provided to the teachers at CHSAS:

The school has provided me with a Smartboard and overhead projector, the administration has pushed for this.

Our administration fully supports our endeavors when the impact on student learning is evidenced.

Administration is understanding and creative of the budget constraints and does a good job keeping funds available for important projects.

The school informed me of a STEM program for teachers through a staff-wide email. Administration encouraged participation in a STEM program by speaking with a select group of teachers, asking them to consider participating.

This school has a very high level of support straight across the board. The support of the administration, teachers, and in many cases, the community, is simply top-notch. I am very pleased with the support system in place at this school.

A representative from Eli's Cheesecake, a major partner of CHSAS, noticed the difference between CHSAS and other agricultural schools in the country that he came across at FFA conventions, where teachers said they "were not supported by their schools." The administration's support for teachers at CHSAS allowed for the passions of the teachers to come through and for a higher sense of focus on providing quality instruction at the school, according to this representative.

3.9.3 Summary

The administrative structure at CHSAS provided a strong foundation that supported the success of the school. The history of the school was marked by a notable level of stability in the principal role, a tradition that was carried on by the current principal, Dr. Hook. This stability in leadership and in the associated vision and ten year plan of the school had a carryover effect on the teaching staff and their buy in for that plan. Similarly, the stability in the administrative team likely contributed to a strong, positive relationship between the administration and the instructional staff, one that was characterized by a high level of support from the principal and his team for the work, resources, and professional development of the teachers at the school. Finally, CHSAS also had a good relationship with the CPS district central office, one that helped provide financial supports for the unique work being done at the school.

3.10 SUPPORTS FOR UNDERREPRESNTED STUDENTS (CC 10)

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

3.10.1 Design

CHSAS was designed as a college preparatory high school with an agricultural theme, drawing students from across the CPS district, which encompasses a large metropolitan area. Its mission statement included three developmental goals for its students: college level competencies, marketable skills, and technological proficiency. Its vision was to "create a positive learning environment" and to integrate academic and agricultural programs to support student learning of rigorous academic content. The school meets it goal as a college preparatory school though its agricultural pathways particularly. This combination of goals implemented in the real world of work environment, also provided opportunities for students to develop non-cognitive skills and character traits related to success in and out of school.

Supports for new students began with a two-week orientation for incoming ninth graders. Throughout their time at CHSAS, students were encouraged to seek help from their teachers if they encountered difficulties learning particular subjects. Teachers were expected to be available

during lunch or after-school hours to tutor students. Special Education teachers supported students with IEPs. One class at each grade level was co-taught by a content-area teacher and a special education teacher. The special education teacher helped any student who was struggling with course material, not just the students with IEPs. There was also a mastery learning/tutoring system in place for ninth and tenth grade students.

CHSAS had two academic counselors on staff to work individually with students, particularly older students who were preparing college, scholarship, and financial aid applications. Although the career and college counseling was done in the context of agricultural careers and college majors, these supports were provided to students who were interested in other careers and college majors. Students also had access to various career and college supports, including the "What's Next Illinois?" website that helped them find potential careers and college majors that fit their individual interests and needs. Work with these resources began in the ninth grade when students took the required Agricultural Careers and Leadership course.

Opportunities existed through CHSAS for students to experience the world of work associated with different agricultural careers. Between the ninth and tenth grades, students were required to spend two weeks on campus completing supervised agricultural experiences, a 0.25 credit requirement. During tenth grade, they rotated through the five agricultural pathways: Animal Science, Food Science, Horticulture/Landscaping, Agricultural Mechanics, and Agricultural Business. This further supported their development of career interests and led to selection of a pathway to specialize in during their second two years of high school. Finally, the local FFA chapter at CHSAS was a major presence at the school, providing wide-ranging learning opportunities and experiences. Every student at CHSAS was required to be a member of the FFA during their time at the school, though they could decide how active of a participant they wanted to be, whether as an elected officer or as a volunteer for events and projects.

3.10.2. Implementation

They teach them how to live a lifetime. They don't just teach them regular math and science.
CHSAS parent commenting on why she chose the school for her child.

3.10.2.1. School Culture

3.10.2.1.1. Agricultural experiences as opportunity structures. Compared to other inclusive STEM schools in the U.S., CHSAS is older and well established. It was founded more than two decades ago, before the current wave of interest in ISHSs. It seemed to have come from another era, yet had a similar goal as current ISHSs; to prepare students for college through a program that focused on STEM. But at CHSAS, STEM disciplines were integrated with one another, and made real and relevant through agricultural curricular pathways that required each student to care for living things daily on a working farm. This resulted in a culture of caring and a work ethic that included physical work rather than just cognitive work. This school culture permeated the school and was a pervasive student support; students and teachers worked to keep the farm going and in the process, supported one another. The agricultural foundation seemed to be more than a theme for curriculum and instruction; it was a metaphor for a farm family and provided a sense of place. A ninth grader in a focus group remarked:

I really like the school. It supports each and every student. It is like a big family. They want everyone to do their best. Tutoring is after school, but you have to have the integrity to go and do it. The counselor is always there to help you and make a plan. I came to this school not knowing anyone and I didn't go to freshman connection [an orientation program for incoming ninth graders]. I thought I was going to be quiet. I grew a strong bond with my teachers and that was unusual. I really trust my teachers. We have a special education branch—the regular students and the (low incidence) special education students are always interacting. Teachers might see you and see you are stressed, and they reach out and help you. There are so many races and religions here—it is really diverse. This school feels inclusive.

This quotation from a ninth grader is a good introduction to the supports available to students at CHSAS. Some students and parents reported coming to the schools specifically for the agricultural offerings, but others came because the school had a good reputation for college preparation. It was seen as a safe school. The neighborhood surrounding the school was older and well-established with fewer immigrants than other areas of Chicago. It included large proportions of both White and African American working class Chicago families, many of whom had deep Midwestern roots and who could recall the area when it was primarily a farming community. Some parents grew up in farming communities, elsewhere. Others saw the "food-to-table" movement as a current example of a new business and life trend that was worthwhile. The community was proud of CHSAS and interacted with the school through unusual means—buying products produced by the students at their farm stand, or simply enjoying the presence of an eighty-acre working farm in the Chicago city limits. One parent said, "The community embraces the presence of the school in this neighborhood and is proud of its uniqueness." Another parent pointed out, "We live nearby. The facility itself is a great facility, the concept of the last farm in Chicago. They do real things. It's a bigger picture of what life it really about."

In focus groups, several students mentioned that their parents had grown up on farms, and that they wanted their children to have this kind of experience. The value of the farming experience extended beyond mere nostalgia. Parents and teachers said that the agricultural experience contributed to students' life skills in a unique way. Involvement in agriculture provided a STEM connection that could not be duplicated in other realms of work-life. The life skills acquired were directly related farming. A retired president of Wright Junior College put it this way:

You want people to solve problems by thinking through them and perhaps directing the thought process. I think the teachers at CHSAS tend to do that—make the students think and solve problems and think critically. I bet this is frustrating for some of the students who were [merely] given answers [in earlier grades]. A characteristic of all good schools and good teachers is helping focus students so they find answers…Maybe it transforms them in terms of their thinking. For every young person who chooses one of the many careers in agriculture…there is nothing so powerful in making students aware on issues related to health and food.

The FFA at CHSAS accordingly had a major impact on the experiences and opportunities available to the students at the school. A representative from the University of Illinois who worked closely with CHSAS students stated, the FFA "created a framework for the application of STEM and for leadership development." The networking opportunities that students gained

through participating at FFA conventions, plus the leadership and agricultural sciences skills that they gained made this work an especially valuable facet of the CHSAS experience and represented a unique system of supports for students. More about the FFA is described in the Informal Learning critical component narrative of this case study.

3.10.2.1.2. Agricultural and life skills. Perhaps because this school was located in an older, established, blue collar community, we heard many comments about the importance of getting students ready for life in an unpredictable economy, perhaps viewed as important as getting ready for college in this community. CHSAS accomplished this through the agricultural career pathways, which were both hands-on and required sustained student efforts. Consequences for school assignments were about more than grades; they affected living things. Required educational activities, which included Supervised Agricultural Experiences (SAE) and Applied Agricultural Activities (AAA) blended seamlessly into real-life experiences. Each student was involved in a long-term project that involved keeping the animals reproducing and healthy, maintaining the hydroponic gardens, preparing large quantities of food safely, or repairing and maintaining heavy farm machinery and buildings. None of these activities could be forgotten casually or put aside without the entire enterprise suffering. The stakes were high, but the rewards seemed great in terms of practical knowledge and college preparation. Additionally, as an agricultural teacher explained, these activities helped students "learn to take constructive criticism, because they can see their own inefficiency. It [built] work ethic to have the opportunity to fail."

