

Maine School of Science and Mathematics Situation Analysis and Review of Peer Residential STEM Schools



Prepared for the Business Planning
Committee/Discovery Committee
By Hart Consulting

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Over 150 stakeholders of the MSSM community – Committee Members, Board of Trustees, Faculty, Staff, Students, Parents, and Alumni – participated in presentations of early analyses and provided valuable input that shaped the analysis and conclusions.

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Executive Summary

The Maine School of Science and Mathematics (MSSM), founded in 1995 in Limestone, serves as the state's public residential school providing science, technology, engineering and mathematics (STEM) focused curricula to some of Maine's brightest and most motivated students. The school has been successful in educating many students over the years that have gone on to pursue careers in science-based fields, many remaining in the state.

After 25 years of success, the school is facing physical and financial limitations with aging and outdated infrastructure, years of flat funding from the state, pressures on families to pay full room and board, and lack of university and research partnerships. To respond to these growing challenges, the Board of Trustees commissioned a Business Planning Committee to develop a new business model that preserves "the superior academic program in a safe environment for the students in MSSM's care and to identify partners to support the model."

The Business Planning Committee launched workgroups to conduct outreach and research to understand the opportunities and possibilities for MSSM and its role in Maine's economic and educational landscape. The Partnership Committee met with more than 35 business and education leaders in the state to seek input and the Discovery Committee commissioned research to understand the economic and education landscape in Maine, and how successful peer public residential STEM schools in other states operate. The research yielded the following findings:

Maine's State Economic Plans Call for More STEM Trained Workers as Key to Economic Growth

- Maine's economic development plans call for investments in talent, infrastructure, and innovation to fuel economic growth. The US Chambers of Commerce studies estimate that 50% of the country's growth in GDP is tied to innovation. To achieve these goals, Maine will need more STEM trained workers.

Many Maine Students Are Falling Behind in Math Proficiency and Lack STEM Opportunities

- Maine student's proficiency levels in reading and math are lower than New England states and much lower for economically disadvantaged youth compared to others in the state. 2018 11th grade math scores for economically disadvantaged were 19% proficient compared to 43% all other students.
- Too few students have access to rigorous STEM education opportunities in Maine and most are found in the regions with more resources and population.

The In-Depth Review of Six Peer Public Residential STEM Schools Provided Insights into School Operations (AR, IL, LA, SC, MI, NC)

- All but one of the schools are located in rural poor states like Maine.
- All of the peer schools are well funded by their states, 75% to 100% of the budgets are covered through state appropriations. MSSM is funded at 68%. MSSM is the only school that expects families to pay for full room and board. Some schools require meal fees and programming fees. All schools, including MSSM, offer financial aid to qualifying families.
- MSSM has the lowest enrollment capacity at 140, the others ranged from 236 to 680. With four grades, MSSM graduated the fewest students by far. Most other school have

11th and 12th grades only. The peer schools describe their value to their states as “producing numbers of STEM graduates” each year.

Key Supports for Success

While there are various operating models, the schools shared several key supports for success.

Partnerships for Research with Universities and Industry. All of the schools support students in finding research opportunities as a critical component of the STEM school experience. Five of the seven actively place students in research sites off campus. Four require research to graduate and three are active in international opportunities.

Dual Enrollment. Dual enrollment agreements with universities provide students with early college credit, providing challenging curricula and allowing them to move through higher education more quickly, saving students time and money. The formal agreements expand the course offerings and validate the rigor of the coursework as college level.

Mission Appropriate Facilities. Each of the peer schools started out in repurposed buildings, since that time most have modernized or built new buildings, and others have capital improvement plans underway. The investments and upgrades in mission appropriate facilities and dormitories support school expansion as well as student wellness and safety.

Social Emotional Health. In every school, the highest priority is student wellness including care and nurturing for the whole student to keep them active, healthy, and happy. High achieving students often have high levels of anxiety, depression, and other issues, so the schools provide wraparound support to meet their needs through residential life programming, professional counseling and health services, and wellness curricula.

Common Challenges

Along with similarities in operations, the peer schools face a common set of challenges as public, residential institutions. They remain concerned about the health, safety, and welfare of students in their care, making this a priority for success. They seek to build positive relationships with the local schools, educators, and families that send students to the residential school. The schools use their extensive outreach programming to turn the relationship into one that provides mutual value. Lastly, they find it critical to tell their students’ success stories about the value of the school and outreach programming in preparing students for successful futures.

Implications for MSSM

The peer magnet schools play prominent roles in their state’s public education and economic landscape as learning laboratories and public providers of STEM education and training to underserved students statewide. Their state legislatures have consistently supported them, helping them grow and expand their reach across the states. MSSM, like its peer schools, has been successful in creating an engaging, stimulating course of study for its high achieving students. Unlike the peer schools, it is relatively unknown in the education and employer circles in the state. Additionally, it has had no significant reinvestment or renewal since it was founded in 1995, leading some to describe it as Maine’s “hidden gem in public education.” MSSM has a strong base and years of success upon which it can grow and implement many of the best practices from the peer schools.

Background

Founded in 1995 in Limestone, the Maine School of Science and Mathematics (MSSM) serves as the state's public magnet school focused on providing science, technology, engineering, and mathematics (STEM) curricula to high achieving students in a residential setting. By many measures the school has been very successful in educating some of Maine's brightest students. In 2019, the U.S. News and World Report ranked the school second out of 17,000 public high schools in the nation and it ranked in the top twenty in the years leading up to that silver spot.

This past year, the Board of Trustees adopted two documents developed by a broad group of school stakeholders that describe the academic and social interests of the students of focus at their point of school entry and at their graduation. Those documents called Mission Appropriate Student and the Portrait of a Graduate describe the MSSM student as an enthusiastic learner, honest and respectful, and independent yet community minded and the graduate as having a mastery of knowledge in many subjects, resilience that comes from persistence, self-awareness of strengths and weaknesses, engagement in community building, and purpose that shapes goals and guides life decisions. See Appendix A.

While MSSM has been successful in educating high achieving students, it has faced difficult financial challenges. The state's allocation of funding has remained flat for the past five years, while operating costs have concurrently increased. Over the years, MSSM has asked families to pay for room and board to bridge the funding gap; it is currently set at \$9,300 per year. The staff recruited students from other countries to pay full fees to help support the school's operating costs. These stop gap measures carried the school forward, but more needs to be done.

In 2019, the Student Welfare Committee voiced concerns for student safety as well as social and emotional wellness, some of the concerns are tied to the configuration and condition of the buildings. As repurposed buildings they are not adequate to support current and future curricula in the sciences and were not designed to support a residential environment. The 2018-2019 Strategic Planning Committee identified the need to address the operational funding gap as well as to invest in the built environment.

This school year 2020-2021, the school faces many added challenges with the pandemic and economic crises. International students could not return to Maine and thus did not pay full tuition. This immediate loss in revenue forced MSSM to cut spending 14% through salary reductions, contract renegotiations, and other cuts. At the same time, the economic recession has had a large negative impact on state revenues and the high rate of unemployment (10%) has impacted families' ability to pay. The current [state revenue forecast](#) released in August 2020, posts a \$527.8 billion (10.8%) drop in revenues for this current fiscal year and \$882.3 billion drop over the next biennial budget. Governor Mills has asked all state departments and agencies to prepare recommendations for budget reductions.¹

The MSSM Board of Directors adopted two resolution statements in 2020 to address the growing challenges, reinforcing their commitment to providing the high-quality education to the students in a safe environment and commissioning a Business Planning Committee to review viable operating models and identify new investment in the school and its mission. The statements are:

- The school is committed to maintaining a superior academic program in a safe residential environment for the students in its care.
- The business model for the school needs to be reconsidered in the broadest sense, and additional resources identified for investment in the school's future.

The Business Planning Committee invited 14 members to serve on the committee, each representing an important stakeholder interest including: Board of Trustees, Executive Director of MSSM, Maine Department of Education, Maine Legislature, faculty, alumni, parent, student, and MSSM Foundation. From this broad group, they convened workgroups to set out on a fact-finding effort to inform the vision and planning work. The groups included: Discovery, Partnership, and Vision.

In July 2020, the MSSM Business Planning Committee enlisted the team from Hart Consulting to conduct a two-part study to support the Discovery workgroup in its exploration of the economic landscape for STEM education in Maine, the operating model and role of other successful STEM magnet schools in their states, and potential opportunities for MSSM to expand its reach. The first part was a situational analysis of the need for science, technology, engineering, and math education and its role in Maine's economy. The second part was a review of successful public residential STEM schools in the U.S., followed by in-depth interviews with administrators from six of the most successful schools to understand their operations and role in STEM education in their states.

Research Questions

The Business Planning Committee identified three major questions to guide the research.

1. What is the current situation in Maine for STEM education and need for STEM workers?
2. What role does MSSM play in the state's educational landscape and economy?
*How does that compare to peer public residential STEM schools in other states?
What role could MSSM play?*
3. How does MSSM's operating model compare to successful public residential STEM schools?
*What are the operating models in other states?
How do they compare to Maine's operating model?*

Purpose of this Report

This report shares the findings from the discovery work conducted by Hart Consulting from August 5th through October 9th 2020. It serves as a reference on key educational and economic indicators for Maine and provides the full set of findings from the review of the peer STEM schools.

The narrative is supported by sets of tables and figures as well as quotes from the participating interviewees. The verbatim quotes are in quotation marks and italics and are attributed to the school or state represented by the speaker to maintain the individual's privacy. Any grammatical errors or misuse of words found within those quotes reflect the conversational spirit with which they were shared.

Situation Analysis

Maine School of Science and Mathematics Profile

Established in State Statute as Maine's First Public Residential Magnet School

Maine School of Science and Mathematics(MSSM) was established in state statute, [Title 20-A, Chapter 312](#), in 1995 as the state's first public residential high school. The statute sets out the following requirements:

- The school's curriculum is designed to exceed state educational standards in the content areas of the system of learning results established in section 6209.
- Students from the state may attend the school free of tuition charges.
- The student or student's parent or guardian shall pay to the school the cost of room and board for the school year. The State shall pay the difference between the cost of room and board and the student's ability to pay the cost.
- Allows admittance for students from other states and countries and students pursuing a postgraduate high school year of education on a space-available basis by paying the cost of tuition, fees and room and board.
- Establishes a scholarship fund and an educational enhancement fund as responsibilities of the school.
- Establishes need for the school to develop a plan for statewide education programs that guarantees opportunities and access to students and educators not residing full-time at the school.
- It acknowledges the need for distance learning to reach students and educators across the state.
- **Benchmarks and assessments.** To establish benchmarks and methods of assessing progress in the levels of academic achievement in mathematics and science for students who participate in school programs and to establish benchmarks and methods of assessing progress in the professional development of teachers who participate in school programs;
- **Report.** To report annually to the Governor, the joint standing committee of the Legislature having jurisdiction over education matters and the joint standing committee of the Legislature having jurisdiction over appropriations and financial affairs on the results of the assessment in subsection 15 and the general status of the school and to provide a financial audit of the school conducted by an independent auditor.

