Baltimore City Public Schools

STEM Plan

2019-2021

2-19-2019

Contents

Executive Summary

"Millions of students across the country are working hard to get through school, only to find themselves ill-prepared to live the lives they hope for." - The New Teacher Project, 2018

There is a STEM specific opportunity myth that if students were to seize the opportunities available to them they could go on to be scientists and engineers and other related STEM careers. Many students do not have access to the classes, instruction, and resources to realistically pursue STEM careers. This problem is not unique to Baltimore City, but it is magnified by concentrated poverty.

Within 3-years City Schools will have improved access to advanced STEM courses, set minimum class time requirements for STEM classes, instituted computer science for all students, established a partnership to recruit STEM teachers, improved collaborative planning options for teachers, purchased science equipment for traditional schools, and finalized a plan to address the shortage of computers.

Ending the STEM opportunity myth (TNTP, 2018) in Baltimore City will require cross-sector collaboration to advocate for, and invest in, Baltimore City students. When students gain access to STEM careers, their futures brighten. When the STEM workforce expands, Baltimore's future brightens.

The Case for STEM Education

"All of the students, in all of our schools, deserve all that a high-quality education makes possible—talents that are discovered, doors that open, and lives that change." – Dr. Sonja Brookins Santelises

City Schools' Blueprint for Success is designed to help students reach their goals. The blueprint is organized into three broad categories: student wholeness, literacy, and leadership. When the blueprint is applied to STEM, students are equipped to be both civic ready and college and career ready. Student wholeness includes ensuring that students have equitable access to STEM opportunities to pursue their passions and develop their potential. Literacy and leadership skills are also needed in STEM careers and are best taught in context. When students are working to better understand the world in their STEM classes, it gives them reasons to read, write, speak, and listen. They develop their voices as they make claims, cite evidence, and explain their reasoning. Working on STEM projects helps students develop leadership skills as they work together to investigate questions and design solutions. How a Baltimore

City student could experience STEM as part of a world-class education is included in the *Investing in our Future* report (City Schools, 2019). This plan is designed to complement the blueprint by defining how City Schools will equip students with the skills they need so they can choose to pursue STEM careers.

Most City Schools students are not earning a living wage, six years after graduation (Baltimore's Promise, p. 1). This contrasts with the average middle-skill STEM worker in Baltimore who is paid 10% more than the living wage (Middle Skills Report, p. 7), and higher skill workers earn more. Students with the ability and inclination to pursue STEM careers mostly lack access to the educational opportunities needed to realize STEM career aspirations. This lack of opportunity has grown as the level of STEM knowledge needed across the workforce has grown in step with advances in technology, increasing the level of STEM education and experience needed (Carnevale, Smith, & Melton, 2014).

However, the demand for skilled STEM workers is growing faster than the supply. Nearly a quarter of all jobs in the Baltimore region – more than 281,000 jobs altogether – require high-level STEM knowledge in at least one STEM field (Middle Skills STEM Report, p. 7). City Schools can open the door to high paying STEM careers for students by providing equitable access to a pipeline of STEM-related educational opportunities and inspiring students to pursue STEM-related passions. Maryland's Department of Labor, Licensing, and Regulation's occupational projections (MD DLLR, 2018) highlight the most in demand careers as well as those with the highest growth potential. Many of those careers have a STEM focus and require varying levels of post-secondary academic attainment (see Appendix A for a list of occupational projections for selected STEM careers).

STEM Vision

All students will graduate from City Schools as STEM literate citizens who can apply science, technology, engineering, and mathematics to investigate questions and design solutions to problems. They will have the option to pursue STEM careers immediately or via advanced degrees.

Each and every City Schools graduate will be:

- Civic Ready: All students will graduate City Schools as contributors to the democracy as STEM-literate citizens with a deep understanding of STEM issues, as lifelong learners and strong self-advocates.
- Career Ready: All students will have the opportunity to participate in a STEM course sequence, leading to industry recognized certification and gainful employment in a STEM field in the greater Baltimore community.
- College Ready: All students are provided the opportunity to successfully complete all requisite STEM courses across the K-12 curriculum. All students graduate with the option to enroll in a STEM major at an accredited institute of higher education without remediation.

City Schools' is working to implement standards-based STEM curricula designed to prepare students to be civic ready, career ready, and college ready. The Common Core State Standards for mathematics and the Next Generation Science Standards spell out practices that mirror college and workforce expectations (Common Core State Standards Initiative, 2019; NGSS, 2013). Practices such as asking questions, developing models, constructing arguments, providing constructive criticism, and designing solutions are all actively developed through the STEM curricula. Engineering design challenges, where

students work to collaboratively design solutions to problems, and other cross-curricular projects are being integrated into the curriculum to purposefully foster skill development for the workplace.

See Appendix B for a list of skills STEM employers and post-secondary education providers are looking for. Tools such as Naviance, at the high school level, build upon the idea of planning for and managing a pathway to graduation while integrating opportunities for students to create resumes and write essays for both job and college applications. Introducing students to email and collaborative documents in Office 365 and Google provide real-world experiences communicating and working together for a common goal. The implementation of a coding curriculum for Computer Science provides students as young as Kindergarten with opportunities to solve problems, defend decisions, and demonstrate grit and perseverance.

