BLURRING K-12 BOUNDARIES:

Marlborough High School Partners with Higher Ed and Industry to Launch STEM Early College Program
ACKNOWLEDGEMENTS

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This case study is part of a new series by the Pathways to Prosperity Network. The series spotlights state and regional members who have made impressive progress toward building high-quality college and career pathways for all students. Visit http://www.jff.org/pathwaystoprosperity to stay updated about the series.

ABOUT THE AUTHOR

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PATHWAYS TO PROSPERITY

About Pathways to Prosperity

JFF's Pathways to Prosperity initiative seeks to ensure that many more young people complete high school and attain postsecondary credentials with value in the labor market. The Pathways to Prosperity Network is a collaboration of states and regions, JFF, and the Harvard Graduate School of Education. Each state and regional member is engaging cross-sector stakeholders in building a system of career pathways for students in grades 9 through 14 and beyond, combining high school and community college, that launches young people into initial careers while leaving open the prospect of further education. Learn more at www.PtoPNetwork.org.

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On a cold day in January, the Marlborough High School cafeteria crackles with excitement.

Ninth graders cluster around project tables, describing their imaginative designs for accessible playground rides. There is a motorized octopus merry-go-round, a space shuttle-themed clubhouse, and a monkey-bar maze strung among 3D-printed trees. Students tell visitors how these projects evolved through research, planning, and trial and error. They worked on the projects all semester, and today, as they present their ideas to guests from local companies at the Ninth Grade Expo, they are poised, prepared, and ready to discuss the creative decisions and teamwork that got them to the end product.

Marlborough High School enrolls just under 1,100 students from a small, industrial community in Massachusetts. Historically, Marlborough has had a relatively suburban feel, and high school graduates could count on plentiful jobs in the manufacturing and service sectors. But the labor market has changed over the past two decades, with lower-skill jobs replaced by a booming high-tech sector. At the same time, the city has experienced a significant demographic shift. Both sets of changes put a new kind of pressure on the high school. To position its increasingly high-need student population for success in a demanding new job market, district leaders knew they had to do something different.

In 2011, the district launched an integrated STEM (science, technology, engineering, and math) program in the middle and high schools with support from a federal Race to the Top grant. A few years later, in 2014, the district joined the national Pathways to Prosperity Network, an initiative of JFF and the Harvard Graduate School of Education (HGSE). With support from a multiyear federal Youth CareerConnect (YCC) grant and strategic implementation guidance from JFF’s Pathways to Prosperity team, the district expanded the emerging STEM program into college and career pathways in grades 9 through 12.

While the YCC grant focuses on grades 9 through 12, leaders in Marlborough intentionally expanded the early college STEM-focused career pathway model, with the goal of creating a seamless continuum for grades 6 through 14. The Pathways to Prosperity team encouraged leaders in Marlborough to make employers and postsecondary educators equal partners in the process of developing these pathways, from conception through implementation.

This case study provides an in-depth look at the innovative approach that partners in Marlborough have taken in designing and developing the K-12 components of college and career pathways as part of the YCC grant. In just six years, Marlborough STEM partners have successfully transformed the learning experience for over 700 young people in grades 6 through 12 with rigorous interdisciplinary projects, thoughtfully scaffolded career-focused learning, and early college coursework aligned with postsecondary programs of study. Students will graduate from high school with substantial college credit, transferable skills, and a clear sense of their career options. They will be well prepared to continue in pathways that lead to and through postsecondary education and on to careers.

The early outcomes have been impressive. STEM program participants’ reading and math proficiency rates far exceed those of their peers, as do their high school graduation and college enrollment rates. Longer-term outcomes such as college completion and employment rates are yet to be seen, but the results to date make it a model worth watching.

This case study is intended for practitioners and policy leaders seeking to understand what pathways look like within a high school so they can develop robust K-12 components of college and career pathways. It describes the core features of Marlborough’s STEM Early College program, identifying major lessons learned, trade-offs and midcourse adjustments, key roles and cost considerations, and the work that lies ahead.
Pathways to Prosperity: A National Network

The national Pathways to Prosperity Network, an initiative of JFF and the Harvard Graduate School of Education, is a learning community of 14 states and regions committed to developing college and career pathways, enabling students to transition smoothly through high school, into higher education, and on to family-supporting careers—particularly in high-demand sectors like information technology, health care, and advanced manufacturing.

Participating states and regions engage employers and educators in building systems of rigorous academic and career pathways designed to launch young people into initial careers, while leaving open the prospect of further education.

Efforts to build pathways are typically anchored in programs of study that span secondary and postsecondary education, with a focus on a specific high-demand industry and the courses and experiences needed to be prepared for employment in that field. Schools offer early and sustained career information and advising systems. Employers provide a continuum of work-based learning opportunities. Intermediaries recruit business, nonprofit, and public employers as partners.
A DISTRICT AND COMMUNITY IN TRANSITION

Ten years ago, Marlborough High School operated like any other large U.S. high school.

Students took seven classes a day, individually slotted into a complex master schedule that included general education, honors core courses, and a slew of electives in everything from health to accounting. The four-year graduation rate hovered near 82 percent; about 78 percent of Marlborough High School graduates went on to college.¹

These outcomes weren’t necessarily concerning. In the recent past, young people in Boston’s MetroWest region could access decent-paying jobs with or without a postsecondary education, but since the early 2000s, the job market has changed dramatically. A booming high-tech sector—led by large employers like Dow Chemical, Raytheon, and Hologic—began to seek entry-level employees who had completed some postsecondary education and who could think critically, manage complex technology, and collaboratively solve problems.

At the same time, Marlborough experienced a demographic shift. A growing community of immigrants brought diversity to the city. Some households also struggled financially due to the changing economy.

Today, students in Marlborough speak 29 languages at home, according to the Massachusetts Department of Elementary and Secondary Education’s District Analysis and Review Tools for English Language Learners. Nearly 36 percent are economically disadvantaged.

Marlborough High School Principal Daniel Riley explains that, for him, these simultaneous shifts created an “increased sense of responsibility to get kids on a path to the middle class.” With a growing number of students who would be first in their families to attend college or who lacked documentation necessary to access college financial aid, Riley was eager to design a high school experience that would allow students to complete some postsecondary training and gain the skills needed to obtain family-supporting jobs. A challenge is that students of color, English language learners, and students from low-income families are currently underrepresented in the STEM program. Riley and other leaders in Marlborough are proactively developing strategies, such as changing recruitment tactics and expanding enrollment, to address this issue.
Impressive Early Outcomes

Marlborough’s STEM Early College students are already outpacing their peers on several important measures of college and career readiness.

- 100% reached proficiency in English language arts in 2016, compared with 79% of peers.
- 92% achieved math proficiency in 2016, compared with 57% of peers.
- 92% of sophomores passed the Accuplacer college placement test in 2016.
- 100% of the students in the last two STEM cohorts have graduated, compared with schoolwide graduation rates of 86% in 2015 and 89% in 2016.
- 97% of the students in the STEM class of 2016 enrolled in college; 63% matriculated into postsecondary STEM pathways.

