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MOBILE, ALABAMA



SCIENCE



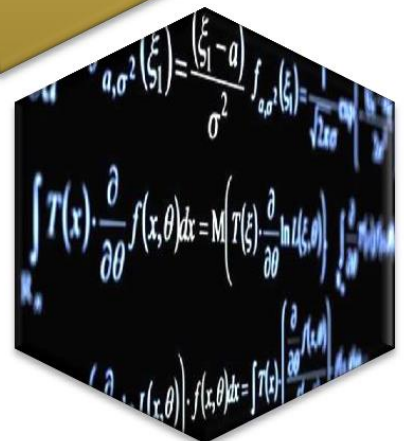
TECHNOLOGY



ENGINEERING



MATHEMATICS



[STEM COMMUNITY BLUEPRINT]

The STEM Community Blueprint represents the culmination of years of dedicated efforts to support the district's education outcomes and the community's workforce development efforts.

STEM COMMUNITY BLUEPRINT

Findings from the Mobile STEM Alliance

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INTRODUCTION

Since 2006, Mobile's education, business, and community leaders have worked together to understand, plan, and implement an integrated approach to teaching and learning Science, Technology, Engineering, and Mathematics (STEM) to support high quality public education and address local and regional workforce gaps. Since that time, under the leadership of the Mobile Area Education Foundation, over \$6 million dollars has been invested in middle grades STEM education in Mobile resulting in:

- the formation of the Engaging Youth through Engineering (EYE) program
- development of nationally recognized middle grades STEM curriculum, the EYE Modules
- the development of the Mobile County Public School System's middle grades STEM Improvement Program
- approximately 400 educators, businesses, and community members engaged in STEM experiences
- approximately 10,000 middle grades students experiencing STEM lessons.

In 2011, the Mobile Area Education Foundation (MAEF) was awarded a grant from the Toyota USA Foundation to further develop capacity in Mobile County to sustain and scale STEM education at the middle grades. The *EYE on STEM Leadership Academy* developed a cadre of STEM leaders –teachers, administrators, teacher educators, and business/industry leaders – who have the capacity to scale up, sustain, and institutionalize the successful STEM reform efforts that are emerging from the *EYE* program and the Mobile County Public School System (MCPSS) STEM Improvement Program.

The **STEM Community Blueprint** represents the culmination of years of dedicated efforts to support the district's education outcomes and the community's workforce development efforts. The blueprint is designed to:

- Articulate a vision for STEM education in Mobile County, Alabama
- Describe the previous achievements in developing a foundational STEM education movement in Mobile County
- Report the current status of STEM education and it's connection to existing education and workforce development strategies (Graduate Ready, Signature Academies)
- Identify critical next steps and priorities for all stakeholders

BACKGROUND

What is STEM and Why Should We Care?

STEM is a widely accepted acronym for science, technology, engineering, and mathematics. It represents the key skills in highly technical careers and training. These skills can be found in jobs that utilize abstract complexities of Theoretical Physics, the life-saving potentials of biotechnology, to the world shaping products of engineering, and everything in between. STEM isn't just about jobs, however. It is about preparing young people as early as elementary school to develop a greater familiarity with STEM concepts. STEM is about strengthening students' content knowledge, inspiring their sense of curiosity, and giving them the tools and habits of critical thinking to understand the world around them.

Why is STEM such an important topic? First of all, it is a gateway to available jobs and careers in the American economy. While many low-skilled jobs are being outsourced to other countries, the American economy is growing in its need for high skilled workers. Each year millions of high skilled jobs go unfilled, simply because American students and workers are lacking essential fundamental training. Over the next decade, this gulf region is expected to widen to as many as 10 million available jobs. These jobs are stable and high paying. Consider this, an employee in a STEM related field with an Associates Degree makes more than a person with a four-year liberal arts degree. The American economy has shifted, and STEM is about ensuring all youth are able to participate in that economy. It is time we challenge our assumptions about mathematics and science. Everyone can "do math and science". Through careful planning and strategic implementation, STEM subjects can enhance critical thinking skills and foster pedagogical best practices without adding to the workload that is already ever present for teachers. What's more, this focus on building crucial 21st Century learning skills in students can dramatically improve the climate and culture of school, making learning more relevant and engaging for teachers and students. With an intentional strategy, Mobile will ensure all of its students, male or female, minority or White, low-income or wealthy can succeed in America's STEM economy.