Students are more likely to develop STEM skills and identities when their school experience interfaces with the other influences in their lives (Hoffer, 2016). Citywide collaboration would more efficiently equip Baltimore students with the skills to join the STEM-literate workforce.

Definitions

STEM Definitions:

- STEM consists of science, technology, engineering, and mathematics as individual disciplines and as the integration of these disciplines (Community for Advancing Discovery Research in Education).
- STEM careers require skills in science, technology, engineering, and/or mathematics.
- STEM education requires students to use mathematics and technology to investigate questions and design solutions to problems.

Disciplines:

- Science: students are required to take general science classes and students can take advanced classes
- Technology & Computer Science: general technology classes include computer science & students can select a CTE computer science pathway
- Engineering: general science classes include engineering design challenges and students can select a CTE engineering pathway
- Math: students are required to take general math classes and students can take advanced classes

Categories:

1. **General STEM Classes (baseline for all students):** How students experience STEM instruction starts with required science, math, and technology courses. These courses are interconnected so students do not experience skills and content in isolation.
    a. Science classes with integrated problem solving and engineering design challenges
    b. Math classes with integrated science, engineering, and technology application problems
    c. Technology courses with integrated engineering, coding, science, and math

2. **Select STEM Classes (available to all students):** Students can choose to take advanced courses such as *Calculus*, interdisciplinary STEM courses, such as a *STEM Practicum*, or a series of classes, such as *Project Lead the Way,* to prepare for STEM degrees or specific STEM careers.
    a. Advanced courses in science, math, and programming (6^{th}-12^{th})
    b. Career pathways (9^{th}-12^{th})
    c. Interdisciplinary STEM classes
3. **Out of School Programs (available to all students):** A variety of enrichment programs, such as competitive robotics programs, and workplace internships enable students to apply a variety of STEM concepts to achieve specific goals.
    a. Academic programs
    b. Competitive programs
    c. Internships/mentorships
    d. Field experiences

Gap Analysis & Long-Term Goals

How students experience STEM in City Schools varies tremendously from school to school. Students have a range of access to general classes, select classes, and enrichment opportunities. Within STEM classes, the quality of instruction can be affected by the shortage of certified and licensed STEM teachers and insufficient school-based STEM support structures. Limited resources have also resulted in shortages of instructional materials, including computers. How students experience STEM in City Schools depends on access, instruction, and resources.

Access

Students can access a mixture of general STEM classes, selective STEM classes, and out-of-school STEM experiences. General STEM classes are required at all schools, while selective STEM class offerings and out of school STEM experiences are school-dependent. See Appendix C for a map of STEM experiences currently available to students.

How students access STEM classes is school-dependent. City Schools does not mandate how class time is scheduled for each subject. Since most scheduling decisions are left to schools, class times for STEM subjects can be insufficient to complete the curricula and master grade-level standards. Since mastery of future standards depends on mastery of preceding standards, insufficient class time results in significantly lower achievement. The extent of the problem is not currently measurable as elementary schools, and elementary/middle schools, do not schedule courses for specific times. High school courses meet for set class periods that range from 75 minutes per day for 90 days, to 60 minutes per day for 180 days. When STEM classes are scheduled for less time than is required by the curriculum, students meet with limited success.

What STEM experiences students can access is also school dependent. City Schools does not mandate which select courses are offered and schools cannot afford to staff select STEM courses for only a few students. However, schools with larger student populations are more likely to have enough students to staff select STEM courses. Some schools offer STEM-related career pathways, but there are limited

options for burgeoning career fields like Cybersecurity and Computer Science. Schools also determine out-of-school STEM programming. Out-of-school opportunities are typically limited by funding and staffing constraints. Data is not available for out-of-school STEM programs managed by outside organizations.

Equitable Access Goals:

- All students will have enough class time to experience the entire curriculum.
- All students will have access to advanced courses.

Instruction

"Knowledge of subject matter is a prerequisite for effective classroom instruction."
Qualities of Effective Teachers by James H. Stronge, p. 13

Effective STEM instruction requires teachers who are experts in their content area and there is a nation-wide shortage of trained STEM teachers. Currently 72% of STEM classes are taught by certified and licensed teachers. However, elementary through 6th grade teachers are licensed as generalists and certification does not necessarily reflect expertise in STEM areas. In critical areas, like computer science and physics, the teacher development pipeline is simply insufficient to meet demand. For instance, City Schools has 23 out of 51 (45%) physics teachers who are certified and licensed to teach physics. In this case, demand for physics teachers significantly exceeds the supply, as the University of Maryland system graduates an average of two physics teachers per year.

Job-embedded coaching and ongoing professional learning can help retain existing STEM teachers and maximize their effectiveness. Some of the larger high schools can afford to provide a couple teachers, who do not teach a full schedule, so they can support other math or science teachers. Smaller schools lack the economy of scale to provide release time for department leads. Ongoing professional learning opportunities are offered by the district during district-wide professional development days and as after-school programs. However, ongoing professional learning opportunities are often under-utilized due to the competing demands on teachers' time.

Equitable Instruction Goals:

- All STEM classes will be taught by licensed and certified teachers.
- All STEM teachers will have access to on-going professional learning and job-embedded coaching.

Resources

Standards-based STEM curricula prepare students to meet performance expectations which often require hands-on materials. However, schools have limited resources. Hands-on instructional materials, required by the curricula, are often unavailable. Similarly, computers are often unavailable for STEM instruction. On average four students share one computer/tablet (based on computers currently under warranty and does not take into account devices that are not working).