Source: Marlborough High School, 2017

A Rapidly Changing District

<table>
<thead>
<tr>
<th></th>
<th>Percentage of economically disadvantaged students</th>
<th>Percentage of students with a first language other than English</th>
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<tr>
<td>2005-06</td>
<td>26%</td>
<td>21%</td>
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<tr>
<td>2011-12</td>
<td>40%</td>
<td>31%</td>
</tr>
<tr>
<td>2017-18</td>
<td>36%</td>
<td>47%</td>
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Source: Massachusetts Department of Elementary and Secondary Education, School and District Profiles, Selected Populations Report (District), Marlborough. 2
Two years later, Marlborough joined with JFF and other partners in an application for a U.S. Department of Labor Youth CareerConnect grant to scale up innovative high school models geared toward regional labor market needs. The U.S. Department of Labor awarded JFF’s Pathways to Prosperity team a four-and-a-half-year YCC grant to scale innovative pathways. Marlborough STEM Early College High School was chosen as one of three demonstration sites in Massachusetts. (The two other sites are West Springfield High School and Brockton High School.) The YCC grant outlined six core elements of program design, including integrated academic and career-focused learning, employer engagement, individualized career and academic counseling, work-based learning and exposure to the world of work, program sustainability, and program performance and outcomes. These elements closely align with the Pathways to Prosperity Network’s core strategies (see graphic on page 2).
The grant was ambitious in scope, as were the goals of local leaders. They planned to overhaul the secondary school experience, embedding rigorous STEM curricula, career exposure, and college coursework in a nonselective program that would prepare a significant portion of the school population for a demanding labor market. The bold design was matched by a cross-sector governance structure—with school leaders, the regional workforce development board, employers, and local colleges jointly responsible for designing and managing the program.

Now entering its eighth year of operation, the program has evolved in scope and depth each year, adding more expansive employer partnerships and more ambitious dual enrollment options to its core STEM academic program.

### Marlborough STEM Early College Cross-Sector Partners

<table>
<thead>
<tr>
<th>Key Partners</th>
<th>Description</th>
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<tr>
<td>Marlborough High School</td>
<td>Marlborough High School in Marlborough, Massachusetts, launched a STEM-focused early college program to prepare students for college and careers.</td>
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<tr>
<td>Quinsigamond Community College (QCC)</td>
<td>QCC is a two-year postsecondary institution in Worcester, Massachusetts, that offers Marlborough High School students opportunities to earn college credits.</td>
</tr>
<tr>
<td>Partnerships for a Skilled Workforce (PSW)</td>
<td>PSW is a workforce development board in Marlborough, Massachusetts, that serves as an intermediary, engaging employers to offer workplace experiences for students in the Metro Southwest area of Massachusetts, including students at Marlborough High School.</td>
</tr>
<tr>
<td>Marlborough STEM Leadership Steering Committee</td>
<td>The committee, which includes representatives from Marlborough High School, QCC, and PSW, ensures alignment of curricula with industry requirements and helps build the partnerships needed to offer various career-focused learning opportunities. Local employers represented on the committee include UMass Memorial–Marlborough Hospital, Boston Scientific, Dow Chemical, Raytheon, and Geisel Software, among many others.</td>
</tr>
</tbody>
</table>
LAYING A CAREER-READY FOUNDATION (GRADES 6 THROUGH 10)

The foundation of Marlborough’s STEM model is its grade 6 through 10 curriculum, which immerses students in career-focused learning and dynamic, real-world projects.

It’s an innovative approach to teaching and learning that has been shaped in close collaboration with Partnerships for a Skilled Workforce (PSW), JFF, and a dedicated group of local employers.

Integrating Career and Academic Learning

Students can join the STEM program at the end of fifth grade or at the start of high school. Seats are awarded by lottery, with priority given to those from underrepresented populations (e.g., students of color, English language learners, and members of economically disadvantaged families). The program is designed to engage students in collaborative, complex learning that helps them develop skills associated with postsecondary success and needed in the 21st-century workplace. Students have frequent opportunities to interact with STEM professionals and to reflect regularly on their learning experiences and interests, and then use that information to identify their career interests and select a more specialized pathway for grades 11 and 12.

STEM Early College: At a Glance

Marlborough’s STEM Early College program demonstrates best practices in college and career learning, including these notable features:

- STEM-specific small learning communities (grades 6 through 10)
- Cross-disciplinary project-based learning (grades 6 through 10)
- Honors-level core curricula (grades 9 through 10)
- Industry-aligned college courses (grades 11 through 12)
- Carefully staged career exposure activities (grades 9 through 10)
- Internships and work-based projects (grades 11 through 12)
- Individual development plans to guide progress (grades 9 through 12)
The program is both deeply practical and engaging. Explaining the difference between the STEM curriculum and a typical high school course of study, ninth grader Tess le Duc says, “They just learn the basics, but we’re learning how you can change the world.”

When asked about their projects or their future plans, STEM students speak with a degree of self-awareness, specificity, and enthusiasm not typical for their age, and Principal Riley says that is one of the goals of the program. “We want to create passion that stays with them,” he explains. Former PSW Director of Youth Careers Kelley French echoes that sentiment: “If we can go in there and teach them about these careers, instead of just the academics, that excitement might allow them to get through a class that’s more difficult than they expected because they want to be a scientist or they want to be a chemist,” she says. “It’s the inspiration of what they’re seeing out in real life: what it really means to have a career, what it really means to love what you want to do.”

What is perhaps most striking is how widespread the STEM culture is. While most of Marlborough’s STEM students enter the program in middle school, about 20 percent enter in ninth grade. “We see some pretty instant results in a change in behavior,” Riley says. “There’s more self-efficacy. They just have a stronger vision for themselves and why all of this is important.”

What exactly has the Marlborough team put in place to generate this transformation? Students and staff point to five core features of the design of the high school’s STEM program. Feature 1: Small Learning Communities Marlborough faculty members attribute a large part of their students’ success to the support the students receive in small learning communities. The high school STEM program serves 75 to 80 students per grade level. Students in grades 9 and 10 are assigned to a team of five teachers (English, math, science, history, and engineering) and take their four core classes and the engineering elective within that small learning community. On most days, they follow the school’s regular bell schedule, mixing with the rest of the school population during lunch and an additional elective.

The STEM teachers meet daily, with common planning time counting as one of two official contractual duties. They use the time to plan project-based learning days, complementary lessons, and support for students who need it. “A lot of kids are coming into the program at different maturity and ability levels,” says science teacher Stephanie Gill. “The interventions that are required to keep them functioning at a level where they can do projects and complete their content is heavy sometimes. That wouldn’t be possible if we didn’t have the time together.”

The strong relationships that staff members and students form with one another help prevent students from disengaging or falling behind. Gill says she thinks those relationships help foster a sense of confidence and efficacy among the students. “Ninth and 10th grades are really a big adjustment,” she explains. “You get dumped in ninth grade with kids who maybe weren’t in your middle school team, and now you have to partner with them and do a presentation in front of 20 people you don’t know—all of those things are really stressful. The STEM kids have been through it. They know their peers. There is way less anxiety.”

Feature 2: Project-Based Learning Twice a semester, the schoolwide schedule breaks for an extended learning day. Non-STEM students spend the time on field trips and in study halls. For those in the STEM program, the time is dedicated to project-based learning that is designed to simulate the workplace by exposing students to real-world issues and professional roles. STEM teachers create additional opportunities for project-based learning by freeing up their own class periods roughly twice a month. On those additional “PBL days,” they remove the walls between their classrooms, allowing students to rotate based on where they are in their projects and what sort of support they need. In total, STEM students spend about 10 percent of their core academic time working on interdisciplinary projects. Each semester, high school students are assigned a major project. (In middle school, students take...
Students work in small teams to devise a unique solution to a complex, multistage problem, such as an energy-efficient system for a tourist destination or a playground experience that is engaging and accessible for kids with disabilities. Students find these hands-on projects both fun and meaningful. They are further motivated by the freedom they have to think creatively and by the ownership they have over their projects.

Teachers serve primarily as facilitators and resources. They introduce students to each phase of the project and specific requirements (such as keeping a design journal) and then students are responsible for divvying up roles (e.g., chief executive, chief financial officer, and marketing director) and determining how to use their time.