Statute Places MSSM in Limestone

The enabling statute placed the school in Limestone Maine at the site of the former Limestone High School when Loring Airforce Base closed. MSSM currently shares the building with the Limestone Community School, a PreK – 8th grade school and has its dormitories in the former elementary school building nearby. The original Limestone High School building was built in 1973 and the building now used as a dormitory in 1952.

Finances

The MSSM operating budget for the current school year is \$5.3 million, the state's allocation is \$3.7 million, or 68% of the cost. The state's contribution has not changed in five years, even as operating costs have increased. MSSM's funding is allocated from the state's general fund within

the Department of Education budget. While initially the state covered the full budget of the school, over the years, the legislature limited its obligation to cover the academic expenses, leaving MSSM to raise full costs of room and board. To make up the gap in full state funding, Maine parents and families are currently expected to pay \$9,300 annually for room and board, non-Maine resident students are expected to pay full cost at \$42,000 in 2019-2020. The tuition payments from the international and out of state students made an important contribution to close the income gap. The school, with state support, provides financial aid to qualifying Maine students. Currently 32% of students receive support.

Students

In the fall of 2020-2021, MSSM enrolled 129 students. Students come from all over Maine, from out of state, as well as from other countries. See Table 1. Since 2015 enrollment has ranged from 124 to 148 and is capped at 140 due to bed space in the dormitories. The students are:

- 43% girls, 53% boys
- 32% from low income families
- International students over the last six years have come from Japan, South Korea, Ukraine, Vietnam, Russia, and China.

Table 1. MSSM Student Enrollment 2015 – 2021

Origin	2015/2016	2016/2017	2017/2018	2018/2019	2019/2020	2020/2021
Maine Students	122	125	122	135	126	126
International Students	2	6	12	13	11	2
Out of State Resident						1
Total Enrollment	124	131	134	148	137	129

Recruiting

Students are recruited in four ways, outreach through the Department of Enrollment, former student referrals, word of mouth, and as MSSM summer camp participants. Between 70 – 90% of the students are past summer camp participants. MSSM staff and students hold open houses each year for prospective students so they can visit campus and learn more about the residential program. The staff review all applications, culling out the students whose background does not meet the minimum qualifications. Once the high achieving students are identified, they are invited to enroll. For many years, the number of applicants has never exceeded the available spots eliminating the need for a waitlist.

Faculty

Faculty at MSSM are highly skilled instructors, all but one has a master's degrees in their area of expertise and 25% have doctorates. The student teacher ratio is 8 to 1. The school does not rely on faculty from University of Maine at Presque Isle (UMPI), rather, from time to time, MSSM faculty serve as adjunct professors at the university. The faculty are responsible for student instruction and are active on national activities such as serving as reviewers for the College Board and other national STEM boards. Except for a few, faculty are not responsible for managing extracurricular activities with the students nor work in the summer camps.

Academics

MSSM provides a challenging, rigorous academic program to its high achieving students. Its classes are higher levels than a typical public high school, offering rigorous courses of study with many AP and college level courses. The school has a relationship with University of Maine at Presque Isle (UMPI) for dual enrollment and college credit attainment. As the University of Maine System (UMS) has recently received a unified accreditation for all its campuses and programs, the early college relationship is now system wide rather than tied solely to UMPI. While the change opens more options for dual enrollment, it comes at a cost. UMS will now receive the aspirations funding for the enrolled students and MSSM faculty who are teaching the classes will no longer receive that stipend (\$128/credit/student). With the early college opportunities, the students may be eligible to earn an associate's degree upon high school graduation, if they choose that path of study.

MSSM has a very skilled academic counseling service that helps students with their college applications and career planning. The services start in the 11th grade and follow the student through the application process, including seeking financial aid and merit scholarships.

Student Achievement

MSSM students are high achievers, consistently earning high scores on standardized tests. Over the past five years, 95% of students who took at least one AP test, scored a 3 or better on at least one of the tests. This compares to 60% for Maine students who take at least one AP test. The mean test score for MSSM students over the same period was 3.9 out of 5 points, with a mean of 4.2 on the math test. The class of 2020 had nine of its 41 graduates recognized in the 2019 National Merit Scholarship Program.

In addition, the students excel in a variety of academic competitions, outperforming other schools and students. The math team has won the state meets for the past five years, the robotics teams VEX and SeaPerch have won seats at international competitions. The Science Bowl Team has repeatedly represented the state at national competitions.

Residential Life, Social, Emotional and Physical Wellness

MSSM follows a typical boarding school approach to managing residential life with student supports for residential life, physical and mental health, as well as requiring students to engage in a wellness curriculum. There are six adults living in the dormitory with the students. Of those, four are residential life instructors who organize outings, celebrations, arrange for shopping trips, and help students transition into the residential school. The full-time nurse also lives in the dormitory with the students and residential life staff. The nurse dispenses medications and checks on student physical health. MSSM has a contract with Aroostook Mental Health Center (AMHC) to provide mental health services in the dormitories on weekdays as well as through appointments paid for by the student's health insurance. As an important part of residential life, the students participate in a wellness curriculum to learn a variety of life skills ranging from legal consent, Title IX, living with a room-mate, among other topics related to maturity and setting boundaries.

In addition, the school offers extracurricular programming. The students can choose to participate in a variety of groups – soccer, theater, robotics, to name a few. Key Club is a popular extra-curricular group. They also are expected to have jobs on campus such as cleaning crew, assisting

faculty, and other assignments. The wellness instruction and the work duties reinforce the students' place as part of the MSSM team.

Outreach Activities

MSSM operates a summer camp for middle school-aged students every summer. The camp, run largely by adults who are not on the faculty, provides a hands-on, problem-solving experience for students. Annual enrollment is approximately 500 students. The camp provides students with the opportunity to sample STEM education and spend time on the campus. Many of the MSSM students attended the camp prior to enrollment.

MSSM had planned a professional development opportunity for STEM educators in the summer of 2020. The course was rescheduled due to the coronavirus pandemic. The program has grant funding for three years.

Graduates

MSSM students go on to study at prestigious universities, with about 30% staying in state. A recent review of an alumni survey shows that many go on to science and math focused careers – engineers, software developers, physicians, college professors, researchers, chemists, and management positions. Roughly, 27% of the graduates have stayed in Maine.

Maine's Economic and Educational Landscape for Science, Technology, Engineering, and Mathematics Professionals

The Need for STEM and Innovation

STEM jobs fuel innovation and innovation drives economic growth. The jobs of the 21st century are dependent upon STEM skills and knowledge, with one out of five jobs requiring these skills. Moreover, 35% of all STEM job openings will not require a bachelor's degree, making high school STEM training and post-secondary credentialing important supports for employment.

STEM Jobs are Growing Faster and Pay More than Non-STEM Jobs

[A 2017 report from the U.S. Department of Commerce](#) shared that STEM jobs, defined as professional and technical support occupations in the fields of computer science and mathematics, engineering, and life and physical sciences, grew faster than non-STEM jobs in the previous ten-years (24.4% compared to 4.0 percent, respectively).² The U.S. Bureau of Labor Statistics projects that STEM jobs will grow by 8.9 percent from 2019 to 2029, compared to non-STEM growth of 3.0 percent.³ Employees in STEM occupations earned higher wages in 2019, \$84,880 in STEM versus \$37,020 for non-STEM jobs. Among the STEM workers, there are lower wage gaps for women and minorities compared to non-STEM fields.

Maine is Falling Behind in the STEM Economy

Comparing Maine's economic activity in STEM fields shows that the state is far behind the U.S. The National Science Foundation STEM Indicators shows in 2017 annual spending on research and development accounted for 2.80% of US Gross Domestic Product (GDP) compared to Maine at 0.84%. It showed that Maine ranked last out of all states for new STEM doctoral graduates produced per 1,000 employed STEM professionals with doctorates (US 50.9 versus Maine 18.1). Even more telling is that in 2018, the percentage of science and engineering jobs as a percentage of all jobs was 4.89% in the US and 3.57% in Maine.⁴

Maine's Economic Plan Shows STEM Jobs are Critical to Growing the State's Economy

Maine's current economic development strategy, [Maine Economic Development Strategy 2020 – 2029 | A Focus on Talent and Innovation](#), focuses on building talent, spurring innovation, and strengthening infrastructure.⁵ The plan points out that future growth is dependent upon growing the workforce, particularly in science-related jobs such as engineering, technology, and research to support priority growth sectors. The plan addresses four fundamental challenges to economic growth and identifies three growth sectors:

Challenges

- **44.9 vs. 38.2 Median Age** - Maine is the oldest state in the nation with median age of 44.9 compared to 38.2 nationally.
- **50% Loss of Manufacturing Jobs** - Maine lost close to 50% of its manufacturing jobs from 92,300 in 1994 to 52,900 in 2018.
- **5% Point Drop in Earnings** - Average annual private sector employee earnings fell from 83% to 78% of the national average over the last 20 years.
- **25% Less Output/Worker** - Average job in Maine produces about 25% less output per worker (\$88,000 compared to \$120,000 nationwide).

Growth Sectors

- **Wood fiber, renewable energy, and food systems.** The plan identifies key growth sectors based on Maine’s natural resources. It calls for new and innovative ways to use wood fiber, expand the renewable energy sector, and continue to support food systems including agriculture, aquaculture, and value-added food products such as prepared meals and craft beer.

In addition to the state economic plan, the 2016 Maine Innovation Economy Action Plan developed by the Maine Innovation Economy Advisory Board also calls for the state to improve STEM skills at all levels of the educational and workforce pipeline in Maine. Strategies to achieve this include:

- Focus post baccalaureate courses where companies are resident
- Expand remote learning in Science, Technology, Engineering and Mathematics (STEM) courses
- Increase financial aid for post-secondary students in STEM disciplines
- Attract high-quality faculty and graduate students in STEM disciplines through assistance with student loans
- Expand paid internships to high school students and teachers
- Expand “non-traditional” learning for students from different parts of the pipeline (e.g. short courses, seminars, non-credit)

Maine Department of Labor Forecasts an Increase in Engineering and Other STEM Jobs Openings as Baby Boomers Retire

The Maine Department of Labor’s recent forecasts highlight a growing need for STEM trained workforce. In its [Workforce Outlook report](#), it is forecasting 908 job openings in mathematics and computer science jobs and an additional 395 in life, physical, and social science occupations per year from 2016 to 2026. In addition, healthcare practitioners and technical occupations will have 2,671 openings per year.⁶ These openings are from new jobs as well as filling vacancies from retirements. There will be many more jobs that require STEM skills but may not be referred to as a STEM job. To sustain and grow Maine’s economy, more students will need to pursue STEM fields.