Equitable Resources Goals:

- All students will access the equipment required by the curriculum.

- All students will have access to computers/tablets with at least one device for every three students.

Data (Under Review, Not Validated)

A common set of metrics will be used to gauge the current status of STEM in City Schools and to measure progress on access, instruction, and resources. Focus grades of 5th grade, 8th grade, and high school were identified to align with standardized testing and were informed by the key stages identified by the National Society of Black Engineers as part of their strategic goal of reaching an annual graduation rate of 10,000 black engineers by 2025 (NSBE 2025).

The STEM opportunities available to students depends on their access to general classes, select classes, and out of school programs. Enrollment in general and select STEM classes captures the STEM opportunities students are able to access during the school day. Participation data from district-supported out-of-school STEM experiences indicates the current state of out-of-school STEM experiences. It does not reflect the wide variety of out-of-school STEM experiences (Mincarelli 2014) available to some students through a range of formal and informal partnerships with individual schools.

Student achievement on standardized tests reflects how students responded to instruction in both general and select STEM courses. The percentage of STEM classes taught by appropriately certified and licensed teachers captures teacher expertise and indicates the status of STEM teacher recruitment and retention efforts. The effectiveness and accessibility of professional development programs designed to improve STEM instruction are captured by teacher surveys and participation rates.

Resources are key to unlocking many STEM opportunities otherwise available to students. Science equipment purchases determine how much of the curriculum students can experience. The ratio of students to computers and tables captures the basic availability of technology.

Elementary:

Science

- 86% of teachers are certified and licensed
- 15/98 (12%) schools (non-charters) have all the books and equipment needed to teach the curriculum
- Schools (non-charters) have an average of 57% of the equipment kits required by the curriculum
- 5th grade MISA data from 2018 is due to be released in late February or March with a county-by-county breakdown
- Note: Sixty-eight percent of elementary students across Maryland, and 86% of economically disadvantaged students failed to meet standards in science (Salmon, 2018)

Technology & Computer Science

- 100% (1) computer science teacher is certified and licensed
- 39/124 (31%) elementary schools offer technology courses in at least one grade

Engineering

- 23/124 (19%) elementary schools had FLL Jr. and/or FLL robotics programs in 2017-2018

Math

- 88% of teachers are certified and licensed

- 948/6428 (15%) 4th grade students passed PARCC (scoring a 4 or 5)
- 977/6056 (17%) 5th grade students passed PARCC (scoring a 4 or 5)
- Note: Students, who are on grade level in 4th grade, are on track for potential careers in engineering (NSBE 2025).

Middle School:

Science

- 80% of teachers are certified in science or are elementary teachers teaching 6th grade
    - 20% of 6th grade teachers have a science certification
- 2/3 (66%) grades have 6th & 7th grade equipment at non-charter schools in 2017-2018 with 8th grade equipment scheduled to be purchased for the 2019-2020 school year
- 8th grade MISA data from 2018 is due to be released in late February or March with a county-by-county breakdown
- Note: Sixty-one percent of elementary students across Maryland, and 84% of economically disadvantaged students failed to meet standards in science (Salmon, 2018)

Technology & Computer Science

- There are no computer science courses.
- 38/93 (41%) middle schools offer technology courses in at least one grade in 2018-2019

Engineering

- 100% (1/1) teacher is certified and licensed
- 19/93 (20%) schools had VEX IQ robotics programs in 2017-2018

Math

- 84% of teachers are certified in math or are elementary teachers teaching 6th grade
    - 18% of 6th grade teachers have a math certification
- 287/4474 (6%) 8th graders passed the 8th grade PARCC (scoring a 4 or 5) in 2017-2018
- 38/93 (41%) schools are offering Algebra 1 in 8th grade
- 732/5206 (14%) of 8th grade students are enrolled in Algebra 1 in 2018-2019
- Note: Students should take Algebra in 8th grade if they are on track for potential careers in engineering (NSBE 2025). Virtual Algebra is being piloted for students who attend schools that do not have a large enough cohort of prepared students to offer 8th Grade Algebra.

High School:

Science

- 81% of Biology teachers, 69% of Chemistry teachers, and 45% of Physics teachers are certified and licensed
- MISA data will not be released until the 2019-2020 school year
- 19% (8/42) schools are offering at least one AP science course in 2018-2019
- ~9% (487/~5000) of 12 grade students are enrolled in an AP science course in 2018-2019
- 47% (68/144) students who took an AP science exam in 2017-2018 passed with an average score of 2.8 (3, 4, or 5 is passing)

Technology & Computer Science

- 17% (10) computer science teachers are certified and licensed
- 33% (14/42) schools offer computer science courses in 2018-2019
- 12% (5/42) schools have the computer science CTE pathway in 2018-2019
- 10% (4/42) schools offer AP computer science in 2018-2019

Engineering

- 66% (6 teachers) are certified and licensed
- 57% (24/42) schools have registered for the VEX robotics program for 2018-2019
- 14% (6/42) schools have Project Lead the Way in 2017-2018

Math

- 82% are certified and licensed
- 9% (651/7304) students passed the Algebra 1 PARCC (scoring a 4 or 5) in 2017-2018
- 17% (7/42) schools are offering calculus in 2018-2019
- ~4% (~277/~4213) 12th grade students are enrolled in an AP Calculus course in 2018-2019
- 44% (110/249) students took an AP calculus exam in 2017-2018 and passed with an average score of 2.5 (3, 4, or 5 is passing)
- Note: Students should take Calculus in high school, if they are on track for potential careers in engineering (NSBE 2025). As more students enter high school on track to take Calculus due to the expansion of 8th grade algebra, more schools will be able to offer Calculus.