This requires teachers to engage in a fair bit of planning as they lay out the project steps; it also requires them to have a lot of trust in what ninth grade math teacher Heather Kohn calls “organized chaos.”

On any given day, students may be investigating topics online, using the robotics lab to build a component, testing a model, or getting feedback from industry professionals. Because team members’ schedules vary, they may not all be in the same room at the same time, so they have to communicate and make plans with one another—just as they would in a real-life work environment. They receive grades as a team and for their individual contributions.

Students and staff alike speak about how transformative these projects are.

“We’re learning a lot about ourselves and how we work within deadlines and within groups. We’re refining our skills so we’re prepared for college when those deadlines come,” says Miguel, a 10th grader. Adults who are pursuing careers, he adds, “really like to focus on higher thinking, [asking questions like], ‘How could you reshape this so that it changes something in the world?’ I think it’s going to be really helpful that I’ve already started changing my mindset.”

Riley notes that students who have participated in project-based learning stand out from their peers. “They think outside the box more,” he says. “They’re better at critical thinking. They’re better at being creative because they’re presented with some challenging interdisciplinary projects that require them to be just that. They’re better collaborators because they’re constantly working on teams.”

**Feature 3: Honors Curriculum**

STEM students take an all-honors curriculum regardless of their starting places. Teachers find that, with support from teachers and peers who know them well, students rise to the expectations. The curriculum that students explore in their four core classes is not necessarily different from what other honors students at Marlborough High School study. In fact, the STEM teachers typically teach one or two sections with the general school population in addition to their work with the STEM students. They use largely the same lesson plans (based on the Massachusetts Curriculum Frameworks) for both sets of students.
The primary difference between STEM honors classes and traditional honors classes is that STEM teachers often find ways to complement one another's lessons—for example, deliberately sequencing how and when students explore slope in math and velocity in physics (the same concept), or linking a history unit on ancient civilizations with a related study of mythology in English.

The STEM faculty members all volunteered for their positions, and while they didn't receive training in a common type of pedagogy for their core classes, they have learned best practices from one another and from their experiences with project-based learning. They've become better teachers as a result, often integrating mini-projects and collaborative learning into regular lessons. Math teacher Kohn says, “I couldn't imagine teaching a different way at this point. It all feels so natural. If you took this away from me, I'd say, ‘What am I going to do with all this time?’”

The teachers notice that they are able to push their STEM students to think harder—and more independently—than they can with traditional honors students. “The STEM students are able to work in groups and work through things,” says physics teacher Scott Brown. “With the non-STEM students, you tell them, ‘Go,’ and they're lost. They don't know what to do in a group. They're always asking after every little step they do: ‘Is this right? Is this right?’ The STEM students are just able to get into a group and work through things without a lot of input from teachers.”

Riley says he is proud of the transformation he sees in STEM students. “Outside of STEM, if you're in an honors environment, you have to be a very driven student who will go home and do all your math problems without a lot of prodding,” he says. Typically, about 20 to 25 percent of Marlborough students fit that description, but the STEM program turns middle-tier students into high achievers. Entering ninth grade, about 75 percent of STEM students are at a level that would place them in the school’s “college prep” course sequence, which is less academically demanding than honors. When they finish, the percentage has flipped, with almost 80 percent entering honors or AP-level classes in 11th grade.

Feature 4: Career Exploration and Exposure

STEM students have opportunities to interact with local employers and to become deeply familiar with
career opportunities related to their interests. Career exploration activities vary, ranging from employers providing feedback on student projects to mentoring youth during the school day and sharing their career experiences during panel discussions. These activities prepare students for work-based learning, which JFF defines as programs that help students develop skills, knowledge, and readiness for work through meaningful job tasks in the workplace that support entry or advancement in a particular career field. Career exploration and exposure activities are rolled out in stages: by the time they graduate, STEM students are approaching their next steps with a clear sense of where they are headed and why.

In ninth grade, the activities focus on careers and self-awareness. Students take interest and aptitude surveys at the start of the year, and each term they explore a different high-growth sector (computer science/information technology, engineering/advanced manufacturing, and health/biotechnology) by selecting from a trove of online videos that introduce them to opportunities in each field. After viewing each video, students write a personal reflection, evaluating their level of interest and noting other relevant pieces of information, such as the skills required and typical salaries for various roles. These reflections count toward their project-based learning grades (see appendix B for an example).

Ninth graders also have opportunities to interact with local employers who come to the school to participate in panel discussions and to meet with students on project-based learning days. Freshmen visit local companies, too. Site visits typically involve a company tour, a lunch conversation with staff, and a hands-on demonstration or problem-solving activity. “It was the best field trip I’ve ever had. It was so interesting to see how they make everything, like chips and processors. I learned a lot, and I would love another chance to go. Working at Dow is what I want to do someday,” says ninth grader Igor after a visit to Dow Chemical. By the end of ninth grade, students are ready to select an industry that they would like to investigate further.

In 10th grade, the focus shifts to career mentoring, which allows students to explore careers of interest in more depth while building transferable workplace skills. Through a series of one-on-one and small-group interactions, students have extended conversations with professionals in which they practice employability skills, such as listening and speaking clearly, that they'll need in any career. Mentors typically visit on project-based learning days, circulating among students to offer feedback on design problems, answer technical questions, and have conversations about employability skills they use every day—for example, managing friction in groups.

During the first one-on-one mentoring session, the mentors introduce the topic of employability skills. In the second session, mentors explain their careers and talk about their employers, sharing the aspects of their work that they find most inspiring and satisfying; students then have time to ask questions. During the third mentoring visit, students

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deliver their own elevator pitches—describing their work interests and goals to their mentors—and then receive feedback. The fourth mentoring visit is organized as a mock interview. Through these structured conversations, students practice crucial social and networking skills, while seeing how the skills apply to the work of a real professional.

By the end of 10th grade, STEM students are ready to apply for summer internships, participate in job shadows, and engage in informational interviews. While they may select a different industry area from those of their mentors for their 11th grade career pathway, they approach their next steps with much greater understanding of themselves, their possible interests, and how to interact in a workplace.

STEM Career Specialist Laura Bilazarian Purutyan sees an immediate impact from these different interactions. She recalled a time when students had designed an outdoor classroom and a guest employer posed a helpful question about weather. The students adjusted their design before the final presentation based on that feedback. “Talking to someone who does this for a career helped them ask better questions,” Purutyan says, “and they realized talking about work can really be fun.”

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- Laura Bilazarian Purutyan, STEM Career Specialist

In ninth grade, the assignments include quizzes, aptitude tests, learning preference surveys, and reflections on what the students are learning about different industries. In 10th grade, students use Naviance to create resumes, career vision statements, and visual portfolios that become tools they can use in conversations with potential employers. Students continue to use their IDPs in grades 11 and 12 as they select early college pathways, determine which dual enrollment courses they will take, plan for and reflect on work-based experiences, and make decisions about college.

The IDP becomes a sharable collection of data that drives conversations with guidance counselors and families about course selection, internship applications, and postsecondary school plans.

The IDP changes counseling conversations from a simple review of courses to a “student-driven, dynamic process,” says STEM Counselor Elizabeth Kennedy DeHoratius.

By empowering students to make big-picture decisions and consider their interests holistically, the IDP positions them to set goals that they are passionate about and that they will persevere to achieve.

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Feature 5: Individual Development Plan

The final feature weaves the STEM experiences together, helping students take control of their own trajectories. At the start of ninth grade, students create individual development plans (IDPs) in Naviance, a college and career readiness software program that helps students reflect, explore interests, and set future goals. Ninth graders meet with the STEM counselor and career specialist during a series of lunch sessions in which they become familiar with the purpose of the IDP and discuss mini-assignments that will fold into their project-based learning grades.