3.10.2.1.3. Safety. In addition, students, parents, and teachers expressed pride in the diversity of the student body and the safe and inclusive environment at CHSAS. That "safety" might be seen as a student support rather than a given may be a sad but true commentary on the concerns of students and parents living in a large urban area and attending the city school system. One parent said, "CHSAS is definitely safe in terms of location. I know [my son] can travel on his own, I know it's a safe route. I don't have to worry about it." Another parent elaborated with considerable authority on the subject:

We hit the newspaper a few times. We do well in sports. We play in some neighborhoods where other kids forfeit because they don't want to go to that neighborhood, but our kids never do that. They are smart AND tough. They are comfortable because they have that dedication, they feel safe. I prayed for a school like this when my kid was in grammar school. I am a police officer. Hands down this is the safest school on the south side of Chicago.

Students, parents, and educators all commented on the diversity of the school and about how the students' respect for one another and camaraderie were important and valued life skills. CHSAS produced more future agriculture majors who were African American than any other high school and increased the diversity in FFA. Students came from all parts of Chicago and got out of their neighborhoods to prepare for the world of work. One ninth grader in a focus group said, "You learn to interact with all kinds of people. Now it would be frightening to go to a school that's not diverse…When we go to FAA conventions, they are happy to see so many black people."

3.10.2.1.4. Students with disabilities as integral to the program. An important aspect of diversity in this school was programs for students with disabilities who made up about a sixth of

the school's population. Students with disabilities fell into two categories. Students with high incidence disabilities (e.g., learning disabilities, attention deficit disorder, etc.) could enter the school via a lottery system. If they were selected, they could have access to special education through accommodations or special services. By submitting their IEP with their lottery application, applicants could be considered if their combined mathematics and reading scores were a combined total of 10, reflecting relaxed access than for students without disability designation. About forty CHSAS students fell into this category. The goal was to move them down the support ladder so that they could learn with increasingly fewer supports and accommodations as they headed toward graduation from CHSAS.

Another sixty-five students at CHSAS attended a special program for students with low incidence disabilities, housed in a one wing of the school. This program included students with autism, moderate cognitive delays, and those with severe and profound delays. The program also included students with non-cognitive disabilities such as blindness. These students with low incidence disabilities were integrated into the general education program and activities, as well as outside-of-school activities, as much as possible. There was a popular buddy system that partnered students with low incidence disabilities with general education students and allowed all to participate in activities and to share experiences. If a field trip was planned, the field trip form asked the teacher to indicate how he or she would include students with low incidence disabilities. The inclusion and student affiliations appeared not to be mere well-meaning add-ons, but an integral part of the school and its culture: students caring for one another and encouraging one another. This may be related to the caring culture endemic to the agricultural programs. One counselor commented:

Some of the students are here because we are [an] accessible building and a smaller site compared to other Chicago Public Schools. So parents really push their child to be here if the students have lots of difficulties or disabilities. Like our student with muscular dystrophy; he's very accepted in this school. Others have severe hearing loss or forms of dwarfism. Again they're here because this is a setting where they feel safer. We had a blind student who's now a veterinarian. So over the years, we've had a lot of students with significant disabilities that weren't disabilities. With the teachers, it's who's in front of them, not the disabilities. It's what that student brings to the table.

3.10.2.2. School Program of Student Supports

3.10.2.2.1. Freshman orientation. Students attended a special orientation program for two weeks during the summer before ninth grade, where they learned about the school and recognized where all of the classes were located. New students also had the opportunity to meet new people with student peers running the program. Ninth graders noted in a focus group that this orientation "helped us and made us feel welcome."

3.10.2.2.2. Philosophy of personalization rather than tracking. Although CHSAS employed entrance criteria that selected students in the top 60% of prior performance measures, there was latitude for students with disabilities and a substantial range of abilities and academic preparation prior to attending CHSAS. There were over 70 feeder schools, and one student reported that he

had not had science since fifth grade, while others came from strong programs. One teacher expanded on this:

I would say it is very inclusive. We have a wide range of students, not only with their abilities and levels. We get every type of student from all over the city. All different backgrounds and some of them have second languages involved. They all have different needs from reading to writing to language to math. There are a few kids who are homeless...The curriculum we have in place won't shut out any students and we grab their hand and drag them to the higher level. Some schools shut out those kids. Sometimes we personalize our packets and they want their names in the packets.

Another teacher was acutely aware that some students came from families with little experience with college, and needed support for their child who was attending a college prep school; the teacher described why such programs were necessary:

Many of the students are coming from families who have not gone to college. The kids open up and we talk. As freshman teachers I know about 95% of the students in the school. When I have them as sophomores I go to the freshmen teachers and find out how they were doing as freshman. And we catch them— they say we never taught us this—nope we know that we taught it.

CHSAS had to grapple with students of varying achievement levels in STEM, and differences in social capital, or the knowledge to access the college admissions systems. Other students may have had plenty of social capital, but a more restricted range of life experiences. The principal explained the school's approach and philosophy:

The students all take the same type of curriculum, but [we don't say] let's send the smart kids along this pathway and send the kids who maybe aren't so smart or don't do as well at school along this pathway. I think the more schools do that, the more schools set kids up for failure on both pathways because you end up with a lot of smart kids who maybe don't have a work ethic and you have kids who can work hard and show up early, but they don't the capabilities to do the work that the workforce needs. I think because we do both. We have students who end up being pretty well rounded. There are smart kids who aren't afraid to get their hands dirty and aren't afraid to show up early/stay late. We're able to achieve the mission of the school, which is to prepare kids for college and careers. We're preparing them for careers and the vast majority of them will have a stop at college on the way... If they go into Ag that's great. A lot do and a lot don't. Ag is the vehicle…to get them there.

3.10.2.2.3. Academic support. CHSAS had a mastery learning policy for ninth and tenth graders. Students who did not achieve at least a 70% pass rate, for homework assignments and for assessments, either corrected their mistakes or repeated the assignment. The rationale for the mastery learning system in the ninth and tenth grades was to prepare students for their chosen pathways as upperclassmen; they would be proficient in the content areas and equipped with the background knowledge to apply to their learning experiences. A CHSAS science teacher explained the system used for supporting students' mastery learning:

The students have to have their homework assignments done and do their test corrections. The lunchtime tutors help them fix their assignments. If we feel they are not ready, then we won't give it [the test re-take] to them. We post the homework online every night – it is a resource available – we post every night or the test is Friday or Thursday. . .

This system reportedly has encouraged students to work harder and find success in their science class. According to a teacher:
I tell my students that their grade is based on their effort... We don't care when students learn the material as long as they learn the material. I have some students who are failing who are now passing because they get how to work harder. . . When they recognize that they have two tests that they need to do, they face it and go to tutoring. . . That is a fantastic thing—some students take longer than other students—if you don't get it right away—then it isn't the end of the world. If you eventually get it, that is what we care about. In order to be successful at a junior level, you need to know freshman math. It is like building a house—you need a strong foundation.

Tutoring was readily available to students and many took advantage of the services. A mathematics teacher in a focus group commented:

We tutor after school twice a week and there is lunchtime tutoring every day in every lunch period. [Students] have a job, younger siblings to take care of, or sports—and the kids really take advantage of the tutoring and we can at least say we are available. Each grade level—there is at least one class that is co-taught [with a special education teacher]. That teacher is to assist all students… The students that I help during the class are usually not the identified ones (with disabilities), just the struggling ones. We also offer retakes during the breaks. If students have a problem, as long as they sign up and they can come in and take test.

In addition, CHSAS students had access to online classes, ranging from remedial courses for students who failed to master a course during the school year to rigorous courses associated with upper level pathways. Given the varying levels of preparation of the students and the limited ability of students to re-take courses during summers, the school made used the online option. Students in an eleventh grade focus group described using Kahn Academy to support learning rigorous mathematics and science coursework. One of those students explained, "Not everyone learns the same way, so if I can't learn it from my teacher, maybe I can find a video of someone else teaching it that will help me learn it." Another student also noted that in AP Calculus they had to complete 300 Kahn Academy competencies, and that he found the Kahn Academy videos, particularly the chemistry videos, "awesome." Another noted that her US History teacher recommended using a website called Hippocampus for topics in US History: "It can help us learn a specific topic for the AP test."

One student summarized well how helpful these opportunities were in expanding resources for individual learning:

What's good about using technology in schools is, if a student doesn't understand a certain topic, there's always a website available that will help me understand it. It opened my eyes to different possibilities. It gives a different viewpoint to learn different things from different people, shortening the distance between people. They can be on Skype, or making a video or a website.

Not everyone learns the same way, so if I can't learn it from my teacher maybe I can find a video of someone else teaching it that will help me learn it.

Students in focus groups also reported feeling comfortable with emailing or even texting teachers when they needed help outside of the school day. They confirmed that when they emailed teachers on weekends or in the evenings, the teachers emailed them back. In both the focus group with parents and the student focus groups, students and parents referred to using the school's website to learn about events and news, in addition to checking grades and accessing homework. One parent reported learning about a student's award via the web site before the student even came home from school that day.