3-Year Goals and Associated Actions (Under Discussion, Pending Budget Allocations)

Equitable Access

3-Year Goal: All PreK-8 students will have enough class time scheduled to experience the entire curriculum.

Adequate access to the STEM curriculum is essential to protect students from schedules that introduce content gaps every year and compound over time. City Schools is developing minimum class time requirements for all content areas to ensure students have ample access to the STEM curricula in all grade levels. The district-wide scheduling model will ensure that STEM classes are scheduled with enough time to complete the curriculum. STEM career opportunities will remain open to students since they will be able to access the entire standards-based curriculum.

The minimum class time requirements will be fully vetted by the district, communicated to all stakeholders, and implemented at all traditional schools. See Appendix D for the current draft time requirements and sample schedules.

3-Year Goal: Secondary students will have increased access to advanced courses.

Algebra Access for All is creating a pipeline for students to take Algebra in 8th grade. It started with the introduction of 6th Grade Honors Math at 10 middle schools this year. The plan is to add one grade and 10 schools per year until there is 8th grade algebra and the accompanying honors pipeline at 30 additional middle schools. Participating students will be on pace to take Calculus in high school.

All students should also be able to take Physics in high school in 2019-2020. When Biology was the only high school science class students were tested on, only 22 out of 46 (48%) high schools offered physics in 2016-2017. City Schools changed the high school science course sequence to meet the expectations of the Next Generation Science Standards (NGSS) so students are being required to take Biology, Chemistry, and Physics with Earth Space Science integrated into all three courses. The new science course sequence helps students meet the science requirements for higher education so graduating

seniors have the option of pursuing STEM majors in colleges and universities (see Appendix E). Thirty-three out of 42 (79%) of high schools already offer physics even though students are not required to take physics until the 2019-2020 school year.

Foundations of Computer Science is replacing Foundations of Technology as the required technology course. Thirteen out of 42 high schools (31%) are already offering Foundations of Computer Science. By 2020-2021 all high school students should have access to a computer science course and all students entering high school will take computer science for their technology credit.

City Schools does not currently offer a cybersecurity career pathway. Within three years a cybersecurity pathway will be made available in four comprehensive high schools, serving a total of 300 students. City Schools' Career Readiness Office will also work with local 2-year and 4-year colleges to provide related post-secondary options, dual credit opportunities, and articulation agreements. Local industry will be similarly involved in developing internships and other work-based learning opportunities for high school students in the cybersecurity career pathway.

Additional advanced placement (AP) math and science courses will also be offered over the next three years. Schools will have the choice of adding one advanced placement mathematics, science, or social studies course in the 2019-2020 school year. AP course offerings will increase in 2020-2021 with all schools offering at least 1 AP math or science class. By 2020-2021 at least 1 AP math and 1 AP science class will be offered at all high schools.

Equitable Instruction

3-Year Goal: A program to recruit and develop licensed and certified STEM teachers will be established.

> "Research on teacher quality conducted over the last 20 years reveals that, among those who teach mathematics and science, having a major in the subject positively affects student achievement.
> Michael B. Allen

City Schools will work with institutions of higher education to develop at least one STEM teacher-development pipeline over the next three years. The work has already begun. In 2017 City Schools hosted a meeting with the University System of Maryland, discussed opportunities to collaborate to develop a STEM teacher pipeline, and ultimately partnered with UMBC on a couple grant proposals.

Further partnerships will be needed as the demand for trained STEM teachers continues to grow, especially in critical areas like computer science and physics. City Schools would like to issue a call to action to all STEM stakeholders to propose new programs and ideas that will contribute to the development of trained STEM educators to teach Baltimore City's next generation of innovators.

3-Year Goal: All STEM teachers will have access to on-going high-quality professional learning.

One of the primary drivers of the STEM teacher shortage is the challenge of retaining skilled professionals in a competitive job market (Ingersoll, 2009). Systems to support and develop existing STEM teachers are required. Ideally, City Schools would be able to add support staff to each school to provide a comprehensive system of school-based supports and job-embedded training for STEM Schools. However, City Schools has had to undergo several rounds of layoffs over the last several years and is not in a financial position to add staff, like department heads or STAT teachers at each school.

City Schools will continue to maximize the ability of existing staff to provide comprehensive and efficient systems of support. City Schools is currently utilizing math staff in the district office, and virtual learning systems, to support a formal school-based planning process. In addition to regularly scheduled systemic professional development days, teachers can take additional professional development courses such as the 7-day summer content-based courses for elementary science teachers.

City Schools is also working on a plan to develop a system for star teachers to invite other teachers to come plan with them during monthly planning sessions on half-day professional development days. This system has the potential for teachers to learn from each other in STEM content areas like science, computer science, and specialized STEM programs like Project Lead the Way.

Equitable Resources

3-Year Goal: All traditional schools will have science equipment.