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<th>Course Title</th>
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<tr>
<td>Honors Freshman English</td>
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<td>Honors World History 2</td>
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<td>Honors Algebra 1</td>
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<td>World/Classical Language</td>
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<tr>
<td>Art Foundation (STEAM)</td>
<td>Half Year</td>
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<tr>
<td>STEM Project 9</td>
<td>Full Year - Meets once per cycle</td>
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Source: Marlborough High School
STEM EARLY COLLEGE PATHWAYS

(Grades 11 Through 12)

Beginning in 11th grade, Marlborough students can elect into one of six early college pathways through which they may accumulate 12 or more college credits toward a degree in a designated field.

Developing Degree-Specific Course Trajectories

College credits are granted by Quinsigamond Community College (QCC), the school’s primary postsecondary partner. Currently, 95 students are dually enrolled in pathway courses. Most are students who participated in the STEM program in grades 9 and 10, but the STEM pathways are open to all students who elect in and pass the Accuplacer test, which the Massachusetts public college system uses to determine readiness for credit-bearing coursework. (Students can take a summer bridge course if they need additional support to meet the Accuplacer cutoff.) Recently, Marlborough High School and QCC jointly created a high school math class that qualifies students—if they pass—to enroll in a college-level math course without needing to take Accuplacer.

Marlborough’s approach to dual enrollment has evolved significantly since the early college pathways were first established in 2014. The design has become both more elaborate—to serve a range of needs and postsecondary aspirations—and more sustainable. Four design features are particularly noteworthy.

Feature 1: College Courses Taught at the High School

Pathways students take college-credit-bearing courses at the high school from teachers who have earned adjunct faculty status at QCC. The classes take place during the school day and can be taken as part of a regular course load. There is a two-week break in the winter to align the courses with 15-week college semesters.

Initially, pathways students dually enrolled in courses at a local four-year institution, but the per-pupil cost wasn’t sustainable. Riley and his team then tried hosting visiting lecturers on the high school campus, but those classes didn’t sync with the rest of the schedule. They then tried offering online courses, but that option was a tough sell for students who had other commitments at home and work and had trouble meeting online deadlines on top of a full day of high school classes.

In the fall of 2016, the school launched a new model, with high school teachers—who are also adjunct faculty at the college—teaching the courses. So far, the results are strong: 94 percent of students enrolled in college classes in the first semester progressed to the second semester.

Existing Marlborough faculty had to apply to teach the college courses and submit their resumes and transcripts (indicating a subject-area master’s degree) in order to be eligible. The college classes are part of their regular high school course load and are assigned like any other class. The early college teachers are not embedded in the STEM program or a small learning community. They receive support directly from the college faculty and staff, including on-campus training in using Blackboard technology, the faculty portal, and an early alert system for students. (Teachers receive a stipend for the training time, which goes beyond their contractually required professional development as high school teachers.) The college supplies each teacher with a syllabus and a mentor to answer questions.
The first year involved a lot of work, as the early college teachers fleshed out sometimes skeletal syllabi with supplemental materials to help students fill in background knowledge and lessons. Teachers also designed group work to keep students engaged.

It’s a much heavier load for students, too. Karen Bento, who teaches College Composition 1 and 2, covers far more territory than she does with her other 11th graders and assigns more reading and multiple papers. Students meet for the same number of hours as they would on a college campus (that was part of the agreement with the college).

For the most part, students have stepped up to the challenge. (Only three of the 75 students enrolled in English Composition 1 had to withdraw; the remaining students passed and moved on to Composition 2.) “I think most students aren’t aware of their own capabilities and that they can really succeed in a college class,” Bento says. “A lot of students in my class said they worked really hard and they weren’t sure if they’d be able to do it, but then they had a sense of accomplishment and pride that they were able to take a college class while they were still in high school.”

Information technology teacher Sharon Mattingly agrees. “I think it builds hope,” she says. “It’s so wonderful for them to say, ‘I have a college course in my pocket. I did it.’ We have so many who may not be able to afford college. It’s just a wonderful opportunity.”

Feature 2: A Cost-Effective Structure

Students can take up to two college courses per semester as part of a seven-class schedule. They are assigned to college courses as they would be to an AP or honors course and according to the same staffing formula. They are not grouped into a small learning community at this stage, but mix with the general student population.

Aside from fees paid to the college and stipends for faculty training, the courses cost the same as any other high school class. Using high school faculty eliminates the primary cost for the college, allowing it to discount its per-credit fee. Marlborough High School pays $450 per student for a three-credit course, compared with a typical course cost of $900 to $1,000. (Course fees are covered through the YCC grant.) Through ongoing conversations, Marlborough has helped QCC develop a fee structure with further discounted fees of $100 per student for a three-credit course taught at a high school. That is the rate the college has begun to roll out with other schools in the region. When Marlborough’s YCC grant expires, the school will shift to that reduced fee structure.

Feature 3: Differentiated Pathways

The ultimate goal is for all students to be on pathways to college completion by the time they finish high school. Students will have different career interests, with some better aligned to a two-year degree, and others to a four-year degree. Some students may choose to go directly into the workforce, particularly those who, due to their
The Evolution of the Dual Enrollment Plan

**Visiting Lecturer (2013-2015)**
- Taught by college faculty at high school
- Offered twice a week for 15 weeks
- 100% completion rate

**Downsides:**
- Too much downtime for students
- Schedule challenge: course occupied 2 periods per day
- Students need a full year of English to meet graduation requirements
- Cost

**Online Course (Spring and Fall 2015)**
- Offered through Blackboard
- Variety of offerings in foundational academic and CTE areas

**Downsides:**
- Course work added onto a full high school schedule
- 50% completion rate

**Adjunct Model (Fall 2016 to Present)**
- Some courses taught by approved teachers
- Training program for selected high school faculty
- Courses offered on a 15-week college calendar, every school day

- Variety of offerings in academic and CTE areas
- Pathways linked to MassTransfer/associate’s degree programs
- Reduced tuition cost
documentation status, cannot qualify for many types of college financial aid. The staff considered all of these students when designing pathways.

The school has taken four industry clusters—engineering, computer science, biotechnology, and information technology—and developed pathways within each that serve varied goals. A student who is aiming for a four-year degree in computer science—to become a coder or programmer, for instance—can get a jump start by taking up to 12 foundational credits. Meanwhile, a student who wants to go directly into a well-paying job in the computer industry can complete an associate’s degree in information technology during high school. (This pathway includes summer coursework and a split day on the college campus in grades 11 and 12.) A student who wants to join the workforce immediately after graduating from high school also has an option to earn college credits that culminate with an industry-recognized certificate such as a CNC Technologies Certificate (24 credits), a help desk technician certificate (17 credits), or an emergency medical technician certificate (23 credits).