3.10.2.2.4. College preparation, scholarships, and experiences. The academic programs were designed to prepare students for college generally, and students were well-positioned for careers in agriculture if they chose to pursue them. The real life experiences at CHSAS provided students opportunities to encounter aspects of their tentative career choices before they actually went on to college. A parent in a focus group remarked, "My daughter started out wanting to be a vet, but she doesn't like blood, so now she is interested in agribusiness." Another said, "My son is really into mechanical tech; it was tough at first, but he loves to design." A student in a focus group said, "I wanted to come here because the school had a lot of opportunities for animal science. I always wanted to be a veterinarian. This will let me know what is going on before college. Now I am going to Cal Poly."

The rich nature of CHSAS's experiences included summer research internships and club activities directly related to farming such as FFA. While CHSAS students experienced an agricultural environment while attending a school in a major city, they also traveled frequently for events and internships. This provided them with a more expansive view of the opportunities before them. For example project-based learning was employed through extracurricular projects and internship programs during the summer. Students had opportunities to expand their range of contacts, knowledge and skills through science fairs, history fairs, or networking. Through these out-of-school experiences, colleges came to know CHSAS students as good prospects due to their records of academic performance and the skills learned in agriculture pathways. College personnel sought out CHSAS staff out to ask about students interested in new opportunities outside of the school-based pathways.

CHSAS counselors worked with students to help them find college scholarships. The niche role of this agricultural and college preparation made CHSAS students attractive to colleges. The retired president of Wright Junior College said, "They are selected for summer programs because they are interested in agriculture, but they are usually good students. When they are juniors they go down to the University of Illinois in the summer. They try out the university and that puts them a step ahead."

CHSAS students were required to use the resources available on the college and career counseling website "What's Next Illinois?" This website included a career test, an ACT preparation resource, and information on scholarships and internships. Students in focus groups expressed mixed opinions about the helpfulness of this website. Some thought that the suggestions through this website are a too vague, but they generally agreed that the website at

least gave them access to new information. Thus, students were supported by technological resources as well as developing the personal responsibility to search for college and career resources and choices.

A student summarized how the various opportunities worked together to provide students with a variety of experiences, saying:

I thought CHSAS was great. I didn't know that food went through so much processing. I really enjoy going to this school because I have more opportunities for the future. My sisters went here… My parents really like it. There are a lot of opportunities for FFA and at the University of Illinois and Kraft apprenticeships. I now have an office in FFA, and am going to the research thing in U of I in the summer.

3.10.3 Summary.

CHSAS had developed a complete system of student supports, initiated in the summer before 9th grade and continuing through high school graduation when the emphasis was on the best college placement and admissions for graduates. Many of the supports developed at CHSAS were similar to those seen at other ISHSs and included a mastery learning system, tutoring, and careful attention to a personalized college admissions process. Experiences outside school related to agricultural research and internships enhance students' attractiveness to colleges and universities, as they enhance students' horizons and social capital. Two aspects of CHSAS student supports seemed unique to the school. One was the way that the school integrated students with low incidence disabilities into the school program and made these students an integral part of the CHSAS community. The second unique aspect seemed to be an extension of the responsible and caring climate that grows from the culture of going to a high school that operates an 80 acre farm. Students learned to care for living things, responsibly and consistently, and in doing so, learned to care for and support one another creating a uniquely supportive atmosphere.

3.11 EMERGENT THEMES

3.11.1 School Culture

CHSAS exhibited a tightly-knit community based on a caring, supportive school climate and shared commitment to "Our Farm." This was the glue that held together the learning community, and supported high expectations, not only for individual responsibility for learning rigorous course content, but also for developing life skills such as collaboration and a strong work ethic. The next emergent theme, World of Work, explores the sense of ownership students had in "Our Farm."

Peterson and Deal (1998) identified norms of hard work and collegiality coupled with a shared sense of purpose as important underlying norms of a positive school culture. More recently, Rutledge, Cohen-Vogel, and Osborne-Lampkin (2012) found that a school culture emphasizing professional behavior as well as learning was a feature of effective high schools. Recognizing that there is an overlap of the theme of school culture with critical components, this section and the other two emergent themes explore the unique culture at CHSAS and make those connections explicit.

At the core of the school community were committed administrators and teachers with whom students formed close bonds, as described in the section on Administrative Structure. Students also formed strong working relationships with each other. Eleventh graders in a focus group explained that they relied on each other for homework help; in fact, in a project-based learning environment, homework was frequently assigned as group work and students worked together on it, especially during lunch but also after school. With the small number of students per grade—about 120 students—and an even smaller number who were in the same pathway, the students came to know everyone who was in their classes well. The students also noted that students in the honors level mostly had the same schedule and the same teacher for each course. They also confirmed that teachers and even the principal, provided after-school help, and that students could reach out to any teacher for help.

The CHSAS learning community included special education students since CHSAS served as a cluster site for CPS. Thus, the diversity of the student body extended beyond demographic diversity, described in the Context section, to include diversity in learning goals. There was a commitment to including these students in electives, field trips, and social activities such as school dances, using a "buddy system" with other students.

3.11.2 World of Work

One of the distinguishing features of CHSAS was the intentional and explicit blend of CTE and College Preparatory curricula that began the moment students started at CHSAS. All learning was contextualized within the realistic world of agricultural work. Student career interests were further developed through active student involvement in entrepreneurial enterprise at CHSAS. These features are described in this section.

3.11.2.1 Farm Stand and other Entrepreneurial Enterprises.

CHSAS sold agricultural products to Eli Cheesecake (e.g., honey) but students also engaged in entrepreneurial enterprises at the school and at other community events. They staffed a farm stand, sponsored by Eli Cheesecake, to sell produce such as vegetables and baked goods. They staffed a booth at the Garden and Flower show where they sold products made by the students from different pathways and by the special education students, and they held a plant sale each year attracting community members as well as parents. These were real-world work experiences for their students and provided the students in the Agricultural Business pathway with real-world contexts for learning and applying marketing concepts such as pricing in terms of supply and demand. An added benefit was that it provided an avenue of self-funding for school improvements. The Japanese Tea Garden pagoda built by CHSAS students was of such high quality that it sold for $5,000, and the students who built it donated this sum to the school, a substantial funding supplement.

3.11.2.2 Applied Science as an Academic Support.

The curricular design of CHSAS combined Career and Technical Education and College Preparatory coursework, and intentionally built connections between College Preparatory coursework and applied science. The applied science is in agricultural science, also known as agriscience, with each pathway focused on applied science in particular agricultural science fields (i.e., Animal Science, Food Science, Horticulture, Economics/Business, Mechanics). In a

focus group with science teachers, three of the teachers commented on the instructional advantages afforded by this design:

For me, it's great to have examples and ready made references from the agriculture class.

It's really been beneficial with all of our students being able to overlap. Food Science and Animal Science overlap with chemistry. I've already presented [science] material and have had agriscience teachers talk about connections to biology. It's reinforced in the two classes [emphasis added]. *So there's collaboration with tying in chemistry, biology, and physics with the agricultural sciences.* And the kids are very verbal about it: Students make the connections [emphasis added].... *It works really well that way—Agricultural and the disciplinary subjects.*

I don't hear "why do we have to learn this?" as much from the students. They regularly see the connections.

Students in focus groups verified that they "regularly see the connections" across their coursework and commented on how this supported their learning. For example, as one 9th grade student explained in the context of learning rigorous content:

They [courses] are rigorous, but they are different because not many schools teach about agriculture. And here all of the classes are connected [emphasis added]. *And if you understand one class, you should be able to take all of them. Other schools they take history. This school they teach the history of agriculture and FFA. I didn't know agriculture was everything around us.*

Besides the academic support afforded by combining rigorous College Preparatory science coursework with applied science coursework in pathway fields, there was another benefit of combining College Preparatory and Career and Technical Education in the curriculum design, flexibility to consider professional experience as well as teaching qualifications when hiring teachers. The administration encouraged its agricultural science teachers to infuse their curricula with real-world work supportive of experiential learning. The two district representatives we interviewed commented on the power of experiential learning at CHSAS:

The experiential learning here is great. Everyone will take biology, but learning it hands-on and seeing it makes a huge difference. I'm actually a physician, but learning from a textbook versus on the patient is a huge difference. Sometimes learning from a book doesn't make sense, and here you can do it a lot deeper because you experience it hands-on, you see it.

Every moment is a learning moment because things change so quickly here. Like when the horse gave birth to a foal. You can actually see the horse laboring here, instead of just reading about it. Such a deeper learning experience.

Because of the Career and Technical Education curricular component, CHSAS could also target professional development opportunities for the teaching staff on collaborating with professionals in the agricultural fields. Each year, the whole teaching staff engaged in a daylong professional development visit to one of the school's industry partners. Individual teachers could also engage

in specialized professional development activities with agricultural professionals, and bring back ideas for new experiential learning projects. For example, one science teacher described learning more about soil science while working with a farmer on project ideas for high school students:

Last year I worked with a farmer in the summer time. He's got a Masters in soil science; he's not just tilling out there. I worked with him quite a bit about project ideas for kids. He's also a beekeeper.