Hands on materials make the science curriculum come alive as students practice acting as scientists and engineers. Significant initial investment in equipment and sustained investment in consumable materials is required for students to experience science and engineering as envisioned by the NGSS.

The SABES elementary science curriculum was co-developed by Johns Hopkins University and City Schools over a five-year period with funding from the National Science Foundation. Since the SABES elementary science curriculum was adopted in 2016-2017 City Schools has used a combination of grant funding, district funds, and schools to acquire 57% of the equipment kits required for traditional schools to implement the curriculum. Science workshops for school leaders and improved communications have resulted in increased school investment in science materials. Schools are expected to gradually purchase additional equipment as budgets allow. Over the last five years City Schools has invested over $2 million in purchasing equipment and materials for elementary science. Over the next three years City Schools plans to ensure that traditional schools have 100% of the equipment kits required by the elementary science curriculum.

City Schools has spent over $1.5 million over the last two years to purchase the 6th and 7th grade equipment and materials for IQWST, a comprehensive science program that prepares students to meet NGSS expectations. City Schools is currently in the process of budgeting to complete the IQWST rollout to 8th grade in the 2019-2020 school year.

City Schools made an initial investment of $1.9 million in high school science materials in 2015 to begin the transition to NGSS-aligned instruction. That purchase included technology for digital data acquisition and provided a standard set of equipment for all scheduled science classes. However, schools that did not offer physics did not receive the materials. City Schools partnered with the Cary Institute on a DRK-12 grant from the National Science Foundation entitled Integrated Earth Science into Chemistry (ICE). That grant is helping to provide the instructional materials necessary for students to experience Earth science. Over the next three years City Schools also intends to purchase the physics materials necessary for students to experience physics.

3-Year Goal: A five-year contract will be established to reach and maintain a sustainable student/device ratio as close to 3/1 as possible.

STEM careers require students to be proficient with computers. General STEM classes, select STEM classes, and out-of-school STEM programs all require devices. Modern STEM curricula are designed to

prepare students for STEM careers. City Schools currently has approximately four students per computer or tablet. This includes all student devices currently under warranty (including non-operational devices), with the number of computers still under warranty dropping drastically for the 2019-2020 school year.

Over the next three years City Schools intends to develop a comprehensive plan to reach a sustainable student/device ratio and adopt a modern learning management system. Once the target ratio is determined the Office of Teaching and Learning will be able to begin the process of revising the curriculum to make full use of devices for instruction and assessment.

Embarking on a plan to significantly increase the number of computers and tablets in schools will require the district to assume control of device purchases and will most likely require an associated adjustment to the school funding formula. Leasing devices over a four-year period would allow City Schools to ensure that technology in schools remains current, usable, and equitably distributed to students. Initial device rollout and training will be followed by ongoing trainings and a scaled up technical support system that is both easily accessible and sustainable, and a device refresh process to maintain the student to device ratio.

Community Engagement Plan

Changing the landscape of STEM opportunities available to students in Baltimore will require extensive internal and external collaboration. Students, teachers, families, teachers, and school leaders are all contributing. City Schools is seeking additional external collaboration by participating in a citywide effort to develop a STEM ecosystem in Baltimore. The national STEM ecosystem movement is being encouraged by the federal government in order to "bring together school systems, colleges, and businesses to broaden participation in STEM careers" (Committee on STEM Education of the National Science and Technology Council, 2018). A Baltimore STEM ecosystem will magnify collective impact through collaboration and coordination of STEM educational outreach efforts to more efficiently, effectively, and equitably serve the community.

Timeline:

- November 9, 2018: Cross-sector workgroup provides initial feedback on City Schools' STEM Plan
- December: Survey teachers and administrators
- February 6, 2019: Parent and Community Advisory Board (PCAB) provides feedback on City Schools' STEM Plan
- February 19, 2019: Launch a STEM Ecosystem in conjunction with the release of City Schools' STEM Plan for public comment
- February 21, 2019: STEM Plan presentation at public PCAB meeting

STEM Committee Members

- Stacey Davis, Coordinator – Instructional Technology, Media
- Joshua Gabrielse, Director – Science
- Janise Lane, Executive Director – Teaching and Learning
- Michael Rading, Director – Customer Care
- Beth Sappe, Director – Mathematics

- Dawn Shirey, Director – 21st Century Learning
- Stan Wolfe, Director – Career Readiness

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Appendices

Appendix A: Selected STEM Occupational Projections

STEM careers from Maryland Department of Labor Licensing and Regulation's list of long range occupational projections from 2016-2026 (MD DLLR, 2018) are listed below.

Careers	2016	2026	Projected Growth
Healthcare Practitioners and Technical Occupations	172,797	196,957	24,160
Computer and Mathematical Occupations	124,695	132,842	8,147
Registered Nurses	51,778	57,704	5,926
Architecture and Engineering Occupations	59,469	62,584	3,115
Engineers	41,969	44,063	2,094
Licensed Practical and Licensed Vocational Nurses	12,022	13,869	1,847
Physical Therapists	5,065	6,345	1,280
Software Developers, Systems Software	16,345	17,567	1,222
Physicians and Surgeons, All Other	10,318	11,369	1,051
Network and Computer Systems Administrators	13,098	14,114	1,016
Software Developers, Applications	13,255	14,238	983
Life Scientist	13,775	14,589	814
Drafters, Engineering Technicians, and Mapping Technicians	12,655	13,334	679
Life, Physical, and Social Science Technicians	8,323	8,826	503
Pharmacists	6,223	6,716	493
Computer Programmers	5,957	6,427	470
Computer Network Architects	5,395	5,820	425
Web Developers	5,216	5,616	400
Physical Scientists	9,386	9,679	293
Electronics Engineers, Except Computer	5,309	5,583	274
Mechanical Engineers	5,145	5,366	221

Additional Data on Cybersecurity Careers (MD DLLR, 2017)

Where are the most Cybersecurity jobs in Maryland?