A Brief History of STEM in Mobile

In 2006, Mobile business leaders approached the Mobile Area Education Foundation (MAEF) with a significant workforce problem: high school graduates from Mobile County could not apply mathematics and science principles nor did they possess essential workforce skills that local industries required. At the same time, community leaders had learned about an innovative approach to teaching and learning: integrating the teaching and learning of Science, Technology, Engineering, and

Mathematics through engineering design challenges-the approach today termed "STEM." In response, the MAEF partnered with J. L. Bedsole Foundation to organize and send a diverse group to Boston, MA. The group consisted of business leaders, engineers, engineering educators, district curriculum leaders, along with science and mathematics specialists from MAEF and Mobile County Public Schools. During this trip the group learned how this new innovation in education could be used to better prepare students with the academic and workforce skills needed by local business and industry.

As a result, MAEF launched a K-12 partnership driven, workforce and economic development initiative called Engaging Youth through Engineering (EYE). The purpose of EYE is to produce high school graduates that possess 21st century skills (communication, collaboration and creativity) sorely need by Mobile's industries. Furthermore, these graduates will be prepared to apply their mathematics and science knowledge in the workforce. EYE's theory maintains that **students with engaging, real-world, hands-on learning experiences** are more likely to comprehend the value of relevance of mathematics and science content taught in school. **As a result, the students are more likely to want to pursue science, technology, engineering or mathematics college and/or career pathways that ultimately meet Mobile's workforce needs.**

The engineering focused curriculum from the Boston Museum of Science was used to develop after-school engineering clubs and summer camps for 4th and 5th grade students. Another curriculum from the Boston Museum of Science was also used as an engineering-based physical science course for 9th grade students. However, it was of particular importance to all partners of the EYE initiative, to provide a mechanism that impacted ALL students. Research has shown that middle school represents a critical developmental period for students, and interest in mathematics and science often falls dramatically. The approach to middle grades STEM learning required a dramatically different approach. Instead of after-school clubs, or offering a single elective course, a set of STEM lessons would need to be developed that could be taught in every mathematics and science class. Once the lessons are developed every 6th, 7th, and 8th grade student would experience engaging, real-world engineering design challenges that would bring relevance and rigor to mathematics and science. This approach to STEM learning was a radical and ambitious undertaking. Before this approach was introduced, a model to engage ALL students in STEM learning at the middle grades did not exist.

This pioneering work finally made its way into Mobile middle grades classrooms in 2007 as the result of early investment by business and community leaders and the visionary leadership of MAEF and MCPSS educators and leaders. The project received national recognition and funding from the National Science Foundation in 2009. The \$5 million grant to the MAEF further bolstered enthusiasm for STEM education in Mobile County.

The purpose of the 5 year grant funded project was to develop an entirely new kind of STEM curriculum, and to launch a district-wide approach to STEM learning for middle grades students.

The additional funding enabled MAEF to collaborate with engineers, business representatives, curriculum writers, and teachers within Mobile County and from across the nation, to develop the **EYE Modules**. The EYE Modules are a set of 8 comprehensive and extensive teacher instructional guides (See Table 1). Each Module has materials, equipment kits and professional development, enabling middle grades teachers to implement collaboratively in mathematics and science classes. These Modules provide students with opportunities to construct solutions to engineering design challenges. The EYE Modules are a unique set of STEM curriculum with several identifying features. For example, the Modules:

- Are NOT an add-on; they are designed to be implemented in the core mathematics and science classes.
- Equally emphasize mathematics and science content and pedagogy.
- Require collaboration between mathematics and science teachers.
- Provide strategies for building teamwork and problem solving skills.

GRADE	EYE MODULE	ENGINEERING CAREER FIELD
6	Harnessing the Wind	Mechanical Engineering
6	Don't Go With the Flow	Environmental Engineering
7	EYE on Mars	Biological Engineering
7	To Puppies & Beyond	Genetic Engineering
7	Catch Me if You Can	Biomedical Engineering
8	Let's Get Moving	Mechanical Engineering
8	Electromagnetic Motor	Mechanical/Electrical Engineering
8	Eco-Friendly Plastics	Materials Engineering