All college courses are part of the Massachusetts Transfer Block, which allows seamless transfer from a two-year school to a four-year state college. A student who starts a biotech program in high school could go to QCC to complete a two-year biotech program and then transfer to a public four-year

Sample Pathway: 2018 Associate’s Degree in Computer Systems Engineering Technology—Computer Support Option

<table>
<thead>
<tr>
<th>Summer 1</th>
<th>11th Grade</th>
<th>Summer 2</th>
<th>12th Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intro to Microcomputer Applications (online)</td>
<td>Composition I (fall)</td>
<td>Advanced Microcomputer Applications (online)</td>
<td>Introductory Sociology—Principles</td>
</tr>
<tr>
<td>IT Help Desk Concepts (online)</td>
<td>Composition II (spring)</td>
<td></td>
<td>Introduction to Psychology</td>
</tr>
<tr>
<td></td>
<td>College Algebra (fall)</td>
<td></td>
<td>Speech Communication Skills</td>
</tr>
<tr>
<td></td>
<td>Introduction to Programming With C++ (spring)</td>
<td></td>
<td>Technical and Workplace Writing</td>
</tr>
<tr>
<td></td>
<td>Mobile Operating Systems</td>
<td></td>
<td>IT Security Foundations</td>
</tr>
<tr>
<td></td>
<td>Windows Client Operating Systems</td>
<td></td>
<td>Computer Hardware and Support</td>
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<tr>
<td></td>
<td>Networking Technologies</td>
<td></td>
<td>Windows Server Operating Systems</td>
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<td></td>
<td>Internetworking Principals and Protocols</td>
<td></td>
<td>Unix Operating Systems</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Cooperative Work Experience and Seminar</td>
</tr>
</tbody>
</table>
No matter which pathway students choose, they will have completed enough foundational courses to reduce the total cost and the time required for a college degree. Students who don’t enroll in college immediately after high school will have options available should they decide to return to school at a later point in their careers.

**Feature 4: Carefully Selected Courses**

The scope and sequence for each pathway have been carefully crafted, with an emphasis on foundational courses, like English composition and college math, that can count toward core high school graduation requirements, and that students will need to move into advanced coursework. The staff have backward-mapped each pathway, making accommodations where needed. For example, a yearlong version of college math ensures that students who need extra support are ready for college calculus, the starting point for most STEM degrees and one that can be an obstacle for many students. Marlborough graduates will have overcome crucial hurdles before finishing high school.

Where possible, Riley and the team have integrated industry-specific courses, but some courses—like college-level engineering—are simply not realistic because of the equipment or staffing requirements. “We’re at the phase of early college where we’re parsing out what’s appropriate to do in high school and what needs to lead to something more in college,” Riley says.

Sometimes a particular pathway is just too steep to compress into four years. For example, offering students an opportunity to earn an associate’s degree in computer science would require more math than can fit in four years of high school. Instead, the computer science pathway provides a solid foundation in core coursework that will give students momentum toward a degree.

Pathways students are encouraged to supplement college courses with AP courses and other electives that are relevant to their career interests, and those options are delineated for each pathway as well.

**Feature 5: Career Exploration and Work-Based Learning Experiences**

Building off of the career exploration and exposure activities offered in grades 6 through 10, early college pathway students participate in additional learning experiences that deepen their knowledge of their selected fields. This piece of the STEM Early College program is in an earlier stage of development.

The high school’s STEM career specialist, Purutyan, matches students and employers. She also works closely with local employers to shape experiences that add value for both students and the company or organization.

Work-based learning may take the form of paid internships. (Some industries, such as health care, restrict the term “internship” to formal graduate-level roles; in those cases, the school uses the preferred terminology of the employer.) Other
work-based learning experiences are shorter-term—a two-week job shadow experience or a one-week project based at a work site. All of the programs give students a meaningful perspective about what it is like to work in a particular field while providing them with resume-building experience. In the summer of 2017, 30 students participated in internships.

It has been a challenge to get employers on board for this more intensive level of involvement. Purutyan explains that she and her colleagues at PSW are working with employers to “identify innovative ways for employers to engage.” It could be a community problem that students work on solving as a mini-project, or it could be an observational experience. Dow Chemical is one of the employers that has been leading the way: Last year, two students investigated environmental safety and crafted recommendations on how customer communication could be improved. More recently, a group of students created a STEM curriculum kit that Dow staff can use to teach chemistry to second graders.

**Bridging the High School-Postsecondary Divide**

Marlborough isn’t the first high school in Massachusetts to attempt an early college design. Others tried and faced significant obstacles, and for Marlborough, the postsecondary partnership was initially challenging. Early on, Marlborough High School had a dual enrollment agreement with Framingham State University, a four-year institution, but the fixed per-course cost was unsustainable for classes with smaller enrollments. That partnership shifted to a less-intensive collaboration focused on college exposure activities, while Riley and his team worked with Quinsigamond Community College to craft a new dual enrollment design.

The partnership with QCC took some negotiation. Initially, QCC was hesitant because past experiments with dual enrollment had been unsuccessful. In addition, the faculty union raised concerns about staffing for dual enrollment courses. Such tension is common across the country in dual enrollment models that rely on high school teachers to teach college courses. In recent years, postsecondary faculty have become increasingly concerned about a broader shift in faculty hiring practices and the increase in contingent faculty positions at many colleges and universities. In the case of QCC, the union issued a cease-and-desist letter to high schools seeking to offer community college courses with their own faculty, even though the faculty of two-year colleges and high schools belong to the same umbrella union—the Massachusetts Teachers Association.

Ultimately, the QCC administration decided to proceed, and Marlborough High School agreed to a detailed memorandum of understanding that would ensure that all courses met New England Association of Schools and Colleges standards for course rigor, faculty hiring and training, and supervision and evaluation.

Christina Hebert came on board as QCC’s manager of K-12 educational partnerships in 2014 and has been a central figure in the implementation of Marlborough’s early college program. As a first step, she met with all of the deans to address concerns that some had voiced about rigor and to discuss how early college courses adhere to college standards and syllabi. She has also helped the deans engage faculty as mentors.

Hebert troubleshoots with the registrar and is in frequent contact with school staff to ensure that logistics are running smoothly. She is a regular participant in the STEM Early College Leadership Committee, a group of dedicated

Marlborough High School’s. As the public two-year postsecondary option for the region, QCC is also facing new demands from local industries that need graduates prepared for complex STEM careers, and the college feels a particular responsibility to reach first-generation college students for whom community college is an important step into the middle class. Partnering with Marlborough High School to put more underrepresented youth on a path to college (including many who would likely matriculate at QCC) aligns with the college’s mission.

Ultimately, the QCC administration decided to proceed, and Marlborough High School agreed to a detailed memorandum of understanding that would ensure that all courses met New England Association of Schools and Colleges standards for course rigor, faculty hiring and training, and supervision and evaluation.
individuals that contribute to all curriculum design efforts and ensure alignment of pathways with industry credentials. At the college, she has her own advisory board, made up of representatives from different departments, to ensure that communication is flowing across the college.

The STEM counselor at the high school plays a key role. DeHoratius was originally brought on as a part-time counselor for the grades 9 and 10 STEM classes; her hours and responsibilities have increased as the early college part of the program has grown. She now coordinates the dual enrollment program with QCC, helping students select their pathways courses and serving as a link between the two institutions as they reconcile schedules and processes.

QCC’s successful partnership with Marlborough High School helped inspire broader engagement with the early college approach. In 2016, QCC’s president convened a regional institute to discuss developing a more robust and standardized early college model for central Massachusetts. Representatives of about 40 school districts attended, and a subset of those attendees have begun working on developing pathways in manufacturing, information technology, and health care. The eventual goal is to develop 15 to 20 degree pathways for the region.
Aliyah: A Student on the Move

Aliyah Nisbett is in her senior year at Marlborough High School. A Marlborough native, Aliyah joined the STEM program as a sixth grader when her mother, a nurse, learned of the opportunity. Aliyah had been a middle-of-the-road student until that point; she worked hard but didn’t always have a clear sense of purpose. Her experience in STEM has dramatically changed that.

Aliyah says her STEM experience has been “eye opening,” especially in her sophomore year. That was when she took an engineering class and had her first experience using AutoCAD, an advanced machinery design system. Her group created a retractable grabber to assist paraplegic athletes. “I was like, wow, this is something I can really feel passionate about,” Aliyah says. “This is something I can do well.” She loved how the tools allowed her to use her imagination to solve real-world problems and became excited about the prospect of a career in mechanical engineering or biotechnology.