Workforce Region	# Employed
Anne Arundel	10,530
Baltimore City	8,240
Baltimore County	9,900
Frederick County	2,440
Lower Shore	510
Mid-Maryland	12,020
Montgomery	20,950
Prince George's	8,890
Southern Maryland	3,150
Susquehanna	2,510
Upper Shore	530
Western Maryland	900
Grand Total	**80,570**

Source: Occupational Employment Statistics (OES) Program May 2016

What are the highest paying Cybersecurity Occupations in MD?

Occupation	Avg. Salary
Computer and Information Research Scientists	$113,110
Computer Systems Analysts	$95,890
Information Security Analysts	$104,830
Computer Programmers	$89,550
Software Developers, Applications	$103,580
Software Developers, Systems Software	$118,090
Web Developers	$66,720
Database Administrators	$87,440
Network and Computer Systems Administrators	$106,000
Computer Network Architects	$110,710

Source: Occupational Employment Statistics (OES) Program May 2016

What does the future hold for Cybersecurity jobs in Maryland?

2014 Employment Estimate*	86,210
2024 Projected Employment	113,750
% Change	31.5%
Projected Annual Openings	4,100

Source: DLLR Occupational Employment Projections Unit

Appendix B: Employable Skills

STEM employers and post-secondary education providers are looking for the following set of skills and attributes in City Schools graduates:

College and Career Ready

- Identifies personal strengths, needs and interests
- Creates, monitors and revises a multi-year education and career plan with professional guidance
- Applies strategies for self-promotion such as networking, completing applications, writing resumes, and developing interview skills
- Demonstrates specialized pathway-level skills and industry competencies
- Uses technology as a tool to research, synthesize, evaluate, and communicate information

Critical and Innovative Problem Solver

- Effectively acquires and uses information from multiple sources, investigates and evaluates their validity, and synthesizes new learning
- Applies academic and technical learning to authentic projects which include predictable and unpredictable solutions
- Uses inductive and deductive reasoning, making plausible evidence-based arguments
- Demonstrates the inquiry process by examining and explaining a problem and discerning a pattern or structure to formulate a solution
- Select and apply task appropriate problem-solving skills and techniques
- Demonstrates perseverance in the problem-solving process

Effective Communicator and Collaborator

- Demonstrates the ability to adapt appropriately to various audiences and uses a variety of communication methods and tools
- Articulates the value of diversity in collaborative environments
- Demonstrates the ability to listen actively and effectively using oral, written and non-verbal communication
- Applies methods of self-reflection to improve communication and collaborative skills
- Positively collaborates in group settings by demonstrating versatility and flexibility in difficult situations
- Demonstrates understanding of both big picture thinking an attention to detail

Adaptable and Productive Citizen

- Appropriately and effectively uses technology and other resources to fulfill personal and professional tasks
- Responds appropriately to changes in personal and professional conditions and contexts
- Interacts respectfully with people of all backgrounds, gender, ages, races, and philosophies
- Demonstrates time management techniques to efficiently fulfill responsibilities
- Understands and articulates how personal and professional actions impact the global economy, workforce and community
- Understands the importance of healthy choices and productive citizenship
- Uses a variety of techniques to understand and critique what a speaker or author is saying
- Articulates and/or asks for clarification on all tasks assigned

Ethical Decision Maker

- Demonstrates an understanding of integrity and ethical issues related to a chosen career field
- Demonstrates ethical and legal practices consistent with a chosen career field
- Demonstrates adherence to ethical academic standards of practice
- Demonstrates the importance of truthfulness, honesty, and quality in personal and professional practices
- Determines and implements optimal, ethical risk management strategies
- Includes and ethical perspective in the evaluation and solving of problems
- Understands and considers personal and societal effects of decision-making
- Demonstrates responsible digital citizenship through appropriate use of technology and media