The year of our visit, CHSAS had added beehives in an outdoor location to add another real-world feature to their school to support experiential learning. Such additions were ongoing at CHSAS. Many facilities had been and continued to be added (e.g., apple orchard, cattle enclosures, and a golf course). While partners might provide resources or mentoring, CHSAS students did the work associated with creating and maintaining these new agricultural resources.

As noted in the section on the farm culture, CHSAS students were responsible for caring for the animals and plants on the school's campus. Rather than receiving feedback from a teacher on academic work products alone, they also received feedback as they cared for the plants and animals in a real-world context. Student engagement seemed to be enhanced in this context. For example, the section on Reform Instructional Strategies and Project-Based Learning (CC2) included a vignette of an animal science class in which students were very seriously engaged in the experiment with chicks. They carefully prepared the food and water mixed with antibiotics for the group of chicks they were responsible for maintaining, measuring, and observing. To the students, they were valued living creatures, not just experimental subjects, and this added to their serious conduct of the experiment. This bonding continued over a period of weeks and students knew the grown chicks would become part of the CHSAS flock producing the agricultural products the school marketed.

Another key finding was that the world of work at CHSAS resembled real agricultural science work environments because of the professional quality of the lab technology, described in more detail in the section on Technology. Each of the pathways had well-equipped lab rooms with specialized equipment plus apparatuses built by Mechanics pathway students. An example was described in the Animal Science vignette in the section on Reform Instructional Strategies and Project-Based Learning (CC 2). The Food Science lab was outfitted with authentic industrial equipment, some of which the teacher had from previous experience as a food scientist. The hydroponics lab also stood out as a real-world learning environment, with a tilapia tank and backup generator. Even the agricultural business lab had real-world analysis software related to agricultural production and microeconomics, along with a stock market ticker to track commodity and stock prices. In addition to applying carpentry and electrical skills in real-world contexts, students in the Agricultural Mechanics pathway worked with agricultural technology and equipment to maintain a working farm, and earned certification valuable for work in agricultural jobs, such as pesticide application.

In a focus group on the use of technology, one teacher commented that students had access to more current work-place technology through "our abilities to get kids out into the workplace, to reach out." Because pathway teachers had prior professional experiences in their agricultural science area, they could and did reach out to businesses to arrange internships for students which

would afford even more access to the world of work and modern technology. According to a teacher, "students get exposed to things outside in the real world because of the internships, job shadowing, career days, etc."

3.11.2.3 Career Interest Development.

Because of its Career and Technical Education curricular component, CHSAS students began learning about and exploring career options as freshmen. They took two courses in their first year: Basic Agricultural Science and Agricultural Careers and Leadership. Their sophomore year, they rotated through all of the pathways to experience each before making decisions about ranking pathways they would like to explore in depth during their junior and senior years. All students also participated in the FFA and associated informal learning opportunities, including some who wanted to take advantage of the leadership opportunities FFA offered. CHSAS had a strong career interest development program and students were required to sign up for Career Day events of interest to them. Through these events, students had more access to details about different careers in agricultural science fields.

CHSAS students in focus groups were asked about career plans. Some 9th grade students already had a specific career interest that was nurtured in the CHSAS learning environment. For example, one 9th grade student shared that she was already interested in becoming a veterinarian, which was why she wanted to attend CHSAS:

I wanted to come here. I wanted to come here because it had a lot of opportunities for animal science. I always wanted to be a veterinarian, and it will let me know what is going on before college. Now I am going to Cal Poly [for a summer program] and I was able to go to FFA nationals this year too.

Another 9th grade student indicated that her father grew up on a farm and reported that her parents recognized the opportunities afforded by CHSAS, specifically opportunities to participate in the FFA and summer research or work experiences:

My parents really like it and there are a lot of opportunities for FFA, and U of I and Kraft apprenticeships. I am now an FFA officer, and I am going to the research program at U of I in the summer.

In the science teacher focus group, one of the teachers commented on the entry-level learning associated with agriculture and the impact it had on development of career interest:

At the 8th grade level students have a narrow view of what the agricultural sciences are all about. Some think of the farming aspect, the animals, and all that. Upon gaining admissions students do get involved in the agricultural sciences. Become more interested in agricultural careers. This is a small school, the culture is good here. The student may not have a lot of background in agricultural sciences, but once they come here they understand what agricultural science is all about.

11th grade students in a focus group provided more examples of agriculture-related career aspirations and seemed quite knowledgeable of college programs related to agriculture. When

asked about college plans, two students identified Agricultural Business as a major, one identified a combination of science and business, and another, Urban Agriculture, a program at University of Illinois. They mentioned Florida Agriculture, Iowa State, and University of Illinois programs they were interested in applying to. One student shared the following perspective that suggested CHSAS had a strong program to help students make informed decisions on choice of career and college:

This school has a good relationship with several schools that have ag programs. There's a real need for non-traditional urban agriculturalists. Iowa State, U of I, and Florida Ag offered scholarships to four students in each pathway. [They have] classes heavy in business and ag.

A number of students linked attending university summer programs with their college plans, including the research apprenticeship program at University of Illinois, a similar program at Iowa State, and a summer program at California Polytechnic University. This suggests that the opportunity to attend a summer program at a university impacted students' college-going plans. Some of these CHSAS students indicated that they were able to take advantage of these opportunities more than once, either at the same university, such as University of Illinois, or at different universities.

Not all CHSAS students were college-bound, but CHSAS had a strong college preparatory program and support for college and career decision-making, including college visits to explore different academic programs and a colloquium to support students in developing a career portfolio. One of the 9th grade students described:

When you get into honors, we have a college readiness standard—not just senior year but also in junior year—and we have AP classes. Through these classes we can get prepared for college. An Ag [high} school doesn't always prepare you to go to college; some of the Ag tech people learn to work on cars and they are going right into a job. There are a lot of opportunities to push the students to go to college—colleges are always visiting the pathways. There are no reasons students couldn't attend college. We have class colloquium, and we have stuff that we are focusing on from the tests. We have a career portfolio, and it is graded. Everyone at the school has one from freshman year on. It could be like a college portfolio—all of your scores and awards and things form the year. It is really good as a senior. It has everything in there that you need to show what you have done. We have already written our resumes. It [the career portfolio] is a binder. We have an easy record as a research artifact, and we have science fair in it. If anyone wants a record of our science fair it is online.

Besides the strong partnerships with land-grant universities with agricultural programs, CHSAS had strong partnerships with industries as well, as described in the section on Partnerships (CC 5). As already noted, pathways teachers had prior professional experience in their particular area of agricultural science and could and did reach out to contacts in industry and Institutes of Higher Education to help connect their students to internships and to solicit their participation in Career Day events. They also arranged field trips to industry facilities. In the focus group with teachers of agriculture, one of the teachers described how CHSAS elicited agriculture industry interest and involvement:

Our students are unique, so industry experts are a little more interested. People [from agricultural businesses] *come and visit and then they want to get involved. It's different to take "food science" kids to Kraft versus chemistry kids in general. A lot of it has to do with getting the kids prepped and ready. They have a leg up over other science kids.*

Besides the teacher outreach activities, CHSAS had dozens of Chicago area agricultural businesses and colleges that were involved through the school's Business Advisory Council. This provided a solid base for industry and college opportunities for work and research internships, and opportunities for students to find out more about potential careers during the many career day events held at CHSAS. Also, new businesses continued to reach out to CHSAS because of their interest in the students at this unique school. In response to a question about whether business partners had expectations that CHSAS students would go work there when they graduated, the Principal described one example of a business working together with a university to develop a pipeline for agricultural science professionals:

You know what? They [business partners] *may have some hopes. We just met with Cargil who was out here about a month ago. We met them through Cal Poly as a matter of fact. They do two billion dollars of business with just McDonald's. They came out and they spent the day. They went to all of the different pathways and talked to the students. What they're trying to do is set up a situation with Cal Poly where a couple of students maybe would get sponsored by them for tuition to Cal Poly in the hopes they would go back and work with Cargil. That's a great thing, so you know, if you get the right kids at the right time and that's a good opportunity for them, it might be something they would look into. So, I'm sure there are hopes, and we've sent kids to work at Kraft Foods and Quaker Oats, and we've got a couple of former students who teach down at U of I. Some of them will end up at the partners.*

In summary, CHSAS students were uniquely prepared for college majors and careers in agricultural science and business fields. This positioned them for opportunities to explore career and college major options through internships with universities with agricultural science and business programs to extend the real-world experiential learning they engaged in during their high school coursework. Agricultural businesses and colleges or universities had high levels of interest in CHSAS students and partnered with CHSAS on summer internships or research programs, as well as offering Career Day events at CHSAS. Not all CHSAS students would decide to pursue a college major related to agriculture, but all students benefited from the academic support for learning rigorous science content through real-world experiential learning and applied science coursework in their pathways.