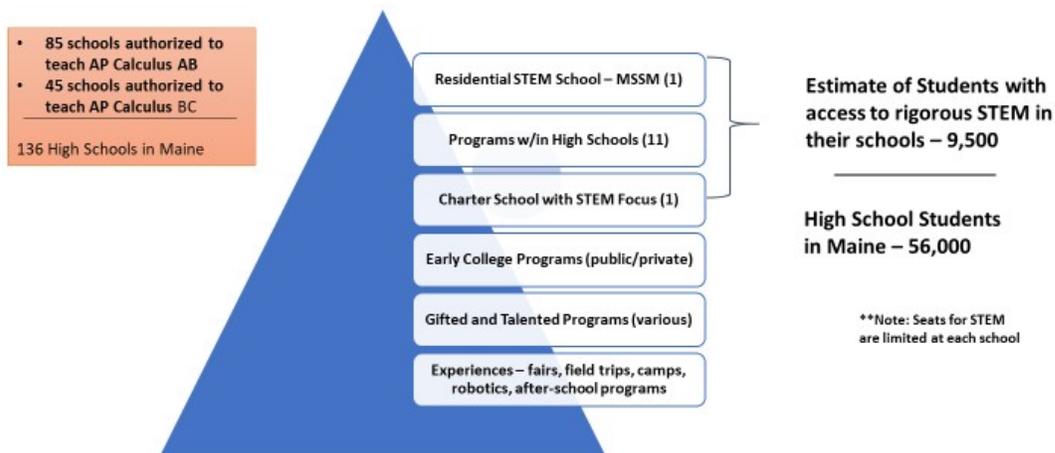
Maine's STEM Educational Opportunities

There are a variety of programs that offer STEM curricula and hands on learning opportunities to high school students in Maine. These include regular course work on science and math, AP courses, in-school STEM programs, the residential magnet school (MSSM), a STEM charter school as well as in a variety of extracurricular activities including camps, fairs, and field trips.⁷ See Figure 1.

While there are a growing number of STEM opportunities, student access is not universal. Oftentimes access to the specialized programs is limited by geography and program capacity. For example, many Maine schools have “Gifted and Talented” programs for high achieving students, it is not clear how many include a STEM focus. Using another measure of access to rigorous courses of study, in 2020, there were 85 high schools out of 136 with a faculty member authorized to offer AP Calculus AB and 45 authorized to offer Calculus BC.⁸ Moreover, some of these extracurricular programs may require a fee or tuition payment. We estimate that 9,500 students out of 56,000 statewide attend high schools with a rigorous STEM program, but it is important to note that the programs have limited number of spaces available to those students, further reducing the number of students with access.

Figure 1.

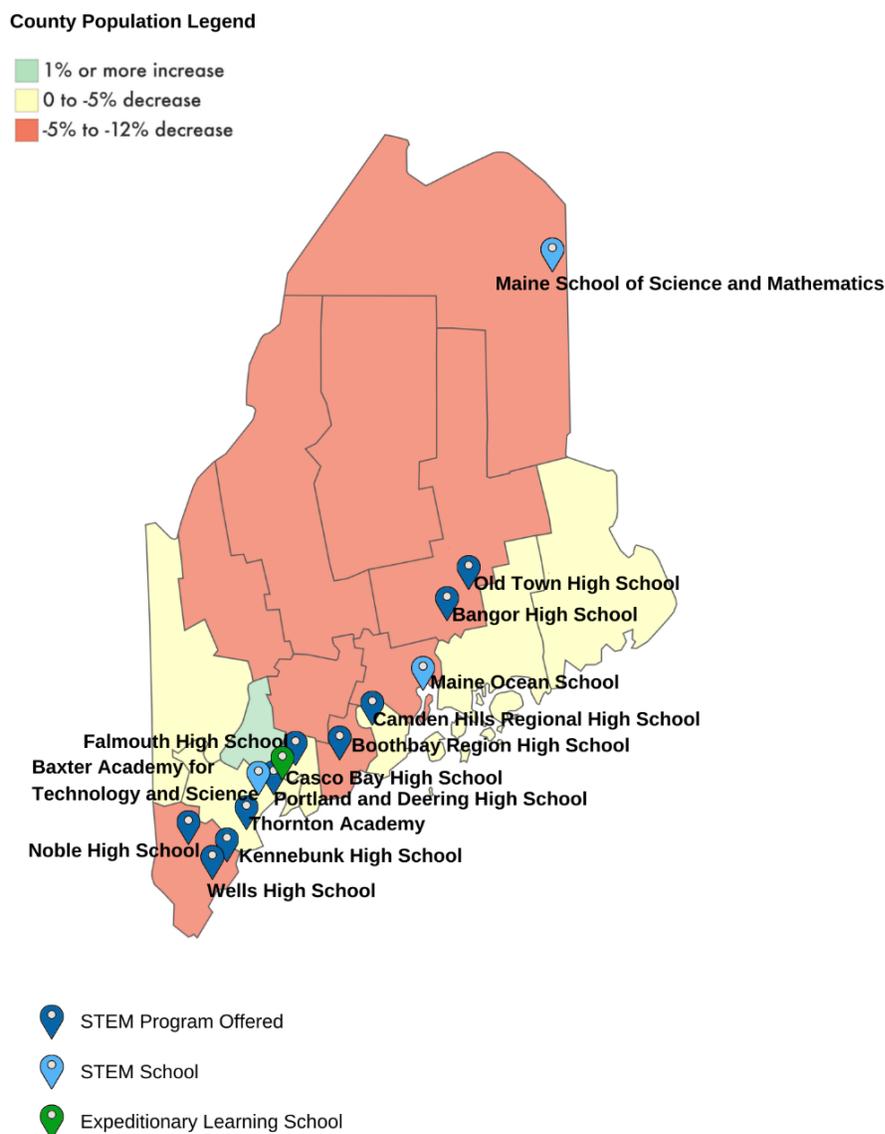
STEM Education Opportunities in Maine are Limited



Taking a closer look at student access to STEM educational opportunities, Figure 2 shows that the current high school STEM programs tend to be located in schools along the more populated I-95 corridor and MidCoast region located in 7 of Maine's 16 counties, with few or no programs in western, central, and far eastern Maine. The map also shows that the counties with the greatest drop in student enrollment are also underserved. That means that the students in the rural outlying areas have fewer opportunities than their peers in the more populated regions.⁹

When looking at the nine counties with limited access, these counties tend to have far fewer students enrolled in public school (all grades), declining school populations, and lower income levels, see Figure 2 and Table 2.

Figure 2. Map of Enhanced STEM Learning Opportunities for Maine High School Students



Maine's Population is Aging and Public-School Enrollment Declining

Over the past twenty years, Maine has seen slow population growth overall and negative growth in several counties. The population is growing older and birthrates are down, leading to lower enrollment in the public-school system. The [National Center on Education Statistics estimated a -](#)

13% loss in student population over the past two decades, with projections of additional loss (-3%) going forward. Table 2 shows the change in student enrollment in public schools by county over the last decade. Except for Androscoggin county, all counties had lower enrollment, with Aroostook, Piscataquis, Waldo, Kennebec, Somerset, Penobscot, Franklin, Lincoln, and York having greater percentage losses than the state average of -5%.

Table 2. Change in Maine Public School Enrollment, 2011 to 2020

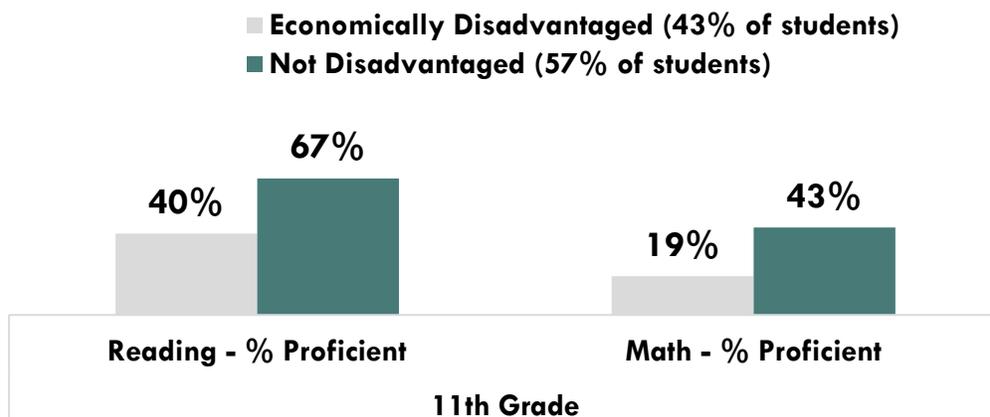
County	Median Household Income (2018)	Student Population change from 2011 to 2020
Androscoggin	\$51,412	4%
Aroostook	\$39,824	-12%
Cumberland	\$69,708	-2%
Franklin	\$48,053	-6%
Hancock	\$53,068	-1%
Kennebec	\$52,929	-7%
Knox	\$55,402	-2%
Lincoln	\$55,180	-7%
Oxford	\$47,275	-4%
Penobscot	\$49,374	-6%
Piscataquis	\$39,470	-11%
Sagadahoc	\$62,131	-5%
Somerset	\$42,491	-8%
Waldo	\$51,564	-9%
Washington	\$41,384	-4%
York	\$65,538	-6%
State	\$55,425	-5%

Sources: Maine Department of Education Public School Enrollment Data and U.S. Census Bureau (accessed from Maine Department of Labor, [CWRI website](#).)

Maine High School Students are Not Meeting Proficiency Standards in Reading or Math

Along with diminishing student population, Maine high school students are faring poorly on proficiency tests. See Figure 3. Of all 11th grade students, 57% are proficient in reading and 35% in math. When looking more closely at the data, economically disadvantaged students perform far worse than those who are not. In reading scores, the proportion of economically disadvantaged students that are proficient is 27 percentage points lower than those who are not in reading. In math, fewer than 20% or one in five economically disadvantaged students is proficient.¹⁰ Low performance in math proficiency scores, starting with 36% proficient in math in 8th grade, has been identified as a red flag for student success and economic development in the Maine [Economic Growth Council's 2019 Measures of Growth Report](#).

Figure 3. Maine Public School Student Proficiency in Reading and Math, 2018



SOURCE: Maine Assessment and Accountability Reporting System (MAARS), <https://lms.backpack.education/public/maine>

Implications for MSSM and STEM Education in Maine

Maine's employers and workforce have a growing need for STEM education and more STEM graduates to fill the jobs that will help grow the economy. While Maine's education sector has developed several innovative STEM programs, the programs may not be reaching the students in the outlying and poorer regions. The low proficiency scores for disadvantaged students underscores the need for strengthening STEM education for all students.

MSSM's enabling legislation establishes the need for the school to develop a plan for statewide education programs "that guarantees opportunities and access to students and educators not residing full-time at the school." It also acknowledges the need for "distance learning to reach students and educators across the state." Given its record of providing high quality STEM education, MSSM has an opportunity to fulfill its mission by providing outreach and distance learning opportunities to those students and educators in underserved communities.

Peer Public Residential STEM School Review

Methods

In August and September 2020, the team at Hart Consulting reviewed 15 public residential STEM schools to understand their operating models and key factors for success. They conducted a web-search to locate public documents, datasets, and background descriptions on all 15 schools and followed up with in-depth phone interviews using a structured set of questions with administrators of seven of the most successful schools. The successful schools were selected on the advice of the Executive Director of the National Consortium for Specialized STEM Schools, a professional association for public residential STEM schools. See Table 3.

