Alabama's Roadmap to

SUCCESS

A Strategic Plan for STEM Education

Developed by the Governor's Advisory Council for Excellence in STEM

November 2019

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Executive Summary

Alabama is a national leader in STEM (science, technology, engineering and mathematics) fields such as aerospace, biotechnology, biomedicine, cybersecurity and advanced manufacturing. The state is projected to need more than 850,000 STEM-related occupations by 2026, but may struggle to fill these positions with qualified candidates. Academically, Alabama's students have fallen behind in math and science proficiency. Significant educator shortages make it difficult to recruit, train and retain well-qualified educators equipped in the methods of a modern STEM classroom, including project-based learning, inquiry and problem solving. Our future workforce is largely unaware of Alabama's STEM careers and the pathways to obtain them.

Although our state has numerous quality in-school and out-of-school STEM education initiatives, they are beyond the reach of many Alabamians, and we are divided into STEM haves and have-nots. Too few students have experiences that promote an "I belong here" STEM identity. At an overarching level, Alabama lacks a common vision to expand and weave our individual initiatives, resources and expertise into a coordinated STEM education network providing the workforce pipeline essential to the future of Alabama's economy.

The Governor's Advisory Council for Excellence in STEM (ACES) was tasked with crafting a roadmap to overcome these challenges. Our goal is to provide all Alabama learners with access to excellent STEM educational programming and experiences that build a solid foundation and provide opportunities for entry into the workforce. Over a six-month period, the Council focused on five priority areas critical to Alabama's STEM education success. We identified 22 priority area recommendations that can take us there. Each recommendation is described in detail within the Roadmap, along with implementation milestones and suggested metrics for tracking our progress.

As the recommendations were taking shape, it became clear that the responsibility for their implementation transcended any one educational entity, state department or industry supporter. Alabama requires a system to interlace our STEM stakeholders into a coordinated network that advocates, oversees and tracks the Roadmap's implementation. Accordingly, the Council developed two additional recommendations to foster the necessary structures for long-term success.

Throughout the six-month process, the Council embraced the idea of fashioning a STEM education Roadmap. Not unlike a team of surveyors, we determined the shape and contours of our current landscape, identified boundary lines, resolved property disputes and sketched routes for new highways and byways. Now we pass the torch to Alabama's education, industry, community and government leaders. Collectively, they can convert recommendations to roads.

The Council is united in their belief that the implementation of these 24 recommendations will positively shape STEM education across Alabama. As a result, empowered STEM learners will successfully reach the STEM destinations of their dreams, fueling Alabama's knowledge-based economy for years to come.

The Governor's Advisory Council for Excellence in STEM

ACES Recommendations

STEM Exploration and Discovery

ED1. Identify exemplary K-12 STEM initiatives and expand/scale their utilization across Alabama's schools, afterschool programs and other educational settings, with particular emphasis on reaching traditionally underserved populations.

ED2. Develop and maintain a user-friendly mobile app and online portal that highlights Alabama's STEM careers and provides a gateway for students, parents, educators and other stakeholders to access STEM programs offered across the state (i.e., summer programs, field trips, afterschool programs, internships, professional learning opportunities, etc.).

ED3. Establish a criteria-driven "Governor's Seal of Approval" to showcase summer programs, afterschool programs, experiential opportunities and periodic events that significantly advance STEM learning and discovery in Alabama communities.

ED4. Continually measure attitudes and career interests of P-20 learners to identify activities and experiences that positively shape perceptions about STEM.

ED5. Braid funding from the Every Student Succeeds Act (ESSA), the Carl D. Perkins Act (which provides for career exploration from fifth grade and above) and the Workforce Innovation and Opportunity Act (WIOA) to expand access to immersive career exploration and discovery activities (e.g., project-based learning, field trips, workplace tours, etc.).

Numeracy and STEM Fluency

NF1. Strengthen the quality of K-5 mathematics instruction by placing a math coach in every Alabama elementary school to provide classroom-embedded instructional support for teachers. Train and support these coaches and their school leadership with a team of regional math specialists. Evaluate the impact of this initiative through a multi-level framework assessing knowledge acquisition, changes in instructional practice and shifts in attitude for students, educators and school leaders.