Work-based learning experiences have deepened that interest. During the summer after sophomore year, Aliyah participated in a program at Raytheon, where she saw real engineers using the same design tools she used in her STEM classes. “We could relate because we know how to use that program,” she says.

The following summer, Aliyah and a classmate researched engineering pathways and created a website, an app, and a series of workshops designed to inspire self-awareness in their peers and to help fellow students use online tools and networking to investigate career options. Aliyah and her classmates planned to pilot the career exploration program with the Marlborough High School staff. That same summer, Aliyah served as the team leader for a project at Boston Scientific, where she and four other students designed, tested, and delivered a STEM exploration activity for 300 children for Bring your Child to Work Day. The activity they devised, called “Build a Boat,” exposed six-to-nine-year-olds to the engineering design process. It proved to be very popular.

In the fall of 2016, Aliyah got an invitation through JFF to go to North Carolina to hear President Obama speak to student leaders about the importance of education and leadership. Describing the experience as “uplifting,” Aliyah recalls that the president spoke about being a role model. “It really changed my perspective on a lot of things, like education,” she says. “Today’s generation is creating what’s going to be next.”

Aliyah is now a STEM ambassador for incoming students at the high school, paying forward what she has learned. As she looks ahead, her sights are set on four-year engineering programs; Worcester Polytechnic Institute, Stanford, Northeastern, and UCLA are among her top choices. She is hopeful about her prospects. “I feel like STEM gives you a lot of exposure to new things,” she says. “As STEM students, you already have that step ahead of other people.”
Marlborough’s STEM Early College design fits largely within existing staffing and scheduling structures while providing a markedly different experience for students.

The biggest departure from how traditional high schools operate is in the roles played by community partners. Several of these entities and individuals have been core to the design, oversight, and day-to-day implementation of STEM learning.

**Workforce Intermediary Partner**

Partnerships for a Skilled Workforce, the regional workforce development board, has been deeply involved in developing the STEM program from almost the beginning. PSW’s engagement as a core partner began shortly after the arrival of Race to the Top funds, and the workforce board played a key role in developing the YCC proposal that has fueled the program’s growth. PSW brings important staff capacity and expertise in career development practices and regional labor market needs to the table. The director of PSW’s Youth Careers Initiative and PSW’s full-time, school-based STEM coordinator have taken the lead on all employer engagement activities, and PSW consultants provide additional support in curriculum development and public communications.

**Shared Leadership**

Principal Riley and former PSW Director of Youth Careers French co-convene the STEM Leadership Steering Committee, a group of 17 individuals representing the district, higher education, and every major industry sector. The committee meets three times per year at the school to provide oversight and input on program implementation. The members have been important thought leaders, helping identify the most important workforce skills to integrate into the STEM curriculum, deepening educators’ understanding of the skill needs in each sector, and helping to engage a broad base of employers. The committee has also played a vital role in solving design challenges, using the varied areas of expertise of its members to examine each problem from every angle.

**Engaged Employers**

Currently, about 200 local employers, representing an array of companies, nonprofits, and public entities, partner with Marlborough High School. As described earlier, Marlborough offers several tiers of involvement. Career exploration activities are accessible to most employers and include panel discussions, career fairs, project feedback days, and mentoring visits during project-based learning days. At the next tier, partners host workplace visits, during which students may tour their facilities, speak with employees, and participate in hands-on activities.

In the upper tier, the most committed employers (there are currently 12) host work-based learning programs at their facilities. These include paid summer internships, multiday or multiweek projects, and job shadowing. Getting employers on board for this level of involvement has been one of the toughest challenges and has required creative planning to design programs suited to varied industries. PSW has developed an internship tool kit so companies can see what’s possible and co-design work-based learning programs that make sense for their industries.

Employers don’t sign formal memoranda of understanding with the school, but instead adhere to a set of written expectations and agree to name a contact at the company (usually a human resources or technical manager) to serve as a point person and employee liaison. Individual employees are invited to join the
the Marlborough STEM Leadership Steering Committee. In the 2014-15 school year, this committee created the STEM Speakers Bureau, a clearinghouse of individuals who volunteer to participate in panels and project fairs and serve as career mentors.

Career mentoring is an area that has been refined over time. School staffers have found that some industry visitors were so advanced in their careers that they had trouble relating back to high school. This past year, PSW recruited younger mentors and asked them to shift their focus from talking about their specific careers to the employability skills that all young people need. Personal job experiences tend to arise organically. “We've found that we have to train the employers,” says PSW STEM Career Specialist Purutyan, “because some come in thinking we want their expertise, and what we want is for them to be able to engage and excite a student, to help them find what they love so they will persevere.” Students and employers have responded well to this shift in focus.

**Linchpin Staff**

Three grant-funded roles provide critical coordination and management functions. The first is former PSW Director of Youth Careers French, who devoted 30 percent of her time to the partnership during the intensive launch and has phased down to 20 percent in the final year of the YCC grant. French played an important management role, convening the Steering Committee and working on the design and refinement of career-focused learning activities.

A second crucial role is STEM Career Specialist Purutyan, a PSW employee who is based full time at the school. Purutyan is the primary person in charge of employer outreach; she solicits and maintains contacts within local companies, finding ways to connect the partnership to their goals (for example, showing General Electric how the school can help it develop a strong pipeline of female scientists). Purutyan uses a tool kit developed by PSW to help make the case to employers and to suggest partnership activities that might suit their capacity. She then provides the training they need to interact with students.
Miguel: Open to Possibilities

Tenth grader Miguel Lopez becomes animated when he talks about his experiences in Marlborough's STEM program. He claims that he used to be shy, but after five years working on projects with peers and having extended conversations with career mentors, his old reserve has been replaced by confidence and enthusiasm.

Born and raised in Marlborough, Miguel set his sights on college and career independence early. His mother and stepfather, who never attended college, made education a top priority for their three children. When Miguel initially heard about the STEM program as a fifth grader, he was enticed by the promise of a free laptop. He and his parents quickly realized the program would open important doors. “It gives you opportunities you wouldn’t usually get,” Miguel explains. “I think it gives you an extra edge.”

One of those advantages is access to career-relevant internships, something he’s seen his older brother struggle to find without the support of the STEM program. Miguel is also excited about the opportunity to earn college credits and certification as a Level 1 programmer in robotics. He says one of the biggest advantages is project-based learning, where there is always room to “take it a step further and do something really amazing.” Projects have taught him a lot about collaboration and helped him develop skills he knows he will need in the future. “You have to know how to compromise, how to delegate tasks, how to pick roles within the group,” he explains.

Miguel originally had his sights set on a career in medicine, but after taking classes in robotics and AutoCAD, he says, “I started realizing, this is something that interests me. These areas are so flexible, and you can use them in so many different careers.” Seeing a lot of options in the rapidly changing technology field, he’s now leaning toward a four-year degree in computer science. “I want to use the skills we’re practicing now to innovate even more,” he says. “I’m still very open to a lot of things.”

Purutyan coordinates all career development activities at the school. She works with students to find internships, helps educators understand how to integrate industry information and resources into the curriculum, and teaches students, teachers, and parents about the labor market. Given the packed high school curriculum, she has to be creative with time, using lunches, project-based learning periods, and weekly career tables to supply the information and support students’ needs.

It’s a big role, and developing systems to manage the workflow has been important. For each Project Expo, for example, Purutyan schedules emails sent to judges. She has developed similar tools and schedules for other recurring tasks.