3.11.2 Parent and Community Involvement

The school put a high degree of emphasis on parental and community involvement. To support parent involvement, the school's website was maintained continuously with the goal of keeping parents informed of school happenings. For example, one parent recounted in a focus group that her son won an award but didn't tell her about it, and she learned about it in her daily check of the web site. Parents also spoke in the focus group about keeping an eye on the 24-hour webcam the school set up to monitor the progress of a pregnant horse in the school's care. Parents spoke frequently about feeling connected to the school, included, and respected. Many parents were

actively involved in school events and projects. In general, parents seemed to be enormously grateful for the school's effects on their children, and the school administration seemed equally grateful for the active involvement of parents.

The school could not be separated from the community, which could be conceptualized at several levels: local, city, state, and national. At the most local level, the school was partially defined by its neighborhood and the fact that it was both "the last farm in Chicago" and "one of the safest schools in Chicago." The school was old, relatively speaking, at 28 years, and was considered a fixture of the neighborhood. The principal grew up nearby and many of the teachers were former students who returned after college. Parents of former students stayed connected to the school via the Business Advisory Council, which was co-led by one parent in particular who was exceptionally devoted to the school. The principal maintained strong connections with former administrators as well. Students interacted frequently with neighborhood residents. Students participated in the City Flower and Garden Show, interacting with and competing against the city's professionals. The summer farm stand, run by students, was another opportunity for students to interact with the local community. Programs like these served the dual purpose of giving students good exposure to the world of work, and informing the community members about the school and its goals. A CPS representative noted, "There are always activities going on here, where community is welcomed in. Go to the barn and you'll see people from community walking through constantly. They have a community day with a big fair. They are very involved with community, businesses here. The alderman is very involved."

At the city level, the school was directly affected by city policies and politics. With regard to Chicago's influence, issues relating to school choice, safety, and politics were most visible. Representatives from CPS described their challenge in creating and supporting schools of choice: "There is that push for school of choice. That's why we start seeing thematic schools, IB or health or college prep. I don't know at what point it becomes watered down. Unless you have 100% choice, at some point some schools will get the leftovers who don't get their choices, b/c all the choice schools fill up, and I hate that term, but that's how it is. There's one low income neighborhood whose kids who couldn't get into their schools of choice had to go to a default school, and that school becomes very low performing. It's a huge dilemma. I don't know if we can go to 100% choice or not. There's a lot of charter schools in Chicago, our high school population has dwindled from 150,000 to 95,000 and going down because they're going to the charters."

And at the state and national level, the school was intimately connected to colleges of agriculture, and agricultural industry partners who interacted with individual students and teachers, and whole programs and pathways. A ninth grader noted, "there are a lot of opportunities for FFA and University of Illinois and Kraft apprenticeships."

The school was well aware of national policy issues surrounding agriculture and STEM. A community partner noted that the USDA has identified 30 critical job shortage areas in agriculture. The school worked hard to inform and prepare students for this type of career, for example by devoting time in the ag leadership class to discussing ag career preparation.

4 EXPLORING THE OUTCOMES DIMENSION

Having explored the design and implementation dimensions in the above sections, the study now examines the student outcomes produced at CHSAS. 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 CHSAS, OSPrI compiled near-term outcome data such as student demographic data, attendance indicators, student scores on state assessments, and ACT results from the Illinois State Board of Education (ISBE) database. The study also gathered information on longer-term outcomes such as high school cohort graduation rates.

4.1 INCLUSIVE DEMOGRAPHICS

Table 8 presents student demographic data from the 2012-2013 school year for CHSAS, the City of Chicago School District 299 (SD 299), and the state of Illinois. It should be noted that the demographic data for the district and state include all grades from Prekindergarten to 12th grade, so these are not fully equivalent comparisons. Nevertheless, the figures indicate that CHSAS served a diverse student body, with substantial proportions of Hispanic, African American, and White students. Notably, however, the school served a smaller proportion of Hispanic students than the surrounding district, and the percentage of Low Income students at the school was significantly lower than that of the district. CHSAS also did not enroll many Limited English Proficient students.

Table 8
2012-2013 Demographics for CHSAS, District, and State

	CHSAS	City of Chicago SD 299	State
Students Served	565	395,071	2,054,155
Grade Levels	9-12	PreK-12	PreK-12
American Indian/Alaska Native (%)	0.4	0.3	0.3
Asian (%)	0.5	3.4	4.3
Hispanic/Latino (%)	24.1	45.0	24.1
Black/African American (%)	38.9	40.5	17.6
White (%)	31.7	9.1	50.6
Native Hawaiian/Pacific Islander (%)	0.2	0.1	0.1
Two or More Races (%)	4.2	1.5	3.0
Low Income (%) *	48.8	84.9	49.9
Limited English Proficient (%)	0.5	17.0	9.5
Students with IEPs (%) **	8.3	13.3	13.6

Note. Data retrieved from Illinois State Board of Education website (http://www.isbe.state.il.us) on December 4, 2013.
* Illinois defines "Low Income" students as pupils age 3 to 17, inclusive, from families receiving public aid, living in institutions for neglected or delinquent children, being supported in foster homes with public funds, or eligible to receive free or reduced-price lunches.

** Illinois defines "Students with IEPs" as those students eligible to receive special education services.

The ISBE publishes school, district, and state-level data related to several "School Environment" indicators, including attendance rates, truancy rates, dropout rates, and mobility rates. In explaining why these particular indicators are examined, the ISBE school report card website (http://www.illinoisreportcard.com) describes a high rate of student mobility as representing "continual student turnover [that is] potentially academically and socially disruptive to both ongoing and transferring students." Similarly, ISBE states that "research shows that chronic truancy has been linked to serious delinquent activity in youth and to significant negative behavior and characteristics in adults." Table 9 presents the school, district, and state-level data on these four indicators for the 2012-2013 school year. The indicators for CHSAS compared favorably to the surrounding district outcomes, with CHSAS having a lower dropout rate, truancy rate, and mobility rate.

Table 9
2012-2013 Student Attendance Indicators for CHSAS, District, and State

	CHSAS	City of Chicago SD 299	State
High School Dropout Rate (%)	0.7	4.7	2.4
Chronic Truancy Rate (%) *	20.5	31.9	9.8
Mobility Rate (%) **	2.6	19.0	12.8
Attendance Rate (%)	93.0	92.6	94.2

Note. Data retrieved from Illinois State Board of Education website (http://www.isbe.state.il.us) on December 4, 2013.
* Illinois defines "Chronic Truancy" as the percentage of students who miss 5 percent or more of school days (9 days of an average 180-day school year) per year without a valid excuse.
** Illinois defines "Mobility Rate" as the percentage of students who transfer in or out of the school between the first school day of October and the last school day of the year, not including graduates.

4.2 STATE ASSESSMENTS

Assessment Scores: How Are CHSAS Students Achieving Academically?

The Prairie State Achievement Examination (PSAE) is the Illinois state assessment used to measure the achievement of grade 11 students relative to the Illinois Learning Standards in reading, mathematics, and science. According to the ISBE website, the administration of the PSAE takes two days, with students completing three assessment components:

1. The ACT Plus Writing college readiness assessment, which includes a set of four ACT multiple-choice tests (English, reading, mathematics, and science) and a writing prompt;
2. Two ACT WorkKeys assessments (Reading for Information and Applied Mathematics); and

3. A science assessment developed by the Illinois State Board of Education, with assistance from Illinois teachers.

On its website, ACT describes the WorkKeys assessment as "a job skills assessment system that helps employers select, hire, train, develop, and retain a high-performance workforce. This series of tests measures foundational and soft skills and offers specialized assessments to target institutional needs" (http://www.act.org). After the students complete the assessments, the ISBE then calculates the composite student PSAE scores using the formulas outlined in Table 10.

Table 10
Formulas for Determining PSAE Student Scores for each Subject

Assessment	Formula
PSAE Reading	The student's ACT Reading test score is combined with the score from the WorkKeys assessment on Reading for Information.
PSAE Mathematics	The student's ACT Mathematics test score is combined with the score on the WorkKeys assessment on Applied Mathematics.
PSAE Science	The student's ACT Science test score is combined with the score on the Illinois State Board of Education's science assessment.

Note. Information retrieved from Illinois State Board of Education website (http://www.isbe.state.il.us) on December 4, 2013.

Based on these student assessment scores, Illinois has defined four performance levels for the PSAEs. The descriptive definitions for each of the four performance levels are presented in Table 11.