NF2. Identify and/or develop a system of validated, high-quality formative assessment tools for P-12 schools that provide teachers and administrators real-time opportunities to identify gaps in student STEM subject learning. Ensure educators are trained in the use of these tools and equipped to interpret student results and respond with appropriate instructional strategies.

NF3. Ensure that rigorous, meaningful STEM courses/curricula and appropriately-trained instructors are available to all Alabama students, regardless of location, socioeconomic background, race or ethnicity. Identify and scale up alternate methods of instruction, where necessary.

NF4. Conduct a multiyear, comprehensive, external evaluation of the Alabama Math, Science, and Technology Initiative (AMSTI) and Alabama Science in Motion (ASIM) program that tracks the implementation of their continuous improvement plan. The evaluation should be overseen by the STEM Council (recommendation SC1), and use criteria developed by AMSTI and other Alabama STEM stakeholders (i.e., assessing the effectiveness of human capital and organizational performance, the model of resource storage/delivery, the impact on student learning, consistency across sites, etc.).

Pre-Service STEM Educator Preparation

PS1. Design and implement a multiyear, statewide teacher recruitment campaign that features the advantages and benefits of public-school teaching, focusing on benefits, job security and lifestyle conveniences.

PS2. Refine the Teachers' Retirement System of Alabama plan to reflect a higher retirement factor, a sick leave conversion and an opportunity to retire after 30 years of service, irrespective of one's age.

PS3. Strengthen and widen the state's onsite teacher mentoring program.

PS4. Identify ways to streamline teacher preparatory requirements. Assess the predictive validity of Alabama's standard requirements for licensure to identify good predictors of program completion, performance in the programs and/or performance in the classroom.

PS5. Develop incentives to encourage participation in STEM teaching fields in middle and high schools.

In-Service STEM Educator Development

IS1. Ensure school, district and community leaders receive professional learning opportunities that highlight the importance of STEM fields and increase awareness of and support for the educational strategies outlined in this roadmap.

IS2. Ensure P-12 educators are receiving high-quality professional learning that meets the ESSA definition of professional learning (sustained, intensive, collaborative, job-embedded, data-driven and classroom-focused) and strengthens both content and pedagogy for STEM classroom experiences. Provide special emphasis on educators serving students traditionally underrepresented in STEM fields.

IS3. Undertake comprehensive program evaluations to analyze the efficacy of STEM-focused professional learning initiatives currently offered across Alabama – focusing on their impact on educator knowledge and practice as well as student outcomes.

IS4. Expand opportunities for Alabama educators to directly experience STEM careers in action (e.g., partnerships with industry, externships, job shadowing, etc.) and incorporate relevant lessons and career connections in their classroom.

Career Pathways for In-Demand STEM Occupations

CP1. Establish a formal definition of STEM-based occupations, which evaluates occupations on a spectrum instead of classifying in a binary manner.

CP2. Utilize the expertise within ACES to guide the establishment of the Technical Advisory Committee (TAC) for STEM occupations and to assist other TACs in clarifying/evaluating the pathways for STEM-related occupations present within their clusters (including the identification of in-demand career pathways and credentials of value).

CP3. Equip students, parents and teachers with Alabama-specific, STEM-related career information and pathways.

CP4. Increase industry partnerships that expose students to STEM careers and expand the number of work-based learning opportunities available within STEM pathways (i.e., job shadowing, pre-apprenticeships, youth apprenticeships, on-the-job training and internships).

STEM Coordination Across Alabama

SC1. Establish a STEM Council that serves as Alabama's lead organization for STEM education and Alabama's point of contact for interfacing with other state and national STEM initiatives. Council membership should be drawn from a cross-section of Alabama leaders representing STEM education, business and policy interests.

SC2. Launch a STEM Council Operations Center, led by a full-time Executive Director, with sufficient staff to oversee and assist in accomplishing the work of the STEM Council. Place the Operations Center at a location best suited to bring together Alabama stakeholders and collaborators. Consider establishing a network of regional STEM coordinators who connect school districts, businesses, institutes of higher education and other community partners to cultivate a thriving STEM ecosystem.

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Key Definitions

STEM – STEM is an acronym that refers to the overlapping disciplines of science, technology, engineering and math.