Table 1. EYE Modules

Since 2009, nearly 6,000 Mobile County middle grades students have experienced the EYE Modules. As a result of the Modules, **EYE students value STEM work and STEM careers more than non-EYE students, report greater confidence in their design skills, and show greater interest in engineering as a career. Furthermore, students who participate in the EYE Modules have significantly higher scores on mathematics standardized tests in areas such as data analysis and probability.**

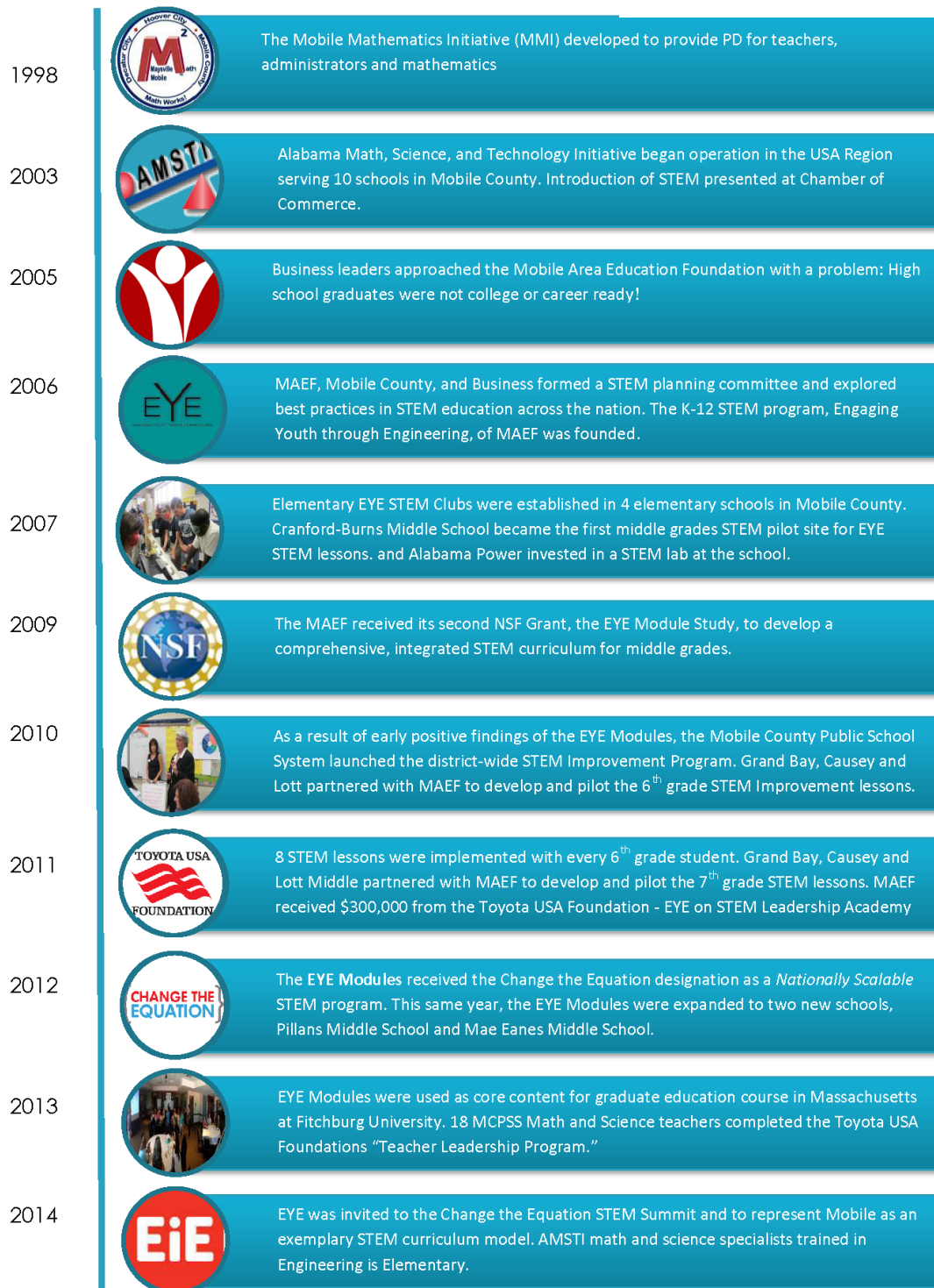
Early positive findings of the EYE Modules, together with the innovative leadership of Superintendent Martha Peek, resulted in the Mobile County Public School System and MAEF launching the district-wide STEM Improvement Program in 2011. The purpose of the Program is to transform the current mathematics and science curriculum to a STEM curriculum more relevant for future workers by:

- 1) incorporating the engineering design process and design challenges into current mathematics and science content standards and district assessments,

2) requiring ALL students to experience design challenges quarterly in both mathematics and science classes, and

3) providing related lessons and ongoing professional development training for mathematics and science teachers.