A third critical role is that of STEM Counselor DeHoratius, whose part-time position is also grant funded. DeHoratius takes the lead on individual development plans (IDPs), working closely with Purutyan to introduce students to Naviance and helping teacher teams develop assignments that help students identify their career interests. She trained older STEM students to serve as IDP ambassadors for newer students and helps students at every stage access additional supports as needed.
Spotlight: Work-Based Learning at UMass Memorial–Marlborough Hospital

UMass Memorial–Marlborough Hospital is among the most deeply committed employers participating in Marlborough High School’s STEM Early College program. As a nonprofit health care provider, the hospital has long provided community education to address health needs. It took some time to design a work-based learning structure that would serve the skill development needs of high school students without compromising patient care or privacy guidelines.

For the past two years, the hospital has hosted a small group of students for the month of July; students spend a total of 32 hours at the hospital, exploring service areas like orthopedics/sports medicine and mental and behavioral health. Students begin by gaining a bird’s-eye view of the hospital through interviews with the hospital’s senior leaders. They then take a deep dive into a particular service area, speaking to experts at all levels of care. For last year’s mental health project, they interviewed the director of the behavioral health unit, the hospital’s chief psychologist, and several social workers, case managers, and staff in the emergency department.

Kimberly Votruba-Matook, the hospital’s marketing and development coordinator, worked with two of her colleagues to coordinate the interviews, handle program logistics, and support students as they developed a community project using what they had learned. “That’s the creative piece,” Votruba-Matook says. “The ideas they come up with are just phenomenal.”

The first summer, students planned a sports injury prevention training program for all school athletes. More recently, students planned a week of activities to raise awareness and break down stigmas around mental health. They designed a “little bag of happiness” for fellow students, with everyday objects as tactile aids to help maintain a positive outlook—like a paper clip to hold things together and a penny for luck. The hospital’s chief executive officer loved the concept and admired the students’ passion, and agreed to purchase enough supplies to distribute gift bags to all 1,300 high school students and faculty members.

The program requires significant investment of time on the part of staff leaders at the hospital, but Votruba-Matook has seen a substantial payoff for all involved. “It’s been an opportunity for caregivers from all different departments and clinical units to connect with our youth and our city in a meaningful way,” she says. “They get to provide their expertise, and that then manifests in this really wonderful idea.”

Votruba-Matook, who participated in the school’s STEM Leadership Steering Committee, is hopeful that this model can be scaled to other industries and beyond the life of the current grant.
The partners benefitted from technical assistance from JFF, an organization that has over a decade of experience supporting the development of innovative early college and career-driven school designs nationally. Perhaps most important to the Marlborough success story, Marlborough High School’s Riley and PSW’s French had a clear vision that they were determined to execute, and they brought on staff who were similarly invested and willing to think outside the box to solve challenges as they cropped up.

**Addressing Design Challenges**

One of the biggest design challenges that the Marlborough team encountered has already been discussed: setting up a sustainable dual enrollment model. After several attempts, Marlborough High School and Quinsigamond Community College have identified an effective and affordable way to deliver college courses, one that meets college standards and is already informing other schools and the state. Other design challenges remain, however. Currently, school staff and partners are grappling with the following issues:

**Expanding paid internships**
Engaging employers to offer internships is a common challenge faced by college and career pathways programs. Hosting an internship program requires significant employer investment and can be daunting for employers that are new to working with high schools. While PSW has developed effective, mutually beneficial approaches with several of the most committed employer partners, only seven out of 30 eligible students secured paid experiences positions last summer. (Five out of 25 did so the summer before.) The STEM career counselor and faculty have adopted creative strategies, such as designing paid experiences that take place on the high school campus, where students complete a product for an employer or a project for the school. While this isn’t the ideal model, the partners are hesitant to ask for too much too quickly from employers and may need to build relationships over time. With support from the STEM Steering Committee, they are still considering options and opportunities.

**Dwindling interest in mentoring**
Very few 11th graders volunteered to participate in a second year of career mentoring. The STEM program leaders believe this may be a developmental issue. Students have been in highly structured small learning communities since sixth grade; 11th grade is when they have more opportunities to make choices about how they spend their time. They have a clearer understanding of their career interests and may prefer to network and find an adult mentor with whom they make a genuine connection instead of being assigned to a mentor. Staff are responding to this challenge by considering other ways to generate mentor matches, including through work experiences.

**Dual enrollment recruitment and retention**
While student interest remains high in grades 6 through 10, the district has faced participation challenges with dual enrollment classes. Some 11th grade students have not been able to enroll in their intended dual enrollment courses because of scheduling conflicts, and about 10 students didn’t pass the Accuplacer test that would make them eligible to take Composition 1, the first course in the sequence for most pathways. Enrollment in the new information technology pathway was especially disappointing last year: only two of the 14 students recruited signed on. There may be a combination of factors at

Marlborough High School and its partners have charted new territory in many ways. It has been a path that has involved some stumbling and a lot of persistence and creativity.
play—including how the school communicates the value of these courses relative to other advanced course options. The school may also need to figure out a way to set up support systems to keep students engaged in their selected pathways after they leave the intensive support of their small learning communities. While the high school ideally hopes to retain students in the college and career pathways they select, it would be helpful to clearly convey that, even if they don’t stay in the pathway, dual enrollment classes are a win-win because they give students a chance to earn college elective credit.

Equity is another challenge that leaders in Marlborough are grappling with. Previously, about one-third of middle school students were enrolled in the STEM learning community, which had a large waiting list. STEM students were receiving more instructional time and much more interdisciplinary learning, and their outcomes were very strong. The program had become so popular that the city’s more affluent families were signing their children up in large numbers; even with a lottery system that provided preference to underserved groups, high-needs groups were significantly underrepresented (see table on page 28). Students of color are currently underrepresented in the program: just under one-third of STEM students are Latino, whereas Latinos account for nearly half of all Marlborough High School students. The Marlborough team has worked to recruit and enroll students representative of the student population, reserving priority spots for students of color, English language learners, and young people from economically
disadvantaged families. This school year, the district expanded the program to all students in the middle and high schools, making it the default experience for every student. Given the high demand, Marlborough leaders viewed this expansion of the program as the only fair thing to do.

**A Surprisingly Lean Budget**

Given the tangible impact on students, it’s surprising how little Marlborough’s STEM program actually costs. That is largely because the bulk of programming falls within traditional school structures. STEM students attend school for the same number of hours as their peers and stick to a very similar schedule; most of their classes follow the same state-approved curriculum. High school faculty who teach dual enrollment courses work according to the same union contract as other Marlborough faculty. As a result, the STEM program is largely budget-neutral, with a few exceptions, particularly during the startup phase.

Federal grant funding was critical during the planning and launch phase. Two large federal grants covered, among other things, curriculum development, professional development for teachers, and strategic equipment purchases. Equipment included 3D printers, lab hoods, state-of-the-art industrial robots, lasers, videoconferencing equipment, a CNC router (a computer numerical control cutting machine), software, and a van to transport students to their job placements and the community college campus. The grants also covered three important staff positions, previously discussed.

In total, Marlborough High School received approximately $1.3 million in federal grant support from YCC. Its intermediary partner, PSW, received an additional $540,000 over four and a half years. Marlborough High School allocated the majority of its budget (53 percent) to equipment purchases. The remainder was allocated to other costs, such as professional development, teacher stipends, and transportation (19 percent); supplies (11 percent); personnel (14 percent); and staff travel (3 percent).

**Sustainability**

Looking ahead at the sunset of federal funding this year, Riley and his team aren’t especially worried. The state has already begun to show greater investment in helping schools with equipment upgrades, which Riley likes to think was influenced by a visit that the state education secretary made to Marlborough, where he saw what students can do with advanced STEM equipment. The state is also increasingly committed to expanding early college models, which Riley hopes will create a sustainable source of funding for dual enrollment courses.