Appendix C: Current Student Experience Map

		K-2	3-5	6-8	9-12
Science	**General Courses**	K: 3 SABES Units, 1-2: 4 SABES Units/Grade	6 SABES Units/Grade	4 IQWST Units/Grade	Biology, Chemistry, Physics
	Select Courses				AP, IB, Environmental Science
	Out-of-School	Curriculum-Embedded Experiences	Curriculum-Embedded Experiences, Science Fair	Curriculum-Embedded Experiences, Science Fair, Maryland Science Olympiad	Maryland Science Olympiad, Science Fair
Engineering	**General Courses**	Engineering design challenges in each SABES unit	Engineering design challenges in each SABES unit	Shake tables & CO2 car launchers were purchased in 2015, not in IQWST.	Engineering design challenges in each science course
	Select Courses			Project Lead the Way - Gateway	Project Lead the Way (PLTW), Introduction to Robotics (CTE Program of Study)
	Out-of-School	Robotics (FLL Jr.)	Robotics (FLL)	Robotics (VEX IQ)	Robotics (VEX)
Mathematics	**General Courses**	Eureka K-2	Eureka 3-5	Eureka: 6th, 7th, 8th	Eureka: Algebra I, Geometry, Algebra II, Probablity & Statistics or Transition Course
	Select Courses			6th Grade Compacted, 7th Grade Compacted, 8th grade Algebra I	Pre-Calculus, Calculus or AP
	Out-of-School				
Technology & Computer Science	**General Courses**				Foundations of Computer Science (taking the place of Foundations of Technology)
	Select Courses	Technology Class (taught at some schools for up to once a week): Transitioning to Code.org curriculum	Technology Class (taught at some schools for up to once a week): Transitioning to Code.org curriculum	Technology Class (taught at some schools for up to once a week): Transitioning to Code.org curriculum, supplemented with Google Technology Applications	AP Computer Science CTE Programs of Study: Computer Science Cisco Networing, Health Professions, and Advanced Manufacturing
	Out-of-School				

Opportunities in black text are in all schools while opportunities in gray text are in some schools.

Appendix D: Minimum Class Time Requirements

Recommended minimum class time requirements with example scheduling templates with for grades K-8 will be released for the 2019-2020 school year. The current draft of the recommended minimums (with sample schedules) are listed below for comment and review.

City Schools STEM Program of Study

Content Area	Kindergarten	1st - 2nd Grade	3rd – 5th Grade	6th – 8th Grade	High School
Science	55 minutes daily for 5 weeks each quarter	60 minutes daily for 5 weeks each quarter	60 minutes daily	48 minutes daily	3 required science courses 1 additional science course recommended
Technology & Computer Science	45 minutes weekly, for one semester	45 minutes weekly, for one semester	45 minutes weekly, for one semester	48 minutes weekly, for one semester	1 computer science course
Engineering	Embedded in math and science classes & Addressed through electives				
Mathematics	60 minutes daily 300 minutes per week	85 minutes daily 425 minutes per week	85minutes daily 425 minutes per week	68 minutes daily 340 minutes per week	4 required math courses

Other Core Content Areas & Scheduling Considerations

Content Area	Kindergarten	1st – 2nd Grade	3rd – 5th Grade	6th – 8th grade	High School
English/ Language Arts	140 minutes daily • 90 minutes Foundations • 20 minutes small group • 30 minutes FS	150 minutes daily • 90 minutes reading • 30 minutes Foundations • 30 minutes small group	115 minutes daily • 85minutes reading • 30 minutes small group	68 minutes daily • 68 minutes reading	4 required English courses
Social Studies	55 minutes daily for 4 weeks each quarter	60 minutes daily for 4 weeks each quarter	30 minutes daily	48 minutes daily	3 required history courses
Art/Music/ PE/Library/ Health	45 minutes per week for each content area with Library for one semester	45 minutes per week for each content area with Library for one semester	45 minutes per week for each content area with Library for one semester	48 minutes per week for each content area with Library for one semester	1 required physical education course 1 required health course Other courses are electives

PreK Sample Schedule

8:15 – 8:30 (15 min)	Morning Meeting
8:30 – 9:30 (60 min)	Math
9:30 – 10:50 (80 min)	ELA WW
10:50 – 11:15 (25 min)	Choice
11:15 – 12:00 (45 min)	Recess/Lunch
12:00 – 12:35 (35 min)	Choice
12:35 – 1:10 (35 min)	ELA SG
1:10 – 2:10 (60 min)	Science/Social Studies
2:10 – 2:55 (45 min)	Resource

Kindergarten Sample Schedule

8:15 – 8:30 (15 min)	Morning Meeting
8:30 – 9:30 (60 min)	Math
9:30 – 10:50 (80 min)	ELA WW
10:50 – 11:15 (25 min)	Choice
11:15 – 12:00 (45 min)	Recess/Lunch
12:00 – 12:35 (35 min)	Choice
12:35 – 1:10 (35 min)	ELA SG
1:10 – 2:10 (60 min)	Science/Social Studies
2:10 – 2:55 (45 min)	Resource

Grade 1 Sample Schedule

8:15 – 8:30 (15 min)	Morning Meeting
8:30 – 9:30 (60 min)	Science/Social Studies
9:30 - 10:10 (40 min)	ELA WW
10:10 – 10:55 (45 min)	Recess/Lunch
10:55 – 11:45 (50 min)	ELA WW
11:45 – 12:15 (30 min)	ELA FS 30
12:15 – 12:45 (30 min)	ELA SG 30
12:45 – 1:30 (45 min)	Resource
1:30 – 2:55 (85 min)	Math

Grade 2 Sample Schedule

8:15 – 8:30 (15 min)	Morning Meeting
8:30 – 9:30 (60 min)	Science/Social Studies
9:30 - 10:10 (40 min)	ELA WW
10:10 – 10:55 (45 min)	Recess/Lunch
10:55 – 11:45 (50 min)	ELA WW
11:45 – 12:15 (30 min)	ELA FS 30
12:15 – 12:45 (30 min)	ELA SG 30
12:45 – 1:30 (45 min)	Resource
1:30 – 2:55 (85 min)	Math