In addition, they interviewed two leading STEM education professionals in Maine, one from the Maine Department of Education, the other from the Maine Mathematics and Science Alliance. The interviews lasted 60 minutes on average and some respondents provided follow-up information. The interviews were conducted between August 12, 2020 and September 11, 2020. Each recorded on the Zoom web conferencing software and transcribed using the online services Rev.com.

Limitations

The review was conducted using publicly available documents and the findings are subject to the limitations of the original source. In addition, the phone interview information was not independently verified and may be subject to the limitations of the respondents' recollection or knowledge of the subject matter as well as the interviewer's interpretation. In several cases, such as with financial data, additional in-depth research is recommended.

Web Research and In-depth Interviews

- Arkansas School for Math, Sciences, and the Arts
- Illinois Mathematics and Science Academy
- Louisiana School for Math, Science, and the Arts
- Maine School of Science and Mathematics
- Mississippi School for Mathematics and Science
- North Carolina School of Science and Mathematics
- South Carolina Governor's School for Science and Mathematics

Web Research Only

- Alabama School of Mathematics and Science
- Gatton Academy of Mathematics and Science in Kentucky
- Georgia Academy of the Arts, Mathematics, Engineering, and Science
- Indiana Academy for Science Math and Humanities
- Kansas Academy of Mathematics and Science
- Missouri Academy of Science, Mathematics, and Computing-CLOSED
- Oklahoma Schools of Science and Mathematics
- Texas Academy of Mathematics and Science

Table 3. STEM School In-depth Interviewees and Schedule

Public Residential STEM School or Stakeholder	Interview Date
South Carolina Governor's School for Science and Math	8.14.20
Mississippi School for Mathematics and Science	8.19.20
Illinois Math and Science Academy	8.20.20
North Carolina School of Science and Mathematics	8.20.20
Louisiana School for Math, Science and the Arts	8.25.20
Arkansas	8.26.20
Department of Education	8.26.20
Maine Math and Science Alliance	9.11.20
Maine School of Science and Mathematics	8.21.20 9.22.20

Peer Schools' Background

Peer Schools' State Demographics

The six peer public residential STEM schools vary in demographic complexion from each other and from MSSM. See Table 4. Three are poorer southern states, Arkansas, Louisiana, and Mississippi, two are northern states including Illinois and Maine. Five of the seven schools' states have low population counts, while Illinois and North Carolina are among the nation's most populated states, ranked 6th and 9th respectively. Maine stands out as the most rural state with a population density of 44, closer to Arkansas (58) and Mississippi (64) also with low density. Illinois, North Carolina, and South Carolina have higher densities and more urban areas than the four other states.

The peer school states differ in median household income with Illinois topping the list above the national average at \$70,145 and Mississippi, the lowest, with \$42,781. Maine has the second highest median household income level of the group, but it is below the national average. The educational attainment rates rankings are similar to income, the rates range from Illinois with the highest at 35.8% of the population over the age of 25 with a bachelors degree or higher to Mississippi as the lowest at 22.3%. Maine has the next highest attainment rate at 33.2% and is slightly higher than North Carolina 32.3%.

Table 4. Peer Schools' State Demographics

	Population 2019	Population Density 2020 (p/sq mile)	Median HH Income 2018 (\$)	Bachelor's Degree or Higher 2019 (%)
U.S.			63,179	33.1
Arkansas	2,915,918	58	49,781	23.3
Illinois	12,830,632	228	70,145	35.8
Louisiana	4,533,372	108	49,973	25.0
Maine	1,328,361	44	58,663	33.2
Mississippi	2,967,297	64	42,781	22.3
North Carolina	9,535,483	218	53,369	32.3
South Carolina	4,625,364	173	57,444	29.6

Source: U.S. Census Bureau Data, accessed through State Fact Finder.

Governance and State Oversight

The seven public residential schools are autonomous in their operations but each has a different relationship and place in its state government budget and oversight. See Table 5. Like a local public school, each manages its own budget, faculty and staff, however, they are exempt from many, if not most, of the K-12 state requirements that local public schools have to meet. Their faculty do not have to be certified public school teachers and their course curricula are not guided by the state. Three schools' budgets are found in the higher education systems, one is a standalone item under the Board of Education, two are in the Governor's budget, and two are

budget lines in the state's K-12 education department. Four of the schools own their own buildings, two lease their buildings from their host university. Maine leases and owns its buildings.

Table 5. Peer School Governance and Building Ownership

School	Year Founded	Governance	Building Tenancy
Arkansas School for Math, Sciences, and the Arts	1993	Higher education system	Own New buildings 2012, 2019
Illinois Mathematics and Science Academy	1986	State agency under the Board of Higher Education	Own
Louisiana School for Math, Science, and the Arts	1983	Governors budget	Lease buildings from host university
Maine School of Science and Mathematics	1995	Department of Education, K-12 Budget	Own and share buildings
Mississippi School for Mathematics and Science	1987	Board of Education (k-12 system)	Lease buildings from host university
North Carolina School of Science and Mathematics	1980	Higher education system	Own buildings Built new second campus across the state
South Carolina Governor's School for Science and Mathematics	1988	Governor's budget	Own Built new in 2001

State Support for Public Residential STEM Programs

The six peer residential STEM schools receive strong support from their states. Four of the schools receive more than 95% of their budget from state allocations. The two receiving 100% are part of their state's university system. Two states with lower per capita income than Maine, Louisiana and South Carolina, support 95-98% of their residential STEM school budget. Mississippi, the state with the lowest mediana household income in the set, provides 75% of the school budget. MSSM stands apart with only 68% of its budget paid by the State of Maine. See Figure 4.

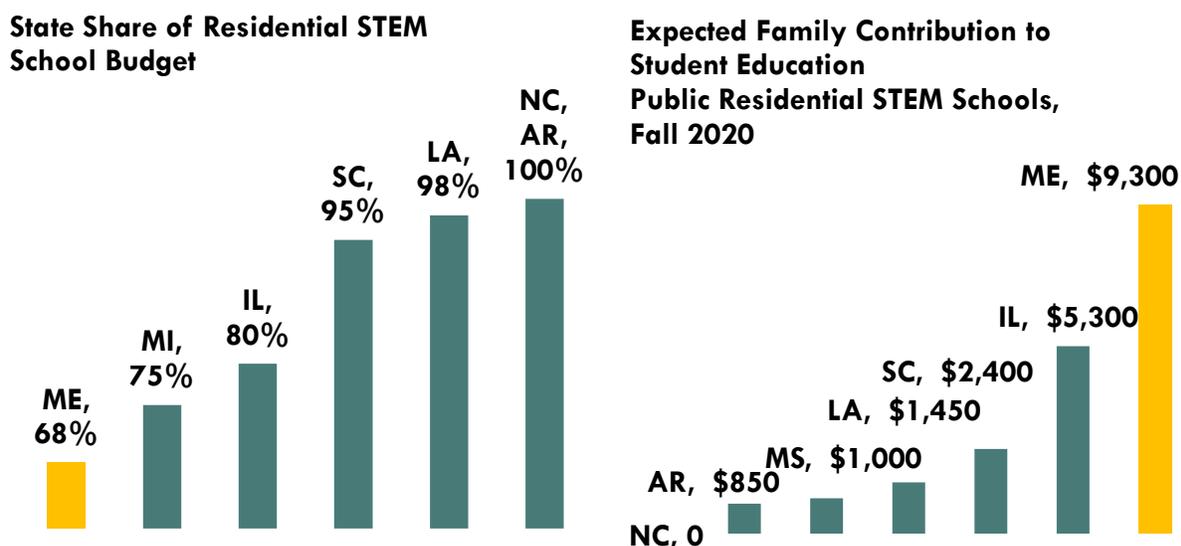
Perhaps a better indicator of state support and success is a school's plan for growth. Currently, North Carolina is building a second public residential STEM school campus across the state from their flagship high school and Illinois and Arkansas are in the planning stages of adding more dormitory facilities to upgrade facilities and expand student enrollment. Arkansas completed a new \$18 million dormitory project as recently as 2012.

Family Support

Five of the six peer schools expect families to contribute fees to cover meals, as they would if the student were at home attending high school. They all had a means to subsidize these fees for qualifying families so that no student was turned away due to inability to pay. Illinois has a sliding scale fee system. MSSM has the highest required contribution, asking families to cover both room and board. It also has financial aid available from the state to support low income students. See Figure 4.

“We’ve had great support even through the recessions of the early 2000s to not lose speed. I mean, we were building a massive building right when the recession hit, and it continued to be built. The state recognizes the benefit that we bring.” South Carolina

Figure 4. State and Family Contributions to Public Residential STEM School Budget



Peer School Enrollment and Graduation Rates

The schools range in student body size from 129 in Maine to 680 in Illinois. All of the schools host grades 11 and 12, while three currently offer grade 10. Arkansas is piloting a 10th grade class and South Carolina has approval to add 10th graders, but has not opened that option yet. The peer school representatives described their student degree completion as the “number of STEM graduates produced each year,” a reminder of the value to the state’s education and economic landscape.

In discussing enrollment, the school representatives explained that the residential schools’ enrollments are typically constrained by the capacity of the dormitories. If an additional grade is added, it would more than likely result in reduced slots for upper grades, thus reducing the number of STEM graduates each year. However, some of the schools are exploring adding 10th grade so that the students have more time to cover foundational and elective coursework before they graduate. See Table 6 and Figure 5.

Maine has the lowest number of graduates each year, but it compares better when calculated as a per capita rate where it falls closer to the middle of the range. See Figure 6. In comparing acceptance rates, the comparison schools report turning qualified applicants away each year. Maine typically accepts all qualified applicants and rejects unqualified ones. See Figure 7.