STEM Education – While this phrase has become a common part of education and workforce conversation, there is no universally accepted definition of what STEM education means. It is more than achieving competency in the individual STEM subject areas; learners must be able to integrate concepts from multiple disciplines and use that knowledge to solve complex problems. STEM education often includes instructional practices that actively engage all learners in an interdisciplinary project—or problem-based approach, tied to a real-world, authentic challenge. Throughout the process, students use various technologies to assist their inquiry, research and communication.

The Committee on STEM Education from the National Science and Technology Council[1] notes:

> *Over the past 25 years, STEM education has been evolving from a convenient clustering of four overlapping disciplines toward a more cohesive knowledge base and skill set critical for the economy of the 21st century. The best STEM education provides an interdisciplinary approach to learning, where rigorous academic concepts are coupled with real-world applications and students use STEM in contexts that make connections between school, community, work and the wider world.... Modern STEM education imparts not only skills such as critical thinking, problem solving, higher order thinking, design and inference, but also behavioral competencies such as perseverance, adaptability, cooperation, organization and responsibility.*

STEM Careers – This seemingly straightforward term refers to careers that utilize concepts from the STEM fields, yet organizations disagree on which careers fit this description. All groups include careers related to the core fields of engineering, life science, astronomy, physics, chemistry, earth science, mathematics and computing and information science. Some include health-related jobs such as physicians, nurses and technicians, while others include psychology and the social sciences like political science and economics. Still others argue that STEM careers should be determined based on their use of practices and problem-solving processes rather than field-specific boundaries. These varying definitions partly explain the widely-ranging estimates for the number of individuals employed in STEM fields, the overall representation of traditionally underrepresented minorities and whether STEM fields are experiencing a surplus or scarcity of employees. All definitions include workers with different levels of educational attainment, from high school diplomas to advanced degrees.

How This Roadmap was Developed

Governor Kay Ivey appointed 78 volunteers to the Governor's Advisory Council for Excellence in STEM (ACES) and tasked them with formulating the Alabama "Roadmap to STEM Success." Over a six-month window, these STEM stakeholders shaped the Roadmap through a series of in-person and virtual meetings. Council representation included STEM-focused industries, public universities, private colleges, community colleges, K-12 schools, career centers, afterschool networks, community foundations, chambers of commerce, informal educational centers and research institutes. These were joined by individuals from the Alabama Departments of Education, Early Childhood Education and Commerce. The names and affiliations of Council members are listed on page 42.

The Council was organized into six working committees, each focused on a priority area as identified by Governor Ivey:

1. **STEM Exploration and Discovery**
   increasing student interest in STEM through in-school and out-of-school opportunities
2. **Numeracy and STEM Fluency**
   increasing student proficiency in STEM subjects and supporting strong standards with best-practice instructional resources and assessments - special attention is given to mathematics, the gateway to understanding and mastering other STEM disciplines
3. **Pre-Service STEM Educator Preparation**
   recruiting and preparing a cadre of well-qualified educators
4. **In-Service STEM Educator Development**
   supporting Alabama's STEM educators with ongoing professional learning
5. **Career Pathways for In-Demand STEM Occupations**
   ensuring STEM pathways link coursework and experiential opportunities to aligned workforce needs
6. **Equity, Access and STEM**
   ensuring STEM education access for all Alabama students

A steering committee oversaw the work of the priority committees with an eye toward identifying gaps, overlaps and linkages between the groups. The steering committee also made recommendations towards an overall structure to help Alabama accomplish the goals of the STEM Roadmap.

After an in-person launch event in April 2019, the committees spent 12 weeks determining the current landscape of their priority areas and drafting initial recommendations. In July 2019, the steering committee met in-person to review and hone these recommendations, selecting two dozen for inclusion in the Roadmap. During the ensuing 10 weeks, recommendations were finalized, and indicators of success were crafted. Text for the report was drafted and reviewed by priority committee chairs and their members, together with the steering committee.

A draft of the Roadmap was provided to the full ACES membership for review, followed by a final in-person checkpoint meeting at the end of September 2019. All edits, additions, and suggestions were weighed and incorporated as appropriate by the steering committee. The text was incorporated into a final layout in early October and presented to Governor Ivey.

The Importance of STEM and STEM Education in Alabama

The demand for significant STEM action for Alabama has never been greater. Alabama is a STEM-rich state, leading the way nationally in aerospace, biotechnology, biomedicine, cybersecurity and advanced manufacturing.