The school and PSW will need to find a way to cover program management and coordination roles beyond the startup phase. They are currently considering ways to braid multiple funding sources, such as allocating $40,000 for early college programming (tuition, resources, and other supplemental expenses) out of the district’s fiscal allowance, building staffing roles into the district budget, and applying for the competitive Massachusetts Early College Designation, which, if awarded, could bring in an additional $140,000.

<table>
<thead>
<tr>
<th></th>
<th>STEM Program (grades 9 through 12)</th>
<th>Marlborough High School (all students, grades 9 through 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Enrolled</td>
<td>292</td>
<td>1,051</td>
</tr>
<tr>
<td>Male</td>
<td>53%</td>
<td>51%</td>
</tr>
<tr>
<td>Female</td>
<td>47%</td>
<td>49%</td>
</tr>
<tr>
<td>Latino</td>
<td>32%</td>
<td>49%</td>
</tr>
<tr>
<td>African American</td>
<td>5%</td>
<td>3%</td>
</tr>
<tr>
<td>Special Education</td>
<td>5%</td>
<td>14%</td>
</tr>
<tr>
<td>English Language Learners</td>
<td>3%</td>
<td>16%</td>
</tr>
<tr>
<td>Economically Disadvantaged</td>
<td>40%</td>
<td>54%</td>
</tr>
</tbody>
</table>

*Source: Marlborough High School*
In just a few years, the district has rolled out an impressive new model for middle and high school education.

The grades 6 through 10 program of study—with its focus on rigorous, interdisciplinary projects and STEM career exposure—has been transformative, and the grades 11 through 12 college and career pathways, while still evolving, are thoughtfully structured and likely to further improve outcomes. Now the district is taking this model to scale. Beginning in 2016, all fifth to eighth graders were integrated into a slightly revamped STEAM (the A is for “arts”) model. District leaders decided to expand the STEM concept to STEAM to incorporate a broader set of interests for young students who are still discovering their passions, and to enable students to explore a greater range of skills and ways of thinking. Now, all three small learning communities participate in project-based learning, with middle schoolers rotating through 60-day cycles in instructional technology, engineering, and visual arts.

A similar expansion is underway at the high school. Last fall, all incoming ninth graders joined a small learning community with a career-related theme. The high school overhaul is a response to the difference Riley was seeing between STEM and non-STEM students—STEM students were more engaged and clear about their purpose as students—as well as a marked difference in teachers’ sense of efficacy and job satisfaction. “The teachers who aren’t involved in these small learning communities are trying to bear the weight of so many student issues and needs,” he says. “It’s really overwhelming. They don’t feel students know why they’re here on a deeper level. They don’t feel like they have the support of anyone beyond themselves.”

The small learning communities structure has made a significant difference for both students and adults, and the focus on relevant, career-oriented learning has created a culture of positive learning and purpose. It’s a model that school leaders are ready to try schoolwide, with houses organized by three career themes: STEM, business, and arts and humanities. It’s a big move, and one that will require buy-in from many more staff members. (In the past, STEM teachers had all volunteered to join the program and retention was very high.) The school—and the district—will have new lessons to share from this experience in the next year or two.

Meanwhile, Marlborough High School has begun to attract attention from educators beyond the city. The school has become a regular destination for leaders of other districts and state officials interested in innovative college and career pathways. In March 2017, the Massachusetts Departments of Higher Education and Elementary and Secondary Education highlighted Marlborough High School at a convening that helped set the agenda for establishing high-quality early college partnerships across the state. Principal Riley spoke to a group of over 250 stakeholders about the lessons learned in his district, noting that, across the state, there is a “real sense of urgency” about the need to address the gap between postsecondary completion rates and the skills and credentials required by employers for viable middle-class jobs. Riley concluded his address, “This type of innovative program is exactly what we need to keep up with the changing trends in our communities.”
APPENDIX A

List of Interviewees

Daniel Riley, principal, Marlborough High School

Laura Bilazarian Purutyan, career specialist, Marlborough STEM Early College High School

Elizabeth Kennedy DeHoratius, MAPP/STEM counselor, Marlborough STEM Early College High School

Kelley French, former director, PSW Youth Careers

Kimberly Votruba-Matook, UMass Memorial-Marlborough Hospital

Christina Hebert, manager of educational partnerships, Quinsigamond Community College

Scott Brown, science/physics teacher, Marlborough STEM Early College High School

Heather Kohn, math/algebra teacher, Marlborough STEM Early College High School

Stephanie Gill, science/biology teacher, Marlborough STEM Early College High School

Karen Bento, Early College English teacher, Marlborough STEM Early College High School

Sharon Mattingly, Early College business and technology teacher, Marlborough STEM Early College High School

Tess Le Duc, student, Marlborough STEM Early College High School

Miguel Lopez Rivera, student, Marlborough STEM Early College High School

Aliyah Nisbett, student, Marlborough STEM Early College High School

APPENDIX B

Mentoring Assignment #2 Reflection

This mentoring experience was different from last in that you had much more time to spend with one (in some cases two) mentor(s) and to learn in more depth about a particular job sector/role. While the day is fresh in your mind, please write a reflection that addresses the following questions:

• What did you learn about your mentor’s school-to-career path?

• What did you learn about your mentor’s day-to-day responsibilities/activities?

• Describe the industry problem that you and your group confronted, how you approached it, and how you ultimately solved it or came to some resolution.

• What are your thoughts about the industry sector/career you had a chance to explore today? Is it something about which you remain curious?
# APPENDIX C

## Four College/Career Pathways

### 2016 Launch of Early College Pathways

<table>
<thead>
<tr>
<th>Pathway</th>
<th>11th Grade</th>
<th>12th Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Science</td>
<td>Composition I (Fall)</td>
<td>Introduction to Psychology (Fall)</td>
</tr>
<tr>
<td></td>
<td>Composition II (Spring)</td>
<td>Introductory Sociology - Principles (Spring)</td>
</tr>
<tr>
<td></td>
<td>AP Computer Science Principles</td>
<td>AP Computer Science A</td>
</tr>
<tr>
<td>Biotechnology</td>
<td>Composition I (Fall)</td>
<td>Introduction to Psychology (Fall)</td>
</tr>
<tr>
<td></td>
<td>Composition II (Spring)</td>
<td>Introductory Sociology - Principles (Spring)</td>
</tr>
<tr>
<td></td>
<td>AP Biology</td>
<td>Biotechnology</td>
</tr>
<tr>
<td>Health Care (Nursing)</td>
<td>Composition I (Fall)</td>
<td>Introduction to Psychology (Fall)</td>
</tr>
<tr>
<td></td>
<td>Composition II (Spring)</td>
<td>Introductory Sociology - Principles (Spring)</td>
</tr>
<tr>
<td></td>
<td>AP Biology</td>
<td>Anatomy and Physiology I and II</td>
</tr>
<tr>
<td>Engineering</td>
<td>Composition I (Fall)</td>
<td>Introduction to Psychology (Fall)</td>
</tr>
<tr>
<td></td>
<td>Composition II (Spring)</td>
<td>Introductory Sociology - Principles (Spring)</td>
</tr>
<tr>
<td></td>
<td>Engineering Course</td>
<td>Engineering Course</td>
</tr>
</tbody>
</table>

*Source: Marlborough High School*

2 In the 2014-15 school year, the department stopped identifying students as “low-income” and created a new income metric called “economically disadvantaged.” Therefore, the figures in the table before the 2014-15 school year represent low-income status, and the figures after the 2014-15 school year represent economically disadvantaged status.