Table 6. Peer School Student Enrollment

School	Number of Students Enrolled	Grades Served			
		9 th	10 th	11 th	12 th
Arkansas School for Math, Sciences, and the Arts	236		P	✓	✓
Illinois Mathematics and Science Academy	652		✓	✓	✓
Louisiana School for Math, Science, and the Arts	360		✓	✓	✓
Maine School of Science and Mathematics	140	✓	✓	✓	✓
Mississippi School for Mathematics and Science	239			✓	✓
North Carolina School of Science and Mathematics	680			✓	✓
South Carolina Governor's School for Science and Mathematics	271		E	✓	✓

Key: P= Piloting; E=Exploring

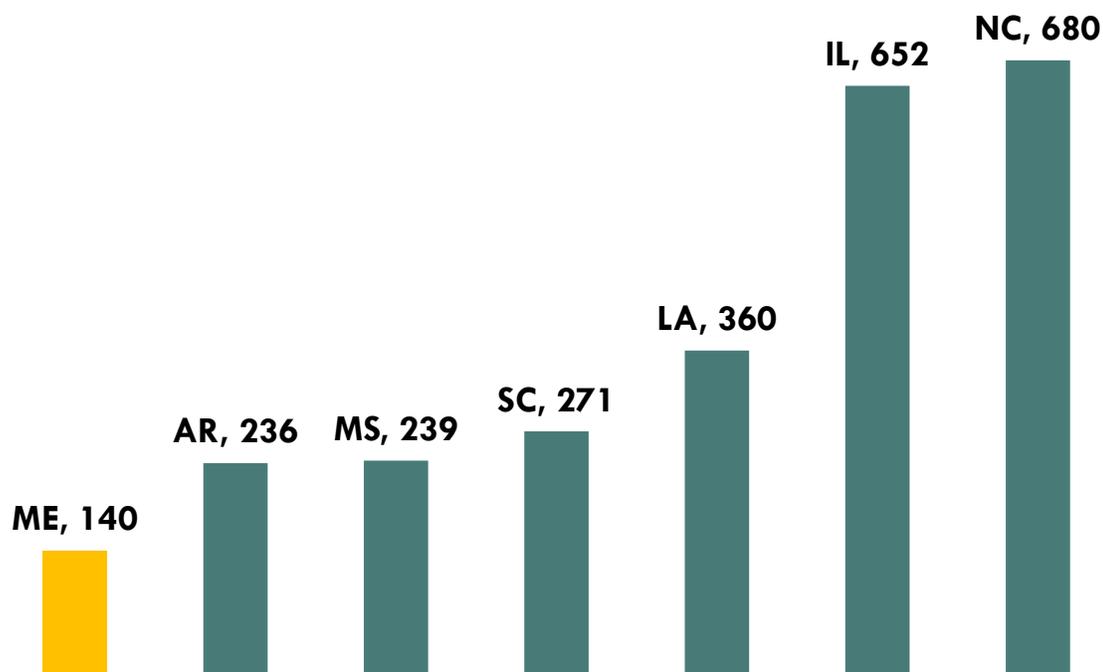
Figure 5. Number of Students Enrolled Public Residential STEM Schools, 2020

Figure 6. Annual Graduates per 100,000 Population Public Residential STEM Schools

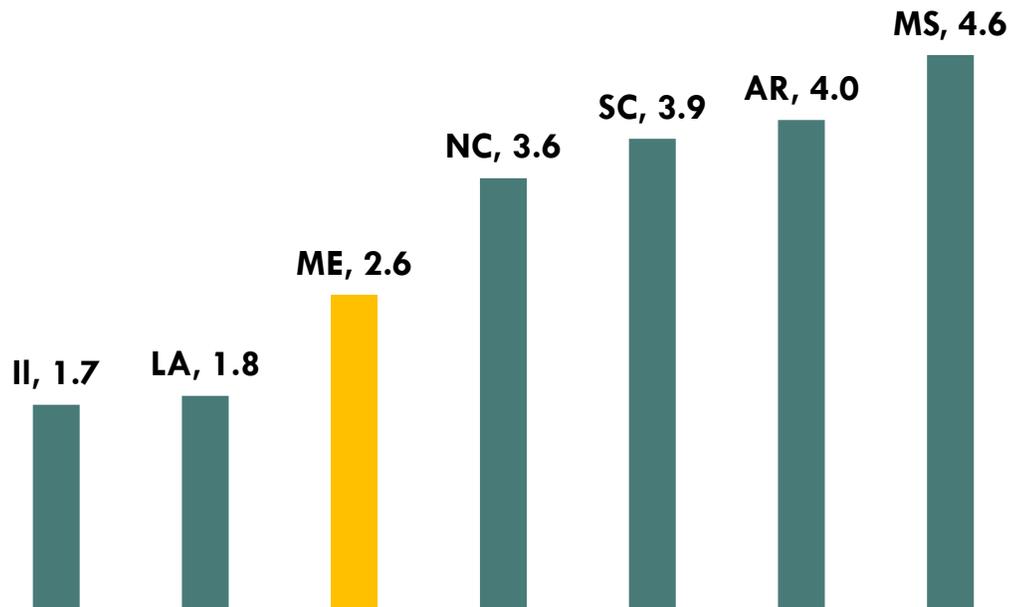
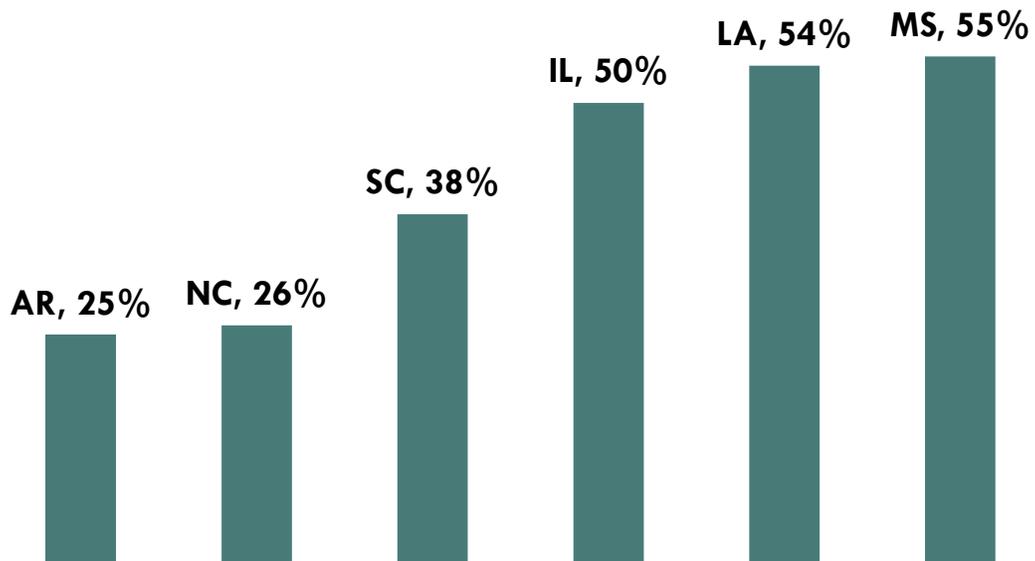


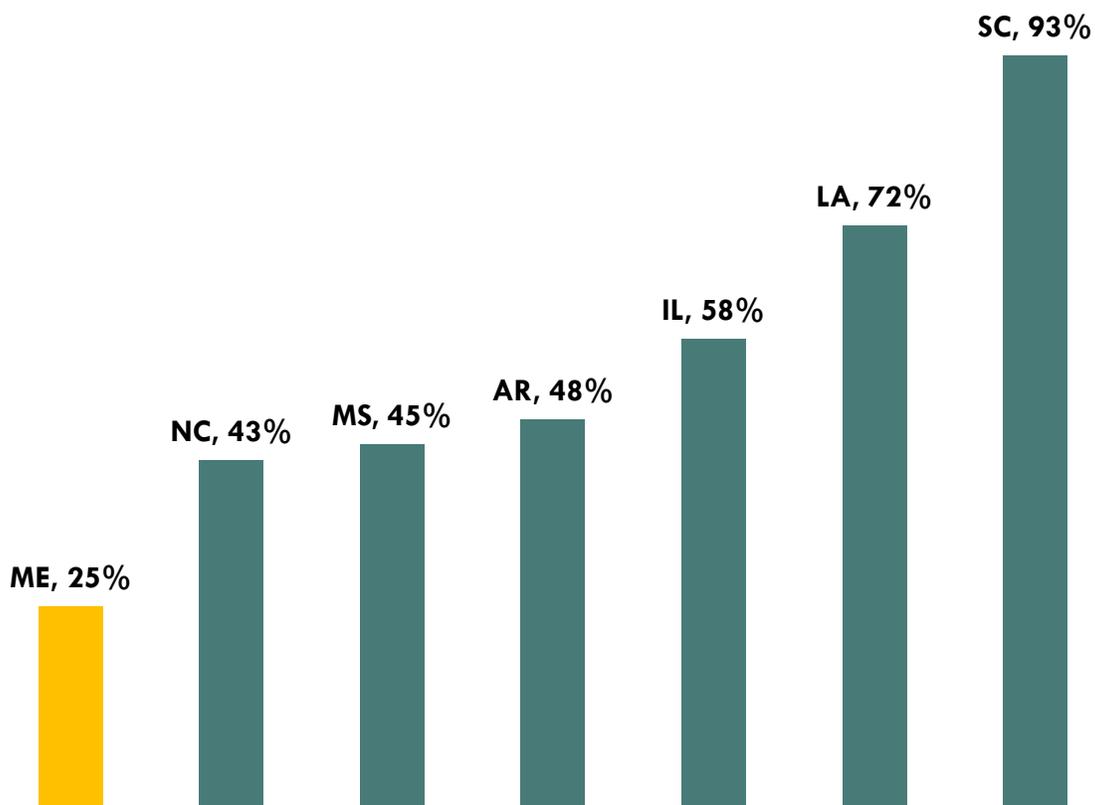
Figure 7. Acceptance Rates from Qualified Students, Public Residential STEM Schools



Faculty Training

The peer public residential STEM schools' faculty come from higher education, secondary education, and industry with many obtaining terminal degrees in their fields. The interviewees described that their faculty join the school because they enjoy working with the high performing students in the dynamic environment. MSSM enjoys the same faculty expertise and commitment to teaching, albeit having a lower share of doctorate level faculty members compared to peer schools. See Figure 8.

Figure 8. Faculty with Doctorates or Terminal Degrees Public Residential STEM Schools



Peer Schools' Role in STEM Education in their States

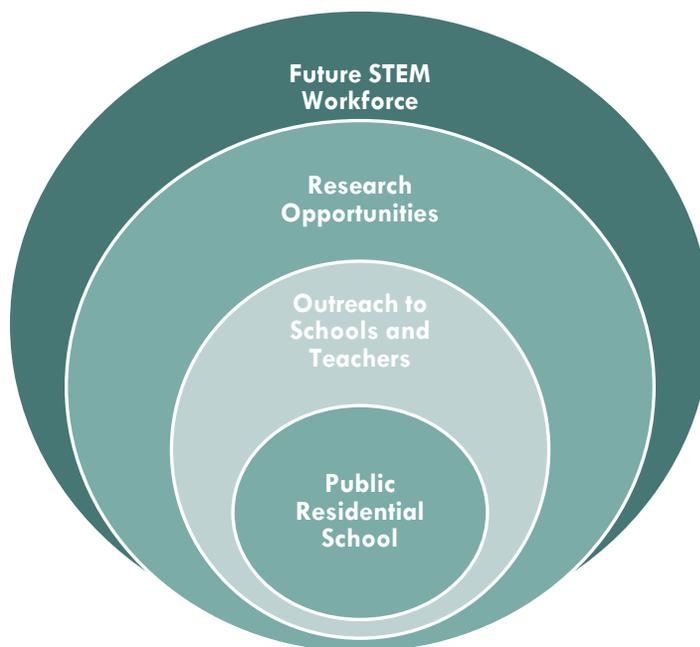
The six peer school representatives described their school's role in the state economic and education landscape as an important pipeline to provide talent in the STEM fields to support the state's research and development initiatives and strengthen the economy. They emphasized the short term value of preparing students for post-secondary education as well as when they return later in their careers to relocate or start a business.