Career opportunity is synonymous with STEM fluency, whether a student's trajectory is a college degree, postsecondary certification, an apprenticeship credential or an occupational licensure. Thirty-four of Alabama's 40 in-demand occupations require secondary and postsecondary STEM education[2]. Between 2017 and 2027, STEM jobs will grow by 9% in Alabama, while non-STEM jobs will only grow by 5%[3]. In particular, there is very high demand for computer scientists across the state with more than 5,000 computing jobs that are currently unfilled[4].

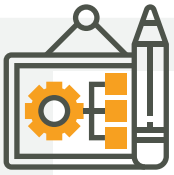
The median wage for STEM jobs in Alabama is $35 per hour, more than twice that for non-STEM jobs[5]. Labor market projections indicate a growing gap in the supply of qualified employees for middle skills jobs – those that require training beyond high school but less than a four-year degree. Shortfalls are expected to be particularly acute in STEM fields such as computer technology, nursing and advanced manufacturing.

Alabama currently faces significant headwinds regarding STEM discovery, learning and career preparation across the preK-workforce pipeline. Persistent achievement gaps are especially present in math and science. Only 31% of 4th graders and 21% percent of 8th graders scored at or above the proficient level in math on the 2017 administration of the National Assessment of Education Progress (NAEP)[6]. While nearly half of Alabama's 2018 high school graduates indicated having an interest in STEM majors and/or careers, only 11% met the ACT STEM college readiness benchmarks[7].

Investing in children's lives very early, and across the spectrum of their learning into early adulthood, ensures economic development and increased living standards for all Alabamians. Nearly all career opportunities in Alabama are influenced in some way by the STEM disciplines — significant numbers of vocations are rooted in STEM — and whole new STEM professions are consistently coming online. Providing all learners with access to STEM education and career pathways is the responsibility of us all.

Equity, Access and STEM

All students – regardless of gender, ethnicity, geography or income – deserve an education that includes access to rigorous coursework, is taught by well-prepared teachers and provides opportunities to gain 21st century skills needed for future careers. Unfortunately, in terms of STEM education, this vision is out of reach for many Alabama learners. Many females, African Americans, Hispanics, Native Americans, students from rural communities, learners with disabilities and individuals with low socioeconomic status lack access to high-quality, STEM-focused initiatives and resources. Negative gender-based stereotypes impact girls' engagement with STEM content. STEM teacher shortages primarily affect minority and low-income communities. Cost, transportation and a lack of programming prevent underrepresented populations from participating in out-of-school activities and experiences. The impact of this inequality is reflected in a variety of metrics, from lower expressed interest in STEM to lower average math and science ACT scores among Alabama's underrepresented populations (see table[7] below).



2018 Average Alabama ACT Scores by Race/Ethnicity

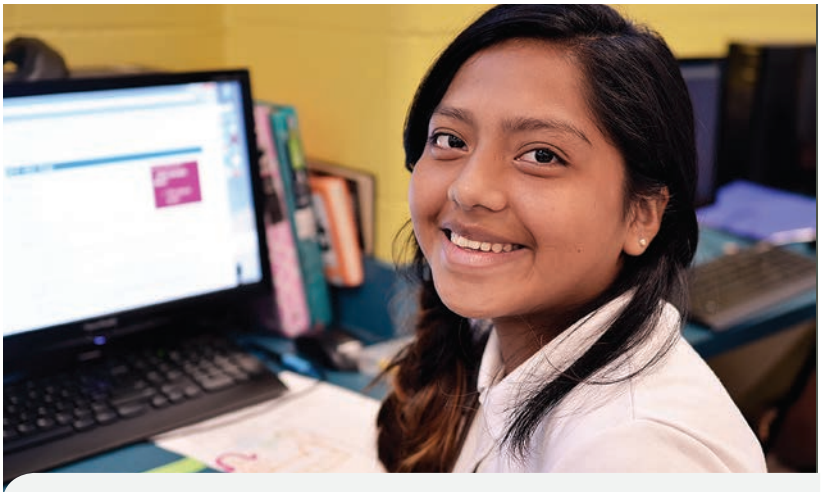
Race/Ethnicity	Number	Math	Science
All 2018 AL High School Seniors	58,177	18.3	19.0
Native Hawaiian/Pacific Islander	51	16.8	17.2
American Indian/Alaska Native	458	17.2	17.9
Asian	877	24.0	23.3
Hispanic/Latino	3,596	17.3	17.7
Black/African American	16,336	16.0	16.5
White	31,665	19.5	20.4
Two or More Races	2,121	18.6	19.5
Prefer Not/No Response	3,073	17.6	18.1