Chart 1. Timeline



Over the next three years, 24 STEM lessons were developed by MAEF curriculum writers and Mobile County middle grades mathematics and science teachers based on the EYE Modules. By 2013, 240 mathematics and science teachers had received training on the STEM lessons and every student in 6th, 7th, and 8th grade experienced hands-on, engineering design challenges in both mathematics and science class.

Even as STEM learning was becoming a district-wide initiative and the EYE Modules were expanding to new schools, the MAEF and District Leaders recognized the need for additional support to sustain and scale the STEM education movement in Mobile County. In 2011, the MAEF secured funding from the Toyota USA Foundation to develop a cadre of STEM leaders- teachers, administrators, teacher educators, and business/industry leaders – who will have the capacity to scale up, sustain, and institutionalize the successful STEM reform efforts that were emerging from the EYE initiative. As a result, 18 Mobile County mathematics and science teachers participated in the Teacher Leadership Institute, 50 teacher educators experienced a yearlong STEM Seminar training series, and a cadre of 20 district leaders, principals, and business/community leaders founded the Mobile STEM Alliance. They began developing a long-term strategic plan to sustain STEM education in Mobile County. As more and more educators, business and community members learn about and engage with STEM education, the momentum for scaling high quality STEM programs builds. Thereby, increasing the number of opportunities to engage and prepare all students in Mobile for college and/or career success.

As Mobile continues to draw new, national and international businesses to the region, the demand for highly-skilled, knowledgeable workers continues to grow. Producing the next generation of business, industry, and community leaders requires a vast, multi-pronged, strategic approach. STEM is a critical component to Mobile's multi-pronged strategic approach to ensure its future economic success.

How does STEM support Graduate Ready?

Graduate Ready is a collaborative initiative of education, civic, and business leaders aimed at ensuring that all students in Mobile County are:

- Prepared for success in college and the workplace
- Able to apply learning in real world situations
- Equipped with 21st century workforce skills

Graduate Ready represents an eight-year logic model developed through ongoing collaborative efforts among the Mobile Area Education Foundation, Mobile County Public School System, higher education institutions, civic leaders, the business community and citizens across the county. Mobile County citizens know that we need to transform our schools if we are going to ensure that more students not only graduate from high school but also are truly prepared for the challenges they face afterward.

And we know, to make the necessary changes to our schools demands that the entire community is on board and moving forward together.

The purpose of the Graduate Ready community agreement is to provide multiple personalized pathways and whole child supports for every child to ensure a better quality of life for every citizen in Mobile County. The four key strategies of the Graduate Ready Initiative include:

1. Ensure high-quality teaching and learning from Pre-K through 12th grade
2. Transform all secondary schools to ensure that all students graduate from high school ready for college and career
3. Ensure postsecondary access and completion
4. Sustain improvements through continued education, business and civic leadership

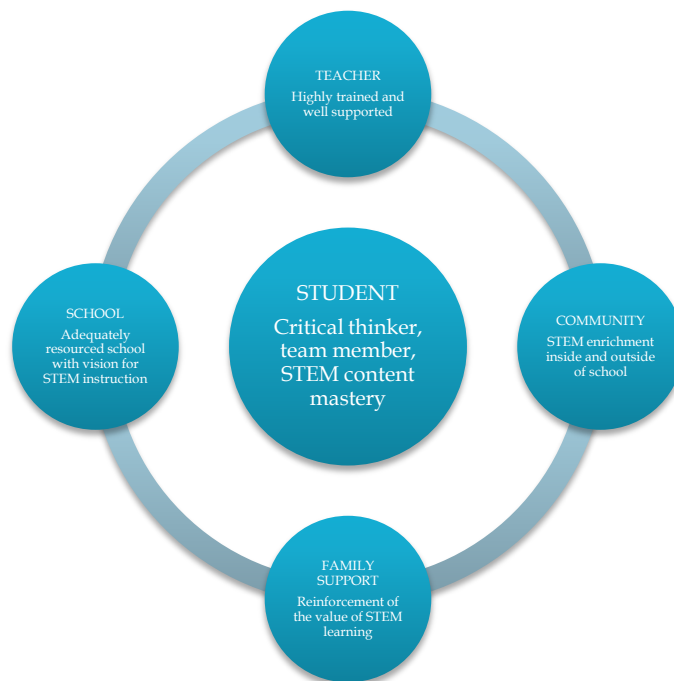
The STEM education movement in Mobile County is one pathway to support high-quality teaching and learning and requires the leadership of education, business and community members for sustainability, scale, and ensuring high-quality implementation.