Table 11
Descriptive Definitions for Performance Levels on the PSAE

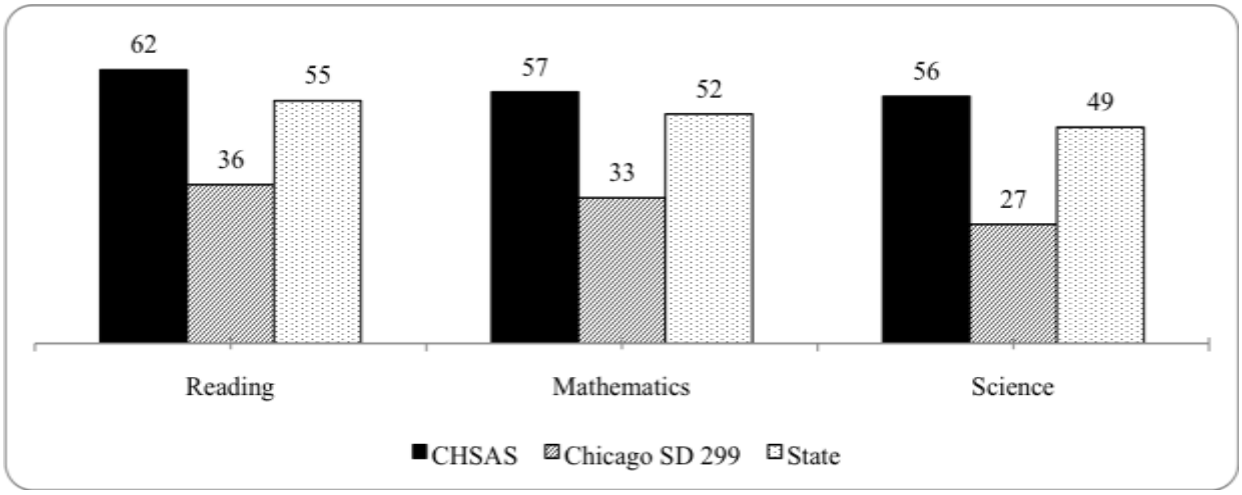
Performance Level	Description
Level 4: Exceeds Standards	Student work demonstrates advanced knowledge and skills in the subject. Students creatively apply knowledge and skills to solve problems and evaluate the results.
Level 3: Meets Standards	Student work demonstrates proficient knowledge and skills in the subject. Students effectively apply knowledge and skills to solve problems.
Level 2: Below Standards	Student work demonstrates basic knowledge and skills in the subject. However, because of gaps in learning, students apply knowledge and skills in limited ways.
Level 1: Academic Warning	Student work demonstrates limited knowledge and skills in the subject. Because of major gaps in learning, students apply knowledge and skills ineffectively.

Note. Information retrieved from Illinois State Board of Education website (http://www.isbe.state.il.us) on December 4, 2013.

Figure 1 displays the 2013 PSAE results for CHSAS, comparing them to the outcomes from the district and the state. For all three subjects, a higher percentage of students from CHSAS achieved at the "Meets Standards" or "Exceeds Standards" performance level than for the district or the state.

Figure 1

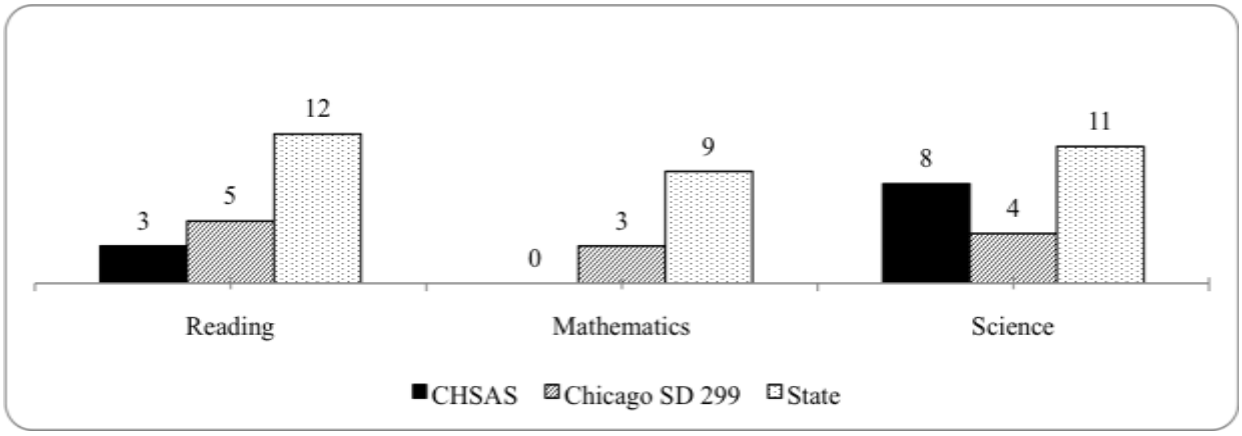
2013 PSAE Results for CHSAS, District, and State (Percent "Meets Standards" and "Exceeds Standards" for all students in grade 11)



Note. Data retrieved from Illinois State Board of Education website (http://www.illinoisreportcard.com) on December 4, 2013.

Some may argue that "academic excellence" reflects more than achieving at the "Meets Standards" level, instead defining such excellence as performing at an "Exceeds Standards" level, as defined by the ISBE. Figure 2 addresses this distinction, presenting the percentages of students achieving at the "Exceeds Standards" level on the PSAEs across the disciplines. Interestingly, the comparisons were not as favorable for CHSAS according to this benchmark; lower proportions of the school's students achieved at this level on the assessments than for the district or state, except for the science PSAE, where higher proportions of CHSAS students attained this level than the district. Interestingly, no CHSAS students achieved at the "Exceeds Standards" level for the mathematics PSAE.

Figure 2
2013 PSAE Results for CHSAS, District, and State (Percent "Exceeds Standards" for all students in grade 11)

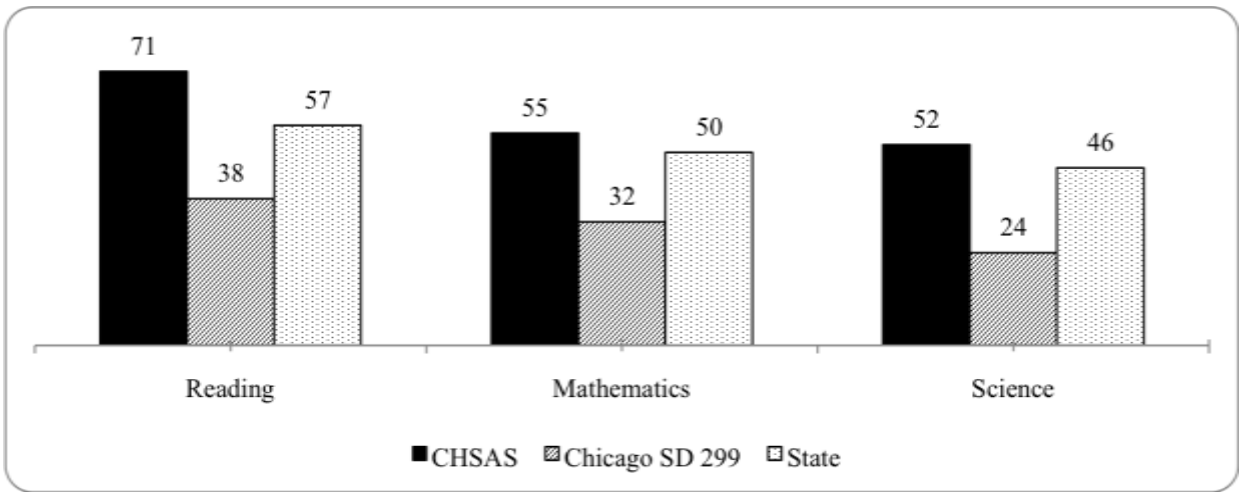


Note. Data retrieved from Illinois State Board of Education website (http://www.illinoisreportcard.com) on December 4, 2013.

Figures 3, 4, 5, 6, and 7 present PSAE outcomes disaggregated for five student groups that are traditionally underrepresented in STEM fields. These groups include: female students, African American students, Hispanic students, low-income students, and special education students. The five graphs below reveal similar patterns as described with the data for the whole student body at the school: for each of the five demographic groups, CHSAS had higher percentages of students achieve at the "Meets" or "Exceeds" standards performance level than the district and state. It is worth noting, however, that when comparing percentages across the student groups, the school, district, and state appeared to struggle more with special education students than for the other groups, as indicated by the lower percentages overall.