Note: ACT defines Collge Readiness Benchmarks as a the minimum ACT test score required for students to have a reasonable chance to success in first year credit-bearing college courses. The benchmarks for Mathematics and Science are 22 and 23, respectively.

These groups are less likely to pursue STEM careers and enter the STEM workforce. Latinio, Native American and African American students drop out of STEM degree programs at a higher rate than white and Asian counterparts[8]. While more than a third of these students begin college with an interest in studying STEM, only 16% actually obtain a bachelor's degree in these fields[9]. Similar findings have been identified for students with disabilities. While STEM occupations have become more diverse over the last 25 years, they are still significantly dominated by white males (see figures at the right[10]). Women have made gains, but remain significantly underrepresented in physical science, engineering and computing. The share of African American and Hispanic workers varies widely by STEM occupation, but they are underrepresented in comparison to their overall participation in the workforce.

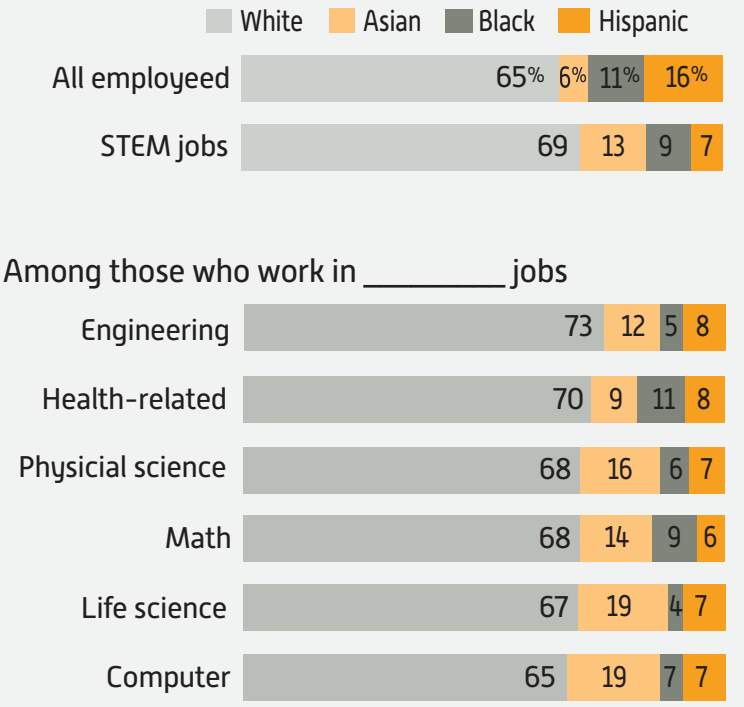
Alabama cannot remain competitive in the global workforce by ignoring these demographic groups. We are, as NIH Director Francis Collins notes[11], "missing critical contributors to our talent pool." Failing to provide access for all students to STEM-focused opportunities, coursework and programs will lead to a loss of talent and untapped potential that pushes Alabama into a downward spiral relative to STEM workforce competitiveness[12]. Diversity leads to better problem-solving, expands the talent pool and ensures long term growth. It results in upward economic mobility for more Alabamians[13], providing a stronger base for innovation, competitiveness and the knowledge-driven economy of tomorrow.

Particular attention should be given to the influence of STEM identity — how individuals think about themselves, who they can become, where they belong and how they think others see themselves with respect to STEM subjects and careers[14]. Learners who acquire a STEM identity tend to engage with



Blacks and Hispanics underrepresented across most STEM job clusters

% of employeed in each occupational group who are...