MOBILE'S BLUEPRINT FOR STEM

Our Vision

The Vision for STEM education in Mobile is clear – all students, regardless of color or background, will develop the habits of mind to think critically, work in teams, and be exposed to rigorous STEM content through teaching that is discovery-driven and engaging. To achieve this vision, Mobile's K-12 educators must be supported in receiving ongoing, job-embedded, high quality professional development connected to STEM. Our schools must possess a vision for STEM instruction and must be adequately resourced to integrate STEM lessons in the curriculum. Our community must provide high quality STEM enrichment activities both inside and outside of school to reinforce learning. Our parents must be supported to stress the importance of STEM to their children, encourage the fostering of critical thinking and discovery, and avail themselves of the many STEM-focused enrichment opportunities across the community.

Our Vision for STEM involves everyone



Achieving Our Vision: Getting to Scale

The critical consideration moving forward isn't a lack of vision in the community. It's an inability to reach scale across the community. With a commitment to **all students**, anything less than a scalable approach is simply unacceptable. As our community continues to draw new industry to our area and as existing industries expand in the region, the demand for a highly skilled workforce increases. STEM experiences in

students' academic careers have the potential to inspire the future generation of our workforce.

Despite significant progress, including the development of nationally recognized middle grades modules, new engineering standards in mathematics and science course of study, district-wide teacher training, improved access to STEM curriculum resources and materials, STEM instruction lacks consistency of high quality implementation across all MCPSS schools and classrooms.

A critical question we now must answer is: How do we equitably sustain and scale STEM so that all students have the opportunity to become part of our local STEM workforce?

Understanding the Current Challenges

Through formal and informal evaluation methods including surveys, on-site observations, and structured interviews of hundreds of teachers, principals, district leaders, business and community leaders, three critical challenges have been identified as persistent barriers to sustainability and scaling of STEM education in Mobile County.

Challenge 1: STEM education initiatives must be aligned to schools' needs and priorities.

- School faculty, staff and leaders have reported that STEM education is “another thing to do.” Successful STEM education can be a tool or mechanism by which schools can achieve academic, workforce, and student development goals. However, when STEM education content and pedagogy is perceived to compete with existing instructional practices, school priorities, then adoption of STEM is hindered.

Challenge 2: Teachers and leaders must broaden their instructional pedagogy to master STEM education.

- If you walk into any middle school today and ask an educator if STEM education is important, they will likely say “Absolutely.” However, successful implementation depends on a deep understanding of content and inquiry-based, hands-on, systematic instructional practices as well as an understanding of the greater context in which students learn (in-school and out-of-school) and the community's educational and workforce goals. Developing these instructional skills is not an overnight matter for an individual teacher-let alone a system with over 240 mathematics and science teachers across 17 middle schools in both rural and urban environments.

Challenge 3: Guidelines and processes for sustaining and scaling STEM education do not exist.

- This is a national as well as local challenge. Schools across the nation are struggling to develop replicable models of STEM education that provide equitable access to students. Many resources and research studies have identified what STEM education should look like and have suggested best

practices for sustained implementation. The challenge now is to customize implementation plans for schools that respond to the needs, culture, and climate of each school in Mobile County.

Despite these challenges, momentum to support and scale STEM education continues to grow within the community as more teachers, leaders, business and community members understand the potential for STEM education to support Graduate Ready outcomes and close the workforce development gap.