Figure 3

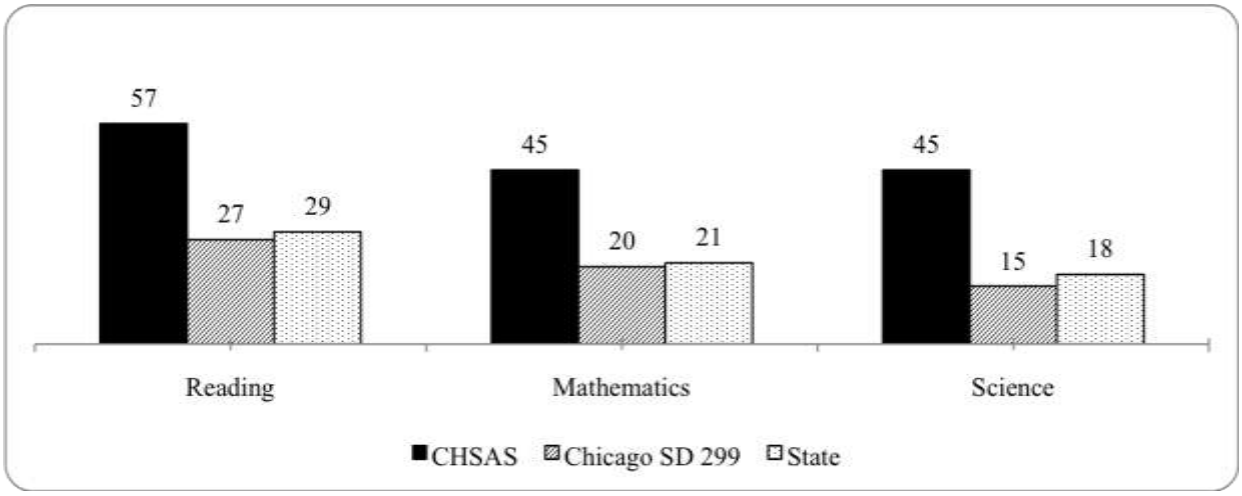
2013 PSAE Results for CHSAS, District, and State (Percent "Meets Standards" and "Exceeds Standards" for Female students in grade 11)



Note. Data retrieved from Illinois State Board of Education website (http://www.illinoisreportcard.com) on December 4, 2013.

Figure 4

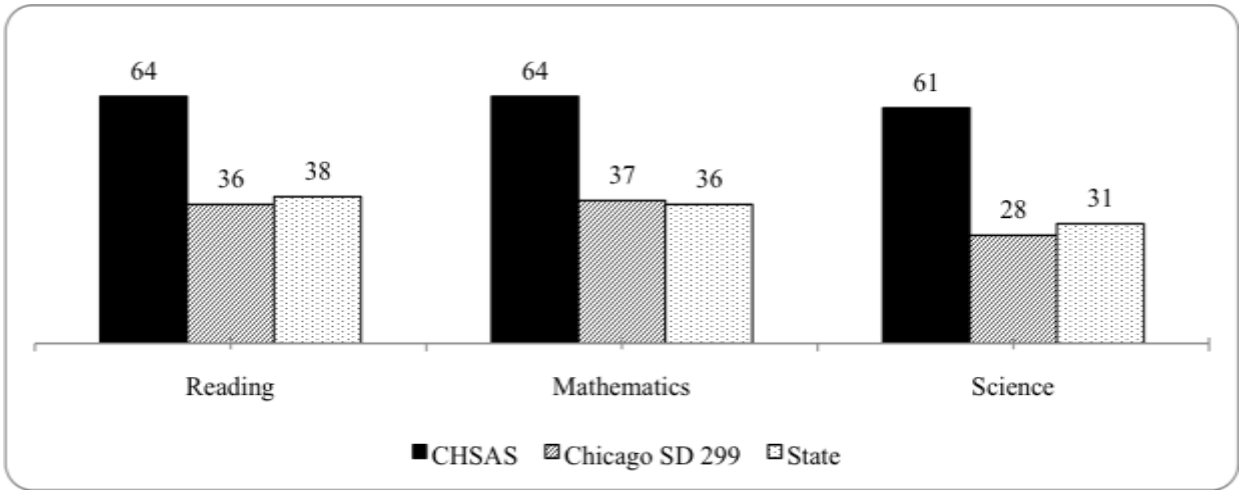
2013 PSAE Results for CHSAS, District, and State (Percent "Meets Standards" and "Exceeds Standards" for African American students in grade 11)



Note. Data retrieved from Illinois State Board of Education website (http://www.illinoisreportcard.com) on December 4, 2013.

Figure 5

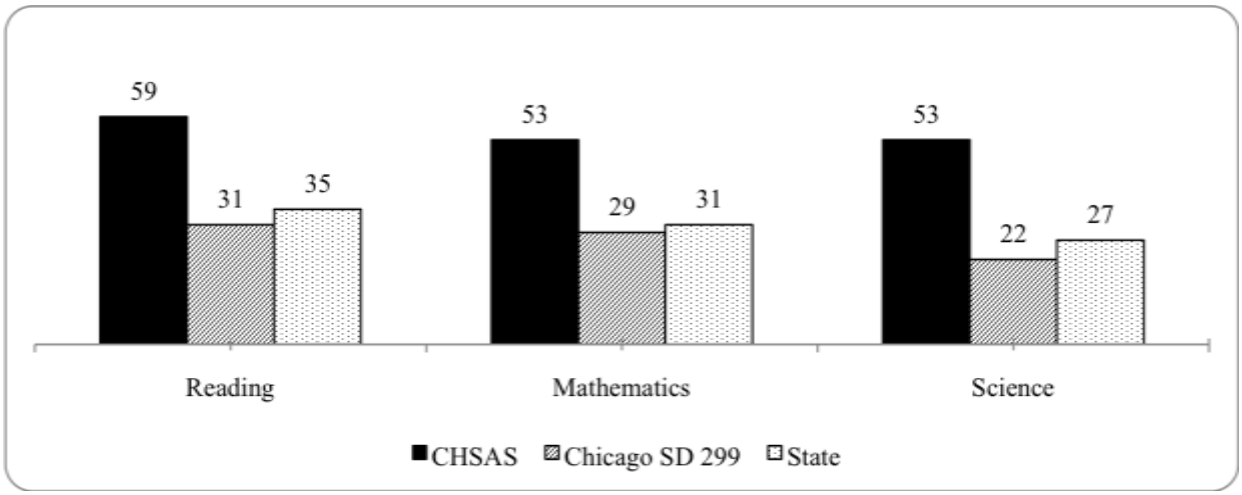
2013 PSAE Results for CHSAS, District, and State (Percent "Meets Standards" and "Exceeds Standards" for Hispanic students in grade 11)



Note. Data retrieved from Illinois State Board of Education website (http://www.illinoisreportcard.com) on December 4, 2013.

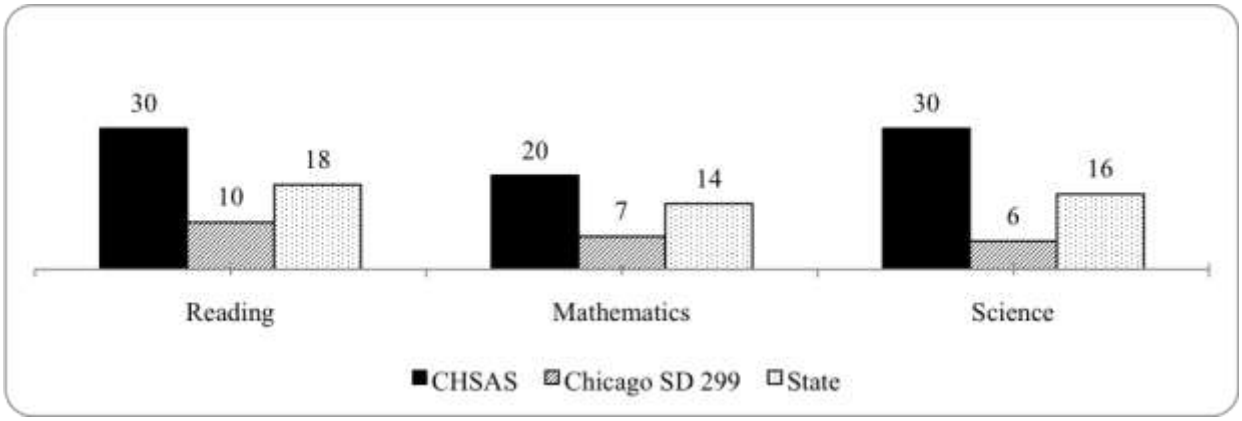
Figure 6

2013 PSAE Results for CHSAS, District, and State (Percent "Meets Standards" and "Exceeds Standards" for Low Income students in grade 11)



Note. Data retrieved from Illinois State Board of Education website (http://www.illinoisreportcard.com) on December 4, 2013.