"... to immediately provide a high-quality option for STEM education for students across the state, but longer range is building that knowledge economy for our state." South Carolina

The North Carolina school commissioned an economic impact study in 2010 that estimated its annual investment of \$20 million created \$500 million in annual economic impact for the state. The study described of the 8,200 alumni, 55 percent have degrees in STEM fields and more than 50 percent live and work in North Carolina. The five other peer schools experienced similar experiences with upwards of 60% of the graduates going on to earn STEM degrees and 50-60% staying in-state to attend higher educational institutions.

At the core of this mission is the residential STEM program that serves as the laboratory of learning to support a wide web of outreach activities in the states. Each school described their charter or enabling legislation requiring outreach to students and educators statewide, spreading their reach beyond the residential program through distance learning, satellite programming, and content/curricula development. See Figure 9.

Figure 9. Core Mission Supports Economic and Education Landscape



Another commonality among the schools is an emphasis on research, oftentimes through a partnership with a university or research laboratory in addition to laboratories on campus. The school representatives also described intentional efforts to reach the whole state, with specific attention on serving disadvantaged regions and students. As a result of the statewide presence

and academic rigor, the schools are sought after by high performing students and well known by educators across their states.

“The mission of North Carolina School of Science and Mathematics is to: educate academically talented students to become state, national, and global leaders in science, technology, engineering, and mathematics; advance public education in North Carolina; and inspire innovation for the betterment of humankind, through challenging residential, online, summer, and virtual learning driven by instructional excellence and the excitement of discovery.” North Carolina School of Science and Mathematics Mission Statement

“The Arkansas School for Mathematics, Sciences, and the Arts, a campus of the University of Arkansas System, is a public residential high school serving academically and artistically motivated students of all backgrounds from throughout the state. ASMSA’s community of learning exemplifies excellence across disciplines while serving as a statewide center of academic equity and opportunity that ignites the full potential of Arkansas’ students and educators.” Arkansas School for Mathematics, Sciences, and the Arts Mission Statement

STEM School Operating Models Support their Missions

In reviewing the seven schools, including MSSM, four operating models emerged that have implications for carrying out the mission: the residential school operations, outreach to the state, and research opportunities. The first model is a stand alone campus model found in South Carolina and Illinois. The second model has the residential high school co-located with a state university such as in Mississippi and Louisiana. The third has the residential STEM high school as a stand alone campus of the state university system as found in Arkansas and North Carolina. The fourth, in Maine, is a stand alone campus co-located with a grade school. See Table 7.

The stand alone campuses had several advantages in fulfilling their missions including having ties to multiple universities for research opportunities and dual credit enrollment. While it wasn’t always easy to work through agreements, they found that having options created more opportunities for students. These schools, in Illinois and South Carolina, describe strong ties to businesses and private laboratories for research and sponsorships.

Table 7. Public Residential STEM School Operating Models

Operating Models	Standalone Campus	Located on College Campus	Campus of the State's University System	Co-located with Local Public School
State Residential STEM School	SC, IL	MS, LA	NC, AR	ME
Faculty Pool to Fill Open Positions	Good	Very Good	Best	Limited
Access to Residential Life Workforce	Good	Best	Good	Limited
Dual Enrollment	Multiple Agreements	Host Campus	Across the University System	Specific Agreement
Ties to Large Research University	Good	Good	Best	Limited
Ties to Businesses and Private Laboratories	Very Good	Varies	Varies	Limited

The campuses that are co-located on a college or university campus benefit from having the amenities, faculty, students, and staff of the university on-hand. They seemed to have lower operating costs as a result of sharing many of the overhead costs with their host. The Mississippi school in particular benefited from sharing the medical, recreational, and library facilities of its host university. When needed, those schools were able to use host university faculty to fill in vacancies on a short-term basis. They also had access to the students, graduate students, and faculty families as a ready pool of applicants to serve as residential life staff.

The campuses of the state university systems in Arkansas and North Carolina are stand alone campuses with full recognition that they serve as the magnet STEM high school of the university

system. They have access to many of the university benefits – healthcare and faculty status without the “publish or perish” requirements. They have wider access to dual enrollment for students as well as to research opportunities.

The MSSM model, the only school with a 9th grade class, benefits from the safety of being located with a public PK- 8 grade school with no routine interactions with older college students.

There is a fifth model among the wider set of 15 public residential STEM schools where the high school is integrated into the university system as an early college model, and all the faculty are university faculty. This configuration benefits the high school by allowing it to focus solely on the student experience, while sharing the faculty and support services of the larger university.

Social Emotional Wellness and Residential Life

Each of the school representatives shared the importance of providing a safe, supportive, nurturing environment for the students. For the most part, students enjoy being in the residential setting with their high performing peers. However, for many, it is their first time away from home and their first time in a challenging academic environment which can be difficult transitions. All seven schools, including MSSM, recognize the need to care for the social, emotional, mental, and physical health of the students to help them thrive. To provide these important services, the schools use a whole student approach to link three aspects of student life – residential living, physical and mental health, and oftentimes, a wellness curriculum. Each school sees the mental health counseling services as critical and separate from academic counseling. See Figure 10.

“...our academics are great, but students don't talk about academics when they graduate from IMSA, they talk about the friendships and their residential life. They talk about the people at IMSA.” Illinois

"Your students may have never experienced anything before in terms of any emotional issues." But the level of stress that they've never felt before when they come here, when you're talking about a more rigorous learning environment, sometimes they're going to be stressing for the first time. Sometimes they're going to make a grade that's not an A for the first time. Sometimes they're going to make a failing grade on an assignment for the first time, and it's going to be devastating to them. And so you may see some things that come up that were underlying, that you've never seen before." Mississippi

Figure 10. Public Residential STEM Schools use a Whole Student Approach



Residential Life

Each of the schools describes having a strong network of caring adults supporting the students in the dormitories. They describe having one adult in charge of the students in a residential building, with additional staff assigned to hallways or wings, depending on configuration. The building directors, in many cases, have bachelors degrees in a related field such as student affairs. The residential assistants sometimes have bachelors degrees or are graduate students studying student affairs. These residential life staff manage the students' dorm life, make arrangements for shopping trips, outings, parties, and other activities. Typically, the residential life staff serve as mentors or adult care-givers to the student residents. They have ready access to administration and parents to meet the students' needs.

"I want to make sure that they know how much we value them. But we can't really pay them enough, because they have the toughest job in the school. They live with the students."

Mississippi

"[Residence Life Coordinators] live on campus. They are the only live-in staff, so those six people, and they rotate. They're on duty 24/7. They get their days off, but someone's always there, and the parents have that phone number that rotates to whoever is on duty. Their main goal is really to be the parent, for lack of a better term, but after that responsibility, which is always there, they actually do a lot of programming outside the classroom for the students. They manage all of our dances, a lot of our clubs, a lot of just field trip activities on the weekend, taking kids to the doctor, taking kids to Walmart for a store run, and that kind of stuff." South Carolina

"Our counselors call it the support diamond, which is the community coordinator, the counselor, the students' academic advisor, and then we include the parents in that." North Carolina

Physical and Mental Health Services

Student physical and mental health are priorities for each of the schools. All of the interviewees expressed how important it is to make sure the students have the supports they need to be safe and healthy, mentally and physically. Louisiana, Illinois, and Mississippi discussed how they weave mental health supports into every aspect of the student and staff experience so that is part of the culture. The schools support three separate but coordinated services in a wholistic approach to keeping students healthy: nursing, mental health counseling, and lifeskill classes.

"Those two offices, that nursing staff and the wellness staff, really partner together for the overall wellness of our students. Like I said, we've been saying it for years and we finally put our money where our mouth is and went from one to two and a half wellness counselors."

South Carolina

"...about a dozen years ago....we had a single counseling center with wellness counseling, social counseling and college counseling all in that same space. The institution determined that it was wise to split those two sets of duties, so that students could engage with wellness counseling, with professionals who were not also writing college recommendation letters".

Louisiana

“Mental health and wellness has been a big topic and goal for us. And so, we do a variety of different whether they be individual counseling, personal counseling, group counseling, and we plan activities that try to have students out exercising physically, whether that be through intramurals, or yoga or... whatever those things we offer for students.” North Carolina

Nurses. To meet student needs, the schools have a nurse or nursing services available 24 hours a day. The nurses dispense medications, check symptoms, and manage off campus health services for students when needed. They have easy access to parents and guardians to keep communication open.

Licensed Personal Counselors/Licensed Social Workers. The Licensed Personal Counselors (LPCs) provide mental health services to the students in groups, one-on-one, and through wellness classes. They run discussion groups and support groups for students to explore issues such as depression, anxiety, stress, and social interactions. They also provide one-on-one counseling to the students. Several of the respondents described that previously the academic counselors handled the immediate mental health issues, but they found that the students needed higher skilled mental health supports. They also said that when the roles were combined, the students were less likely to seek help for their mental health issues. Across all the schools, mental health was seen as a very important issue to address and manage.

“Last year, we saw the need is so great that we hired one and a half more. Now we have two and a half licensed psychologists solely to deal with the mental health of the students.” South Carolina

“But wellness issues keep us up, self-harm issues keep us up, concerns about self-medicating and destructive behaviors. We lost a student to suicide in January and we lost another one in June. We can offer them an amazing experience here, but there’s just a lot we can’t fix.” Louisiana

Off-campus Mental and Physical Health Providers. The schools support the students who need to seek specialized health services off campus. These services are usually covered by the student health insurance. North Carolina reported that they have a fund from their foundation that can be used to pay for more specialized support.

Student Life Skills

Most of the schools require students to take wellness classes to build resilience and life skills. They require seminars that cover topics such as anxiety, depression, time management, healthy eating, substance use, and others. The schools include physical activity as part of their residential life and wellness services offering sports, yoga, running clubs, and other activities. Several of the schools require students to volunteer in the community, offering tutoring, working with disadvantaged youth. North Carolina has a summer service requirement for students to volunteer in their home towns. Campus service is required at Mississippi, similar to work-study on a college campus, with a variety of choices including working with the custodian and assisting faculty in office and support tasks.

“The other thing that we do there is we have a one-hour-a-week seminar that ... We actually have two of them, two one-hour-a-week seminars in the fall that all juniors take. One is called life and leisure, and one is called academic transition. The life and leisure class is taught by

our wellness counselor, and the way she describes it is it's proactive small group therapy."
South Carolina

"...we have a course that our juniors take, which is Resident 101, and it really focuses in on time management, study skills, helping them adjust to life in NCSSM. Then we have a course called NCSSM to College that all students take in their junior year, and that's a course where they get to actually start their application and get support in their essay writing and so forth and so on as a part of that. Trying to identify the right college for them. And then we have a variety of elective resident classes they can take ranging from multicultural America, finance. We have a financial planning class that they can take. We have one that helps them. It's called Marketing You." North Carolina

"We also have a service-learning requirement, so 200 hours that students must complete. Some of them has to be on campus, some of it has to be off campus, all of those." Illinois

Strengthening and Supporting STEM Education Statewide

The peer public residential STEM schools describe their missions as two-fold: providing challenging, stimulating educational experiences for talented students on campus as well as strengthening the STEM education for all students in the state. All of the schools conduct outreach to students and most provide professional development opportunities to educators. They engage local educators to increase their capacity in offering STEM lessons to students and convene students of all ages in hands-on learning opportunities. See Figure 11.