Addressing our Current Challenges: Mobile's STEM Theory of Action

Since the inception of EYE, the goal of STEM in Mobile was to use STEM instruction to increase students' interest and engagement in mathematics and science related content. Evidence suggests that STEM is successful at doing just that. However, the problem in front of us is how to scale STEM to all students in a high quality way. Considering the lessons learned from the first eight years of work, our STEM Community Blueprint lays out the following Theory of Action:

If MCPSS, MAEF, higher education and community partners align STEM programming and implementation strategies to the needs of schools, and if they build educator capacity through high quality professional development, and if they develop a transparent process for scaling STEM across the community, and if they secure adequate resources, then schools will prioritize the integration of STEM practices, teachers will improve their ability to deliver high quality STEM instruction, and students will increase their motivation for and mastery of STEM related content as well as develop critical thinking and teamwork skills.

Goal 1: Ensure STEM is aligned to the needs of schools

Overview: STEM is an essential part of a high quality 21st Century school. Yet, often, the multiplicity of initiatives and requirements imposed on schools cause STEM efforts to seem like an afterthought. The alignment of STEM to needs of schools requires the following actions:

Recommendations:

- Develop a continuous feedback mechanism to gather teacher and principal feedback about how STEM is working in schools and recommendations for improvement.
- Select a cadre of MCPSS Principals, Teachers, and District Administrators to collaborate with education researchers and MAEF to develop a quarterly survey for Principals and a separate survey for Teachers. Reports will be returned to each stakeholder as formative feedback with an annual report and end of year planning session to improve processes and curriculum.

- Ensure STEM work is aligned to school improvement strategies & initiatives. Local and National STEM experts will consult with Principals, Assistant Principals, and school Counselors to develop action plans to align STEM education activities, professional development workshops, and budget allocations with individual schools.
- Connect STEM pedagogy to best practices in instruction.
- Develop an awareness campaign and STEM pedagogy rubric to connect best practice instructional methods and monitor/assess implementation of best practices.
- Provide on-site coaching during STEM lesson implementation as an in-school professional development experience to practice inquiry-based instruction.
- Utilize current practices that are already in place such as content and pedagogy embedded in successful, high-quality education programs and initiatives. (e.g. AMSTI, College Ready Standards, Mobile County Engineering Standards)

How will we know we are successful?

Performance Indicators:

- # of middle schools with an explicit, detailed plan that incorporates STEM into the existing school plan.
- Level of integration at # of middle schools. Develop and use a rubric to evaluate evidence that schools are implementing STEM using a rubric to measure the level of integration (activities, when activities are implemented, # TRs participating, perspectives)

Goal 2: Continue to build Principal, Assistant Principal, and Teacher capacity to implement STEM instruction

Overview: The single most important school-based factor to improved learning for students is the quality of instruction. In order for future teachers to effectively teach integrated STEM, preparation programs should emphasize deeper science and mathematics content development, understanding of how to build 21st century workforce skills and provide opportunities for application and practice of STEM pedagogy.

Taking the following actions will ensure students receive the best STEM experiences:

Recommendations:

- Partner with post-secondary institutions to provide pre-service and in-service teachers with STEM content knowledge, pedagogy, and STEM workforce experience.

- Provide Summer internships/externships for in-service teachers to work or study in STEM fields to develop greater understanding of the application of content to workforce would provide teachers with real-world experience that can be translated into STEM lessons in the school year. (e.g. University of Wyoming's Teacher Engineering Program)
- Offer School Leadership retreats focused on developing STEM education improvement plans that support schools' goals and customized needs.
- Develop a system of Principal and Assistant Principal STEM Leadership trainings.
- Develop a cadre of school leaders to advocate for and provide support to additional schools as they replicate best practices demonstrated by the leadership cohort. (train the trainer model)
- Provide on-site School Leader coaching and support.
- Incentivize STEM educators and principals for their successes and accomplishments through public recognition.
- Develop shared benchmarks and success measures between education, business, and civic leaders.
- Integrate the work of STEM into other broader reform initiatives such as Signature Academies and Graduate Ready.
- Business and Civic leaders work with school leaders to codify high quality standards of STEM education and recognize schools for sustained attainment of these standards (e.g. SAWDC "Champions of Workforce Development" Award).
- Develop a 1 credit hour May-mester course for educators (1 week of 15 hour training + 30 hours of field work).

How will we know we are successful?

Performance Indicators:

- % of teachers scoring at proficient or higher in STEM related instructional practices
- % of Principals & Teachers describing themselves as effective at teaching/leading STEM efforts in their buildings

Goal 3: Develop a clear and comprehensive process for scaling STEM practices across schools.