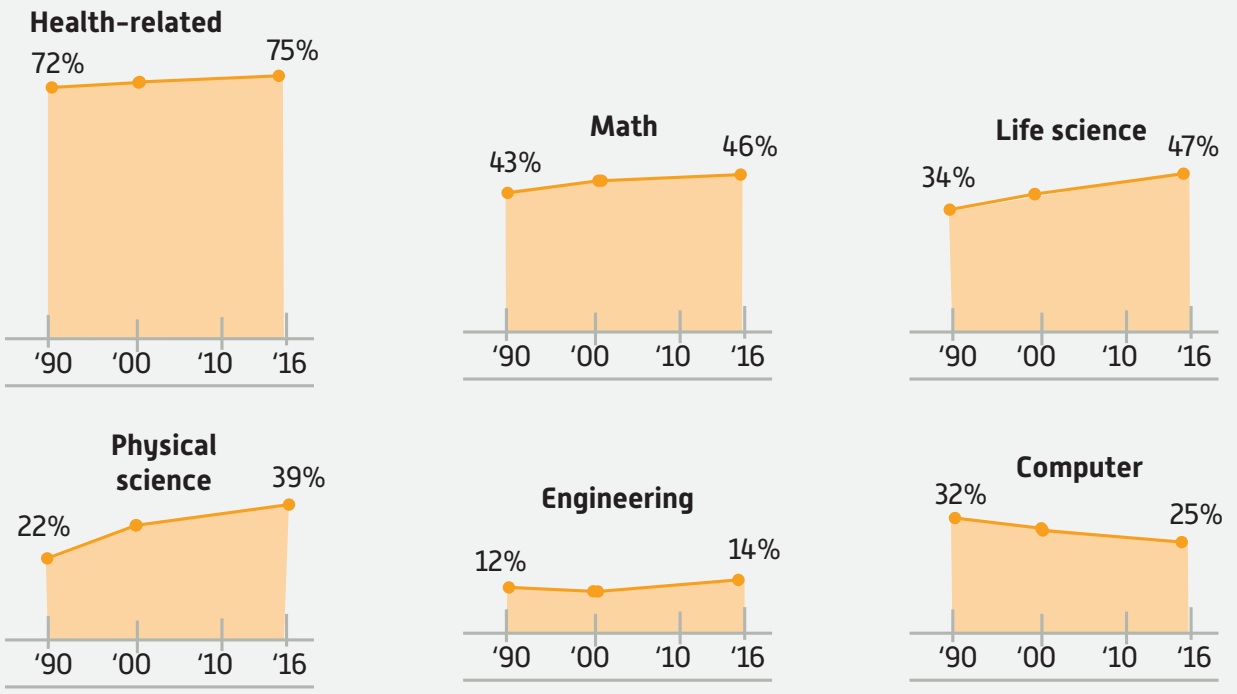
Note: *Based on employeed adults ages 25 and older. Whites, blacks and Asians include only non-Hispanics. Hispanics are of any race. Other and mixed race non-Hispanics are not shown. Engineering includes architects.*

Source: *Pew Reserach Center analysis of 2014-2016 American Community Survery (IPUMS).*

"Women and Men in STEM Often at Odds Over Workplace Equity."

PEW RESEARCH CENTER

Although progress has been made, women are still underrepresented in most STEM fields



Share of employed in each occupational group who are women(%)

STEM content more often and more deeply and STEM identity is a better predictor of entry into STEM careers than academic performance[15]. The concept of STEM identity traverses gender, ethnicity and socioeconomic categories. Providing students with role models who look like them, have similar cultural backgrounds and are enthusiastic about STEM positively impacts STEM persistence and the likelihood a learner will successfully enter a STEM career.

The Governor's Advisory Council for Excellence in STEM affirms that STEM educational initiatives and policies must allocate resources toward strategies that increase access to STEM opportunities, develop a positive STEM identity and promote persistence in STEM for students from underrepresented groups. Our recommendations seek to enhance STEM education and address critical workforce issues by creating multiple pathways to reach all students. Our recommendations also promote STEM engagement in and out of the classroom, recognizing the important role of informal educational settings in expanding access and representation. Specific references to the importance of equity, inclusion and diversity are incorporated into the Priority Area Recommendations and explanations below.