“Our first legislative charge is to serve talented students with an interest in math and science. Our second legislative charge by-law is to continue to support excellence in education of teaching throughout the state.” Illinois

Figure 11. Public Residential STEM Schools Support STEM Education Statewide



Distance Learning	<ul style="list-style-type: none"> • Synchronous – reach students in rural communities • Asynchronous - curriculum for teachers
Cultivating Talent	<ul style="list-style-type: none"> • Promise Program (IL) • Math Superstars (MI)
Summer Camps	<ul style="list-style-type: none"> • On campus and in the communities • Prepare hands-on activities with learning outcomes
Science Fairs/Events	<ul style="list-style-type: none"> • Maker events, robotics • Math competitions, science fairs
Professional Development	<ul style="list-style-type: none"> • Certifications • Technical assistance, curriculum

The schools vary greatly in the scope and share of resources devoted to outreach and education beyond the residential school. MSSM and Louisiana have limited summer opportunities, while North Carolina and Illinois have separate divisions of professionals developing and delivering content online. The Arkansas school, with a long history in providing distance learning in the state, has blended the outreach responsibilities with the residential faculty responsibilities. Mississippi has recently added resources to support outreach. See Table 8.

The schools in Arkansas, Illinois and North Carolina offer deep programming to teachers and students aimed at raising the bar for STEM education statewide. South Carolina and Mississippi are more focused on reaching high achieving students directly through hands on experiences. Louisiana provides support for both educators and students in summer programming, and the faculty engage in the STEM education community activities statewide.

“...25 staff members who don't work with the students in the residential academy, they're focused on developing curriculum and doing professional development for others outside of IMSA.” Illinois

“We don't have a residential program and outreach program. We don't have a residential faculty and outreach faculty. There is one organization and one faculty in service of this combined mission of residential and expanded outreach.” Arkansas

“Last year was the first year that we were able to hire a coordinator for outreach, but advocated to the legislators that we needed this position. They gave us the money for it, ... They're teaching three classes. Generally, they teach around six. Three classes they teach for us, and then they have three blocks built in for planning for outreach, and going to schools or doing some things virtually for teachers.” Mississippi

Table 8. STEM School Outreach and Professional Development Activities

School	Number of Students Reached in Outreach Activities	Professional Development for Educators	Credit Earning Online Instruction to Students*	Programs Supporting Rising STEM Students	Summer Camp
Arkansas School for Math, Sciences, and the Arts	Not available	✓	✓		
Illinois Mathematics and Science Academy	11,000	✓	✓	Promise	✓
Louisiana School for Math, Science, and the Arts	140	✓			✓
Maine School of Science and Mathematics	500	New			✓
Mississippi School for Mathematics and Science	6,000	Enrichment only		Math Star	✓
North Carolina School of Science and Mathematics	1,000	✓	✓	Early Accelerator	✓
South Carolina Governor's School for Science and Mathematics	5,000	✓	✓	SPARK!	✓

*Excluding current virtual accommodations for public health safety.

Residential STEM Schools are Increasing Capacity in STEM Education Statewide

Specifically, the residential STEM schools provide STEM curriculum as well as professional development opportunities to educators in their states. They offer seminars, traditional professional development sessions, training, certifications, and furnish lesson plans along with supporting materials. These capacity building efforts help strengthen the STEM offerings across the state particularly in those regions where resources are limited and students are disadvantaged. The school representatives report that this outreach has increased their visibility in the state and helped them strengthen STEM education statewide.

“We understand even the schools that have resources, fiscal resources, may not have the human resources needed to teach those few kids they have. Sometimes even if it's just two or three kids. Sometimes it may be one kid who needs to take a differential calculus, or a more advanced-level math class. So that's really what we're focused on and trying to do now.”
Mississippi

“Our science faculty will bring interested teachers to campus on a Saturday, and give them six to eight hours of hands-on experiential lab development. These are cheap and easy labs. Here's all the supporting materials for your lesson plans. Here are the supporting materials for actually executing the labs.” Louisiana

“And we do a lot of teacher professional development, content development, and so forth and so on. So we're a resource to the K-12 schools in the state, even though we're not a part of that system..... the courses we offer are very different than you may find in most high schools ranging from honors aerospace engineering to organic chemistry to polymer chemistry to math we offer combinatorics. So, just courses you're not going to see in a typical high school course catalog.” North Carolina

Professional Development on STEM Topics

The peer schools offer professional development for local teachers on several platforms - in person, on campus and online through distance learning opportunities. The representative from the school in Arkansas described that the lessons learned through the residential programming serves as a laboratory to develop curriculum for the STEM educators in the state. The school also has an educator cohort program that provides professional development and guides participants in classroom activities to enable them to become certified in teaching computer science, ultimately preparing them to pass the Praxis certification test.

“We've pre developed a number of curricula that are based on problem-based learning, inquiry based and our four competencies. And so, we're known in the state and in some sectors only as a provider of curriculum for STEM.” Illinois

“We built was a cohort program online course, served as the Instructor of Record and provide the blended learning environment. In parallel to that, the local classroom teacher serves as more of a teaching assistant, but they're going through a year-long training program that's building their own content knowledge, gearing them up to pass the praxis, and gain credential licensure to teach computer science in the state.” Arkansas

STEM Schools Work with Students in Local School Districts Statewide

The peer STEM schools support students across their states with many different opportunities. They serve as resources to educators interested in specific content or curriculum, they provide content directly to students online, and they host a variety of experiential events and camps for students to explore STEM. The offerings include hosting science fairs, math competitions, satellite camps, and on-campus events such as visits or summer camp. The activities are designed to engage students in hands-on problem solving lessons and experiences.

“...we have a science carnival that we've been doing for 28 years now, or 27 years. That is ...for the local community.... And so we have our students dressed in white lab coats. We have the gym here on campus, and it's for second and third graders. So second and third

graders, we'll alternate the city and the county schools, and then we invite the private schools and some other surrounding schools to fill in the gaps. But they come in. All of our students are engaged in this, and we have about eight different stations set up. So they go through in about 50 minutes through these eight different stations, and they're highly engaging. Our students are there performing these demonstrations in your various areas." Mississippi

"And then we have the traveling STEM carnival. When I first became executive director, I looked at that model. I was like, "That's too good to just have it for this area." And so we added a math component to that now, and so we have a few math stations as well where they're doing escape rooms, lock boxes, that sort of thing for small groups, and so we've done that for about five years now. That works very well. We identify an area in the state where we have probably underperforming school district, high concentration of students in poverty, minority as well." Mississippi

"We also go out to satellite camps, and we partner with middle schools and high schools, and host week-long day camps across the state. We really don't partner with the schools other than using their facilities." South Carolina

Early Identification Programs Provide Opportunities to Younger Students, Guiding them into STEM Opportunities and STEM School Enrollment

Two of the peer schools host programs for younger students to encourage interest in STEM fields. The Illinois school identifies high achieving students in fifth grade to enroll them in a "Promise" program where they have hands-on learning experiences with the STEM school faculty. Many of the camps and on-campus events help connect potential students to the residential campus experience, eliminating fears and answering questions from those unfamiliar with boarding school.

"We also have a pre admissions program we call Promise where we begin identifying students in fifth grade and get them into Promise. And about 50% of those students when they apply to IMSA are able to get in especially in seventh and eighth grade an opportunity to be taught by our faculty as well as SAT prep test. There are 400 students in that program. And in ninth grade, they have opportunities to live on campus for a week or two weeks so that they can experience IMSA." Illinois

"...especially in a state or region that doesn't have a strong level of comfort or familiarity with a boarding school environment, is simply getting students to experience time away from home to see the needs firsthand, to interact with the faculty. Even if it's in a short-term model or mindset to build out, that comfort goes a very, very long way when it comes to sparking their enthusiasm for admission." Arkansas

"Math Superstars. So this is a way where we're giving different activities to teachers around the state, and they engage their students over a period of time. And then, those students who rise to the top in those classes or those grades at that school, they're Math Superstars. We invite them to campus. That's grown as well. We had around 700 students here last year, and they compete with each other. We mix them with other students from around the state, and then we give them all a medal at the end." Mississippi

Some of the Public STEM Schools Provide Rigorous Coursework to Students in Local Schools

Students in some of the peer school states have an opportunity to take classes from the residential school faculty at their hometown school via synchronous and asynchronous classes. The North Carolina STEM school offers an extensive suite of online courses to students in their state. Focusing on the value of engineers to the state's economy, the STEM school in South Carolina offers an early engineering program to students at their home high school. The students attend the classes online with faculty from the residential school, eventually earning a full year of engineering credits so they can start college as a sophomore.

"We have a virtual program called Accelerate. We teach two classes in 10th grade, four in 11th, and four in 12th. The idea is all three years, you get an engineering class and a math class, and then we teach English, and chemistry, and physics in the 11th and 12th grade years. Students finish with a year's worth of engineering credit. So, if you go to Clemson or USC's engineering program, you actually enter as a sophomore. Students remain at their home high school. They remain at their house with their families. They take the rest of their classes at their home high school, but we teach those STEM and English classes at our level. So, they're the exact same classes, same kind of teachers that we have." South Carolina

"We provide video conference courses, our faculty teaching from our studios to rural schools across the state where they may not be able to have enough kids don't run a class of honors physics or AP Physics, for example, or they can't get a highly qualified teacher. And so, we were able to create a classroom of 25 students that may be from as many as eight different schools with our teacher teaching synchronous video conference courses. So, we teach about 400 students a year through that program. We also have an online program that has another 400 students enrolled in it, again, from across North Carolina." North Carolina

Research and Partnerships

University Partners Provide Research Opportunities

In addition to agreements with universities for dual enrollment, all of the peer schools provide research opportunities for their students. See Table 9. There is, however, great variation in the type, scope, and rigor of those opportunities. North Carolina and South Carolina schools seemed to have the strongest research programming, requiring the students to participate in graduate-level research opportunities that are paid for by the school. Other schools, Louisiana and Mississippi, described pairing students with university faculty at other locations in the state to conduct research in the summer. In addition to research, the Illinois school described placing students in internships with universities and private companies. South Carolina, Illinois, and North Carolina also provide international opportunities for their students to conduct research.