Overview: Though a number of schools have adopted promising STEM practices, the process of becoming a STEM-based school and receiving targeted supports from community partners is unclear. What's needed is a well-articulated and transparent process for school participation in STEM based initiatives. The following are essential to achieving this goal:

Recommendations:

- Conduct a comprehensive assessment of school-based STEM implementation to create a baseline of STEM education across the district.
- Partner with local and national STEM experts to develop explicit guidelines and STEM education outcomes for schools in different contexts and with different levels of implementation.
- Provide a research-based menu of STEM curriculum resources.
- Publicize the availability of developed, field-tested high quality STEM curricula including the EYE Modules & the MCPSS STEM Lessons.
- Develop a comprehensive STEM marketing and awareness campaign and communication plan to ensure all stakeholders know the value, community vision, and strategy for STEM.
- Develop a cohort of STEM Education Leadership Schools to adapt existing models of successful STEM education initiatives.
- Identify local partner schools through an RFP process to co-create and field test STEM education implementation models using existing, research-based, successful STEM resources (e.g. EYE Modules, STEM Improvement Lesson, Extended Learning Opportunities).

How will we know we are successful?

Performance Indicators:

- # STEM Education Early Adopters schools piloting STEM implementation models
- Growth in school self-evaluation and optional third-party validation of the degree to which they are implementing STEM practices

Goal 4: Invest in adequate resources to support STEM

Overview: Of course, no effort can be truly successfully without the provision of necessary resources. These resources include funding, adequate staffing, and necessary material and supplies of STEM education. The following actions must be taken to secure necessary resources to take STEM to scale:

Recommendations:

- Secure new and align existing funding to develop new practices and content.
- Develop funding strategies using a school-pooled cohort model.
- Investments in evaluation and knowledge sharing and dissemination.
- Seek grant funds in partnerships with institutions of higher education to support the development and field-testing of quantitative and qualitative STEM education assessments that inform and add value to current standardized tests.

How do we know we are successful?

Performance Indicators:

- Amount of funding from outside grants and national contracts
- # of Mobile schools pooling funds to lower costs for STEM
- % of STEM costs covered by private funding sources

Next Steps Timeline

While the recommendations outlined above are all collectively essential for STEM success in Mobile, they cannot be all addressed at one time with fidelity. Over the next year, the Mobile STEM Alliance will address the following key priorities:

Blueprint Goal	Year 1 Priority
<i>Goal 1: Ensure STEM is aligned to school needs</i>	<ul style="list-style-type: none">• Partner with middle schools to determine how STEM efforts can be best aligned to school needs
<i>Goal 2: Support educator capacity-building</i>	<ul style="list-style-type: none">• Develop a comprehensive STEM professional development program for teachers and principals
<i>Goal 3: Develop a clear and comprehensive process for scale</i>	<ul style="list-style-type: none">• Develop an RFP process that allows schools to opt-into STEM practices through a cohort model• Develop a comprehensive STEM marketing and communication plan/campaign
<i>Goal 4: Invest adequate resources</i>	<ul style="list-style-type: none">• Secure grant funding to expand STEM

A CALL TO ACTION

Successful realization of our vision that all students, regardless of color or background, develop the habits of mind to think critically, work in teams, and be exposed to rigorous STEM content through teaching that is discovery-driven and engaging can only happen through partnerships. No one institution can achieve this vision alone. It requires all stakeholders coming together.

For Parents and Taxpayers, this means

- Supporting school funding measures that enable STEM expansion
- Encouraging students to pursue STEM content and learning
- Practicing STEM habits of mind outside of school
- Reinforcing school expectations in the home and community
- Volunteering for classroom and school-based activities in schools

For MCPSS, this means

- Prioritizing STEM as a key district initiative and communicating this priority throughout the district
- Holding schools accountable for developing and implementing an integrated STEM curriculum
- Providing schools with support including teacher, counselor, and principal training

For MAEF, this means

- Securing grants to expand STEM work
- Providing training, coaching and ongoing support to schools
- Developing and implementing a purposeful and inclusive STEM strategy
- Providing opportunities for community partners to support STEM outside of school
- Monitoring progress of efforts to realize Mobile's Vision for STEM

For Business and Civic Leaders, this means

- Providing volunteers and resources to support STEM instruction in schools
- Co-developing curriculum with educators
- Communicating the essential skills needed for STEM careers of the future
- Mentoring and advising students



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