Figure 7
2013 PSAE Results for CHSAS, District, and State (Percent "Meets Standards" and "Exceeds Standards" for Special Education students in grade 11)



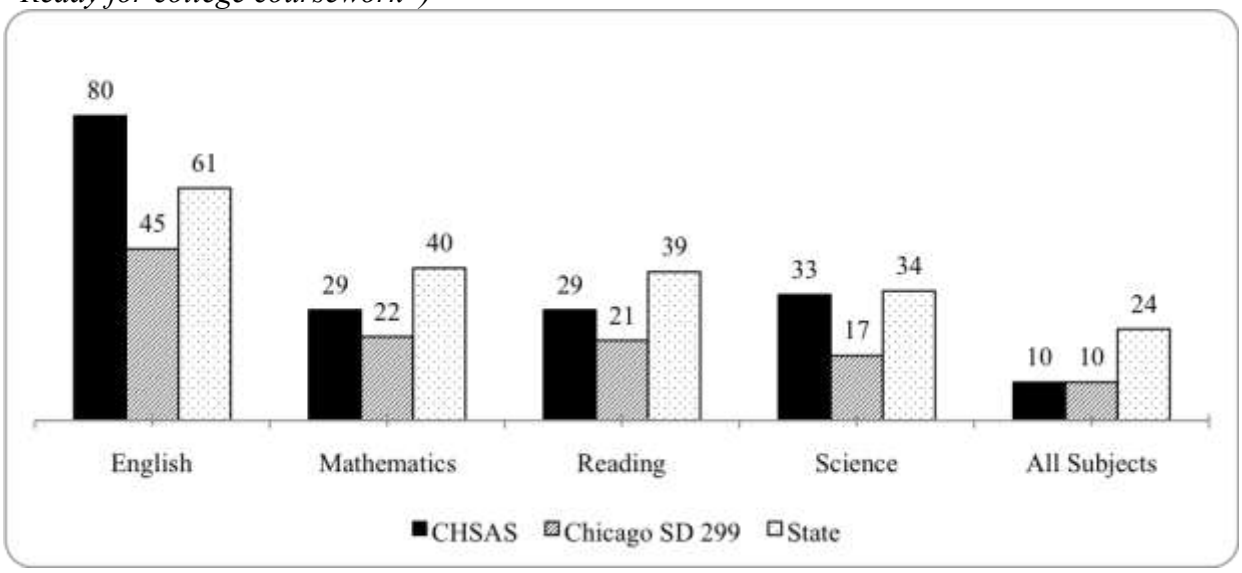
Note. Data retrieved from Illinois State Board of Education website (http://www.illinoisreportcard.com) on December 4, 2013.

4.3 ACT COLLEGE READINESS BENCHMARKS

ACT has established subject-level benchmarks that serve to measure college readiness in each individual subject; students who score above a certain cut score in a particular subject test are deemed to be "college ready" in that subject. The cut scores for the ACT College Readiness Benchmarks in each subject, as established by ACT, are: 18 for English, 22 for Mathematics, 22 for Reading, and 23 for Science. Figure 8 displays the percentages of students who met or exceeded the ACT College Readiness Benchmarks for each individual subject and also the percentages of students who met or exceeded the Benchmarks for all four subjects. While CHSAS outperformed the district and state for the English ACT benchmarks and was roughly equivalent with the state in science, the school lagged slightly behind the state in the mathematics and reading benchmarks. Additionally, CHSAS had a lower percentage of students meet the college readiness benchmarks for all four subjects than the state and only matched the district in this regard.

Figure 8

2013 ACT College Readiness Benchmark (CRB) Results for CHSAS, District, and State (Percent "Ready for college coursework")



Note. Data retrieved from Illinois State Board of Education website (http://www.illinoisreportcard.com) on December 4, 2013.

4.4 GRADUATION RATES

Table 12 compares CHSAS's four-year high school graduate rates from 2013 with those of the district and state. As an overall rate and for each of the student demographic groups represented in the table, CHSAS had higher percentages graduate in four years than the surrounding district. The school also compared favorably with the overall state rates.

Table 12
2013 Four-Year High School Graduation Rates for CHSAS, District, and State (for all students and disaggregated by available student demographic categories)

	CHSAS	City of Chicago SD 299	State
All Students (%)	86.0	69.7	83.2
Male (%)	83.3	64.7	80.3
Female (%)	88.1	74.4	86.1
White (%)	86.0	77.6	89.3
Black (%)	83.8	65.7	70.9
Hispanic (%)	87.5	71.2	76.3
Students with Disabilities (%)	77.8	59.3	70.1
Economically Disadvantaged (%)	83.9	69.2	73.0

Note. Data retrieved from Illinois State Board of Education website (http://www.isbe.state.il.us) on December 4, 2013.

4.5 SUMMARY

According to the student outcome measures considered in this case study, CHSAS generally compared favorably with their surrounding district and state. For the Illinois PSAE assessments administered to 11th graders across the state, higher proportions of CHSAS students met or exceeded standards in all three subjects of reading, mathematics, and science than for the district or the state. Additionally, when these results were disaggregated for five student groups traditionally underrepresented in STEM fields, including female, African American, Hispanic, low income, and special education students, CHSAS again had higher percentages of students who met or exceeded standards for all three subjects across all five demographic groups than the district or state.

Notably though, fewer percentages of CHSAS students attained the higher "exceeds standards" level in the PSAEs for the three subjects than for the state overall. Also, while CHSAS students outperformed or matched the state for the ACT benchmarks in English and science, the school did lag slightly behind the state in the mathematics and reading ACT benchmarks. Nevertheless, according to other student indicators, such as student attendance rates, truancy rates, and high school graduation rates, CHSAS compared favorably with the district and the state. In particular, with regard to the four-year high school graduation rates, CHSAS not only had higher overall rates than the district and the state, but also had higher rates for their female, African American, Hispanic, special education, and economically disadvantaged student groups.

It is worth emphasizing, however, that this OSPrI study is not presenting this student outcome data as causal evidence that CHSAS'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.

5 CONCLUSION

CHSAS has gained a strong national reputation over the past thirty years based on its innovative curricular structure, strong connections to industry and community partners, and immersive culture. These factors were reflected in the critical components that made up the core of this study. Of the ten components considered, seven were determined to be prominent or very prominent at CHSAS. A summary of the findings is presented below.

The most prominent components observed at CHSAS included the STEM-focused curriculum, informal learning opportunities, and real-world STEM partnerships. Through a rich variety of informal learning opportunities, CHSAS provided their students with multiple avenues for exploring career options, preparing for college, and developing both expertise in the agricultural sciences and strong leadership and networking skills. The local FFA chapter at CHSAS was a major presence and unifying experience at the school. Through their participation in FFA competitions and conventions, CHSAS students applied their agricultural knowledge and developed critical skills that prepared them for future work in the field. CHSAS also fostered a strong level of involvement by their students in the ongoing agricultural and fieldwork on the school campus through the SAEs and other responsibilities that students completed. Students also had the opportunity to participate in a rigorous college-level research program at the University of Illinois. Finally, CHSAS provided multiple opportunities for their students to directly experience a variety of career pathways in agriculture, opportunities that helped students get a true sense of the work and preparation needed to enter those fields.

The school was intimately tied to agricultural industry, and this was reflected in the nature and number of industry partners listed by the school. A large and active business advisory council served as a source of academic enrichment, funds, and career opportunity for students. The political and sometimes controversial nature of these partnerships (e.g., genetically modified foods) was discussed in classes and the school put a great deal of effort into remaining balanced and keeping a big picture mentality. Teachers maintained active ties with industry and in the case of pathways teachers, come from the industry they taught about. They drew from this experience in developing the curriculum, giving examples, and forming connections for students. Teachers worked actively with college partners to align curricula and formulate joint programs that made sense.

In addition to these components, CHSAS placed an emphasis on reform instructional practices and integrated technology use in classrooms, and a sound organizational structure that included well-prepared and qualified teachers. The instructional practices at CHSAS were carefully structured so that 9th and 10th graders mastered content knowledge and skills they would need to be successful in upper level courses. They utilized Mastery Learning, in which students needed to persist in their efforts to master the material and re-take tests until they met the benchmark of 70%. This was not to the exclusion of other instructional practices, however. There was an emphasis on integrating subject matter across the curriculum utilizing the agriculture theme to build realistic connections. There were also carefully planned projects to help students build

group work skills they would need in the pathways courses in 11th and 12th grades, and experiential learning in their survey course in 10th grade in which students rotated through the different pathways to make informed decisions of which pathway to "major in." The teachers at CHSAS were selected for their abilities, skills, and motivation to teach in an agriculturally focused high school. They were interested in being part of a team that saw the value in integrating content across the discipline with particular attention to finding and elucidating the connections with content and careers in the agriculture fields. The principal worked hard to provide teachers the time and resources to do their jobs well. Teachers found time to communicate amongst themselves and were given opportunities for professional development through the CPS school system, within CHSAS, in conjunction with University of Illinois, and beyond the school day and year. Teachers' opportunities to collaborate and to learn helped them to feel competent in the implementation of effective reform-based education.

The remaining components, including early college coursework, supports for underrepresented students, and an inclusive STEM-focused mission, received less emphasis from the school. However, that does not suggest that they were absent, only that other components received relatively more focus and attention in the school's design and implementation. Early college coursework was not emphasized in that most students did not take a large number of college or dual-credit courses while at CHSAS. However, careful articulation ensured that students would be ready for college when they arrived. CHSAS also had some academic selection criteria, meaning that students who were struggling in middle school might not have the chance to attend the school. At the same time, students were supported enormously once they arrived at CHSAS, and the school placed a large emphasis on inclusion of students with IEPs.

As a whole, the school stands as a model for agriculture education but also for STEM education more broadly. Given the critical need for career and technical education models that prepare students for college and career, schools like CHSAS will play a prominent national role in identifying models for success.

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