“... our beginning model basically was just strong academics and we added, in the second year, a pretty robust research program that, during the summer between your 11th and 12th grade year, we partnered with the University of South Carolina, Clemson University, and the Medical University in Charleston to carve out six weeks of graduate-level research for our students to complete.” South Carolina

“We have an international component to our research as well. It only serves about 15 only, but 15 is a lot. It serves about 15 students, and so we have relationships with two research universities in Germany, and then one in South Korea, and one in China. We're trying to expand all of our international contacts and partnerships so that we can send more kids that way and bring more kids to us.” South Carolina

“We partner with Duke University, Duke Health, UNC Chapel Hill, UNC Medical Center, North Carolina Central University, in Durham. North Carolina State University, which is a robust engineering and state technical school.” North Carolina

Table 9. Public Residential STEM School Research Offerings

School	Research Required for Graduation	Placements off Campus with University Faculty	International Opportunities
Arkansas School for Math, Sciences, and the Arts	✓		✓
Illinois Mathematics and Science Academy	✓	✓	✓
Louisiana School for Math, Science, and the Arts		✓	
Maine School of Science and Mathematics			
Mississippi School for Mathematics and Science		✓	
North Carolina School of Science and Mathematics	✓	✓	
South Carolina Governor’s School for Science and Mathematics	✓	✓	✓

Some Schools Partner with Industry, but Experience is Mixed

Partnering with industry and private laboratories was seen as important, but the experiences and relationships varied across the peer schools. The North Carolina school, located in the heart of the vibrant research triangle region, has longstanding relationships with many businesses in the area including IBM, Lenovo, RTI, and Pisgah Laboratories. Arkansas mentioned working in partnerships with museums and a medical school. South Carolina reaches out to partners to underwrite the outreach activities, specifically camps and satellite camps and has set a goal to expand partnerships for student internships. Their partners include Duke Energy Services, Boeing, Michelin, and local corporations. Most of the school representatives shared that they see great benefits in partnering and would like to increase the number of partnerships.

“We partner with a lot of the businesses in the Research Triangle Park, which include businesses like Lenovo or IBM or pharmaceutical companies that research. RTI International, which is a big research think tank. So, we have those types of partnerships and then we partner with some smaller entrepreneurial type of companies to give students mentorship who want to be in that type of setting. So there’s a reasonable kind of startup culture here in the triangle, and so we can get students involved and those as well.” North Carolina

“And then across the state, we have some relationships with the Kannapolis Research Campus in western North Carolina where we have students that do work there. And then some of the places like PARI, which is in the mountains, North Carolina, which is the Pisgah Astronomical Research Institute. Different types of places where in the summer students may get opportunities to do mentorship and research, those types of things.” North Carolina

“Students are able to pursue passion and interest in terms of research sometimes with mentors from the Chicagoland area from University of Chicago, Fermilab, Argon, Rush University Hospital, and internships with our innovation hubs across the city.” Illinois

The schools with the most resources were able to provide off campus research opportunities to all of their students. The North Carolina school offers a summer program where students are transported to universities and research institutions to conduct mentored research in a graduate level setting. The school covers room, board, and transportation to the site. They also have January term research opportunities and other independent placement options for students. The Louisiana STEM school pointed out that unless the STEM school can underwrite the program, these types of opportunities can be out of reach for students who need to work in the summer or who do not have transportation to a research site either due to distance or cost.

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Challenges

As the peer school representatives shared information on their schools, they also pointed out the challenges they face. For the most part, the schools share several common challenges. Those challenges fall into five categories:

- Social-emotional health and well-being of the students
- Barriers to recruiting and including students
- Recruiting faculty for some courses and at some locations
- Advocating for state funding and increasing awareness for the achievements of the school and the students

Social and Emotional Health of Students

As discussed earlier in this report, all of the school administrators believed the health of the students is paramount to the success of the STEM school. The students who self-select to attend the rigorous school are high achieving, results-oriented young people. When they arrive at the STEM school, they may be challenged academically by the rigor and receive a low grade for the very first time. They may be homesick or feel pressured in the community of high-achieving peers. In addition, many of the students are on long-term medication to remediate anxiety, depression, and other disorders. The peer schools, along with MSSM, take their responsibilities in health and wellness very seriously and continue to assess the best ways to support the students and families.

Barriers to Recruiting and Serving Students

The peer school administrators described two barriers to reaching students, resistance from sending schools, and the stigma that the residential school is elite. On the first barrier, several of the administrators described that the sending schools were uncooperative with the STEM school in sharing information with students. Some states provide funding on a per students basis, so losing a student meant losing funding. In other states, the schools are judged on student test scores, so losing a high performing student meant a penalty to the school's overall scores. South Carolina enacted legislation to address the pushback, requiring the local schools to share information with the STEM school and allow access to students.

The second barrier to recruiting, mentioned by Arkansas and Louisiana school administrators, is that there is a fear that if a student spends time at the residential STEM school, they will be "liberalized" and that the school is for the elite. School representatives work with these stereotypes and share as much information as they can to show that the school is a public school, open to all, and that as a public school it does not have a political agenda.

Recruiting Faculty

Some of the schools in rural areas report difficulties in recruiting faculty, stating that the rural areas oftentimes did not provide the amenities and social activities to attract faculty and their families. Most of the schools reported challenges in recruiting faculty in physics and computer science. Several were seeking to build a faculty that reflected the racial and gender mix of the student and state population.

Advocating for State Funding

While the public residential STEM schools are supported by their state's legislature, the administrators shared that it is an on-going need and challenge to advocate for funding. Mississippi shared that its budget was cut so much that they had to drop enrollment to cut costs. Since that time, much of the funding has been restored, but it is an on-going need to keep the lawmakers informed about the value of the school and its programming. MSSM, like Mississippi, has experienced sustained flat funding while expenses continue to climb, creating a budget deficit.

Several of the schools have public relations professionals on staff or they rely on communications professionals to develop pitch books to share the student outcome data with stakeholders. Specifically, they share the student engagement numbers both in the residential program and the outreach. They describe the test scores, the matriculation to higher education, and highlight the research and discovery projects. Illinois has students meet with legislators to share their work.

Opportunities for MSSM

The review of Maine's STEM-related economic and education landscape along with the review of the successful peer schools uncovered many opportunities for MSSM's future. The opportunities include:

- Strengthening MSSM's role as Maine's leading STEM school
- Assessing opportunities for new mission appropriate facilities
- Expanding outreach and distance learning programming for Maine's underserved gifted and talented students
- Developing partnerships with universities and research laboratories for research and early college credit

Role as Maine's Leading STEM School

MSSM has an opportunity to expand its support to more students both on campus and in local schools. Like the peer schools, MSSM can use its strong residential program as a learning laboratory to prepare more students for STEM or related careers in Maine. Increasing the number of residential students, developing a robust outreach program to reach STEM students in local schools, and establishing stronger relationships with the higher education and research laboratories would tie the school closer to pathways to future STEM jobs in Maine.

Need for Mission Appropriate Facilities in a Central Location

As a leading STEM education and research institution, MSSM would benefit from having mission appropriate facilities and being closer to Maine's population center. In modern and appropriate buildings, the school could attract more students, staff, and faculty and be more accommodating to new and evolving programming. Moreover, if the school were located closer to Maine's population center, it would benefit from a larger talent pool and the natural synergies that come with proximity to potential partners.

Increase school size. While Maine's enrollment per 100,000 population is in line with the peer schools, its fixed administrative and facilities costs cover fewer students. Typical enrollment for residential schools is about 220 – 280, spreading costs over more students. Maine has an opportunity to consider doubling enrollment to approximately 240 students in new facilities. This will improve the overall efficiency of the school, increasing student teacher ratios, without adding concomitant costs.

Expand Outreach to Underserved Communities

As part of its original authorizing legislation, the state saw great promise in having MSSM play an active role in STEM outreach and distance learning in Maine. The school has an opportunity to fill this part of its mission in supporting the gifted and talented students and their educators in rural, underserved areas. MSSM can become the center for best practices in teaching and learning for STEM fields for schools needing support for their high achieving students. MSSM can also play a more active role in providing extra-curricular activities for students such as hackathons, math meets, and science days.

Develop Partnerships with Universities and Industry for Research Opportunities and Early College Credit

The peer residential STEM schools all have relationships with universities and some with private laboratories for research and early college credit. This is an area of great opportunity for MSSM and for the state's universities and industries. Through the work of the Business Planning Committee, MSSM has already begun to develop new relationships with these institutions to open up opportunities for research and mentorship. Partnering on a college campus or as part of a university system may bring additional opportunities for academics, research, and future growth.

Future Implications for MSSM

Maine's economic future is dependent upon building talent and investing in innovation. Strong STEM skills and education will be critical in filling the talent pool and driving research and innovation. Maine's residential STEM school, MSSM, has a central role to play in strengthening the talent pipeline for these high growth, high paying jobs – eventually providing a good quality of life for aspiring youth.

The review of successful peer schools showed that those schools play prominent roles in their state's public education and economic landscape as learning laboratories and public providers of STEM education and training to disadvantaged and underserved students statewide. Their state legislatures have consistently supported them, helping them grow and expand their reach statewide. MSSM, like its peer schools, has been successful in creating an engaging, stimulating, course of study for its high achieving students. Unlike the peer schools, it is relatively unknown in the education and employer circles in the state. Additionally, it has had no significant reinvestment or renewal since it was founded in 1995, leading some to describe it as Maine's "hidden gem in public education." MSSM has a strong base and years of success upon which it can grow to become an integral part of Maine's economic and education landscape.

Appendix A.

Maine School of Science and Mathematics

Mission Appropriate Student

You may be an MSSMer if you are...

An Enthusiastic Learner

You love to learn. Whether in the classroom, on your own or with a group of friends, you possess a passion for the pursuit of knowledge, a deeper understanding of the world around you, and, by virtue of this, a more intimate understanding and knowledge of yourself.

Honest and Respectful

You fervently believe in the value of honesty in everything you say and do, while recognizing and appreciating the existence of other perspectives. You respect the ideas of others, and you actively support a safe environment that fosters the open exchange of competing beliefs.

Independent yet Community-Minded

You are confident in your own thoughts, but you accept your peers as they are and see them as individual contributors, each in their own way, to your shared community. You eagerly engage in team activities that strengthen inter-personal relationships and that contribute to a culture of mutual support and respect among your peers.

Attribution

This definition was established in a community-wide process in the Spring of 2020, involving the active engagement of the students, parents, alumni, faculty, staff and the Board of Trustees of the Maine School of Science and Mathematics.

Maine School of Science and Mathematics

Portrait of a Graduate

MSSM's mission is to create educated citizen-leaders who will benefit their communities in the state of Maine and beyond. At MSSM, you will share many experiences with your classmates, building strong personal bonds that will last long after your graduation. This Portrait describes the values that the school holds dear and that we as a community hope that you will learn to appreciate and respect as you engage in the MSSM experience. By your graduation, you will:

Mastery

Gain a depth of knowledge in many subjects, and you will gain skills in discovery, analysis, and critical thinking, enabling you to be an effective problem solver. You will learn how to articulate your conclusions in spoken and written communications, enabling you to effectively convey your thoughts for the benefit of others.

Resilience

Appreciate the immense power and sense of accomplishment that come from persistence, and from the development of a curious and creative mind. You will seek challenges every day from which you will gain self-confidence and the ability to face adversity.

Self-awareness

Understand your strengths and your weaknesses, and you will assume full responsibility for your words and your deeds. This self-awareness will enable you to be an effective citizen and to be considerate as you encounter differences in others.

Engagement

Learn the value of active participation in community building. You will come to appreciate that each individual can contribute to shared objectives in different ways through innovation, collaboration, and leadership, and that the coming together of these different skills makes for a more effective and robust community.

Purpose

Graduate from MSSM with a sense of purpose that shapes your goals and guides your life decisions. Your MSSM experience will give you unique advantages and opportunities. You understand the importance of giving back to the people and communities who have enabled your success.

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End Notes

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