Grade 3 Sample Schedule

8:15 – 8:35 (20 min)	Morning Meeting
8:35 – 9:05 (30 min)	Social Studies
9:05 – 9:35 (30 min)	ELA SG
9:35 – 10:10 (35 min)	ELA WW
10:10 – 10:55 (45 min)	Recess/Lunch
10:55 – 11:45 (50 min)	ELA WW
11:45 – 12:15 (30 min)	Science
12:15 – 12:45 (30 min)	Science
12: 45 – 1:30 (45 min)	Resource
1:30 – 2:55 (85 min)	Math

Grades 4 – 5 Sample Schedule

	Grade 4	**Grade 5**
8:15 – 8:35 (20 min)	Morning Meeting	Morning Meeting
8:35 – 9:05 (30 min)	Science	Social Studies
9:05 – 9:35 (30 min)	Science	ELA SG
9:35 – 10:10 (35 min)	Math	ELA WW
10:10 – 10:55 (45 min)	Recess/Lunch	Recess/Lunch
10:55 – 11:45 (50 min)	Math	ELA WW
11:45 – 12:15 (30 min)	ELA SG	Science
12:15 – 12:45 (30 min)	Social Studies	Science
12: 45 – 1:30 (45 min)	Resource	Resource
1:30 – 2:55 (85 min)	ELA WW	Math

Grades 6 – 8 Sample Schedule

	Grade 6	**Grade 7**	**Grade 8**
8:15 – 8:31 (16 min)	Morning Meeting	Morning Meeting	Morning Meeting
8:31 – 9:19 (48 min)	Math	English	Social Studies
9:19 – 10:07 (48 min)	Math	English	Science
10:07 – 10:55 (48 min)	English	Social Studies	Math
10:55 – 11:43 (48 min)	Lunch	Lunch	Lunch
11:43 – 12:31 (48 min)	English	Science	Math
12:31 – 1:19 (48 min)	Social Studies	Math	English
1:19 – 2:07 (48 min)	Science	Math	English
2:07 – 2:55 (48 min)	Resource	Resource	Resource

Grades 6 – 8 Sample Schedule (Even Course Length)

	Grade 6	Grade 7	Grade 8
8:15 – 8:30 (15 min)	Morning Meeting	Morning Meeting	Morning Meeting
8:30 – 9:38 (68 min)	ELA	Science	Math
9:38 – 10:46 (68 min)	Science	ELA	Social Studies
10:46 – 11:31 (45 min)	Lunch	Lunch	Lunch
11:31 – 12:39 (68 min)	Math	Social Studies	ELA
12:39 – 1:47 (68 min)	Social Studies	Math	Science
1:47 – 2:55 (68 min)	Resource	Resource	Resource

Appendix E: Science Requirements for 4-Year Colleges and Universities in Maryland

The state of Maryland requires that all students have mastered the Next Generation Science Standards (NGSS) and have access to science electives (COMAR 13A.04.09.01). Colleges in Maryland require or recommend 2-4 years of laboratory-based science. City Schools requires high school students to take Biology, Chemistry, and Physics. Earth and Space Science standards have been integrated into all three courses.

College or University	HS Science Requirement
Bowie State University	3 years or units of Natural Science
Capitol College	Two years of science
Coppin State University	Two years of Science (Laboratory-based science)
Frostburg State University	3 units if science in at least two different subject areas (with 2 of the units including a laboratory experience)
Goucher College	3 units of Laboratory Science, preferably including Biology and Chemistry
Johns Hopkins University	recommend four years of science
Loyola University of Maryland	Students are encouraged to take the most challenging programs available at their school.
McDaniel College	Recommends three years of work in laboratory sciences
Morgan State University	Science – 3 years or state-approved equivalent: two must be in different areas, with at least one lab experience
Notre Dame of Maryland University	2 units of science
Salisbury University	Two credits in laboratory-based sciences
St. John's College	Two or three years of natural science
St. Mary's College of Maryland	Completion of three high school science units
Stevenson University	3 years, including 2 lab sciences (Biology & Chemistry preferred)
Towson University	3 years of science
United States Naval Academy	1 year each of Chemistry and Physics (with a lab if available)
University of Baltimore	3 units of science (two with labs)
University of Maryland University College	No science specific criteria
University of Maryland, Baltimore County	Science: three years
University of Maryland, Baltimore	Each of the schools at UMB have their own Admissions requirements, UMB offers mostly graduate programs
University of Maryland, College Park	Three years of science in at least two different areas, with at least two lab experiences
University of Maryland, Eastern Shore	Two years of laboratory-based science

Appendix F: Acronyms and Abbreviations

City Schools – Baltimore City Public Schools

CTE – Career Technology Education

ELA – English Language Arts

FLL – First LEGO League

ICE – Integrating Earth Science into Chemistry, a grant funded by the National Science Foundation

IQWST – Investigating and Questioning our World through Science and Technology, the middle school science curriculum

MD DLLR – Maryland Department of Labor Licensing and Regulation

NGSS – Next Generation Science Standards

PARCC – Partnership for Assessment of Readiness for College and Careers

PCAB – Parent and Community Advisory Board

SABES – STEM Achievement in Baltimore Elementary Schools, the elementary science curriculum

STAT teachers – Students and Teachers Accessing Tomorrow, a job-embedded professional development model

STEM – Science, Technology, Engineering, and Mathematics

TNTP – The New Teacher Project