Priority Area Recommendations that Specifically Address Equity and Access

STEM Exploration and Discovery: ED1
Numeracy and STEM Fluency: NF1, NF3
Pre-Service Education: PS1, PS3, PS5
In-Service Education: IS2, IS4
Career Pathways: CP4
STEM Coordination: SC1

Priority Area 1

STEM Exploration and Discovery

Priority Area 1:
STEM Exploration and Discovery

Current Landscape

Learners interact with STEM concepts and applications through a variety of platforms (e.g., inquiry-driven modules, apps and games, field trips, summer camps, independent research, etc.) offered in both formal settings (i.e., P-20 classrooms, lecture halls and laboratories) as well as informal environments (i.e., museums, zoos, libraries, afterschool and out-of-school networks and the workplace). When done well, these experiences increase student interest in and understanding of STEM content knowledge, engage students in STEM practices and connect them to the broader applications of the content.

Importantly, interest and engagement are key indicators of whether students are likely to pursue STEM-based careers. Opportunities to explore STEM fields and discover areas of personal engagement are a critical step in connecting students to the STEM pipeline.

- Alabama is rich with opportunities to engage learners of all ages in STEM, but the availability of programs and initiatives favor communities and districts that have access to the most resources, knowledge and expertise. Opportunity gaps are often concentrated within rural districts and socioeconomically challenged regions.
- In 2018, 49% of Alabama graduates indicated having an interest in STEM majors or careers, compared to 45% of graduates nationally[7]. However, reduced access to foundational STEM courses and out-of-school STEM learning experiences for students who attend high-poverty schools or who live in rural districts hinders the maturation of a diverse talent pool in Alabama.
- Afterschool networks across the state (e.g., YMCA, Boys & Girls Club, Boy Scouts, Girl Scouts, 4-H Club, etc.) and informal learning centers are eager to incorporate and embed STEM learning into their curriculum, but lack training experiences for organization leaders and volunteers that focus on effective strategies for providing integrated STEM learning.
- STEM programming to inspire Alabama students relies heavily on external grant funding. The result is an atmosphere of competition rather than cooperation and collaboration.
- Communication about the availability of STEM programs offered through out-of-school and other informal learning venues is spotty and uncoordinated. Students and parents may not always be aware of STEM-based opportunities available within their region.

Recommendations

ED1. Identify exemplary K-12 STEM initiatives and expand/scale their utilization across Alabama's schools, afterschool programs and other educational settings, with particular emphasis on reaching traditionally underrepresented populations.

- Educational organizations with STEM-based offerings are invited to submit their program for consideration.
- A rubric is developed to review potential programs with respect to best practices in STEM learning (e.g., appeal to diverse learners, ability to improve academic performance and integrate STEM concepts, build partnerships with the community, etc.).
- A task force of Alabama STEM stakeholders utilizes the rubric to assess the programs and identify top scoring initiatives to "scale up" over the following year, using funds allocated by the Alabama Legislature.
- Alabama educators and other individuals who deliver STEM educational programming in schools, afterschool programs and other settings apply to participate in the expanded initiatives.
- After implementing the program, educators participate in assessing the effectiveness of the initiative.

Indicators of Success

ED1a. An increase in the number of STEM-based initiatives that are offered across Alabama, especially in previously underserved regions.

ED1b. Increased participation in STEM programs by students from traditionally underrepresented populations.

ED1c. Increased interest and awareness in STEM topics and careers among students who participate in expanded initiatives.

ED2. Develop and maintain a user-friendly mobile app and online portal that highlights Alabama's STEM careers and provides a gateway for students, parents, educators and other stakeholders to access STEM programs offered across the state (i.e., summer programs, field trips, afterschool programs, internships, professional learning opportunities, etc.).

- For the mobile app/online portal to be effective in its use, program providers must be able to easily upload activity details and links. Consumers must be able to search and filter results from multiple device types. The searchable database offers a comprehensive, updated collection of high-quality STEM opportunities and programs available to students within their local communities.

Indicators of Success

ED2a. The mobile app and online portal are widely utilized by stakeholders across Alabama.

ED2b. Post-launch, program providers regularly update the mobile app and online portal to highlight current STEM opportunities.

ED3. Establish a criteria-driven "Governor's Seal of Approval" to showcase summer programs, afterschool programs, experiential opportunities and periodic events that significantly advance STEM learning and discovery in Alabama communities.

- The rubric for programs or events includes items such as activities, inputs, outputs and short- and long-term learning outcomes that help entities develop new or improve existing STEM programs in such a way to be awarded the Governor's Seal of Approval.

Indicators of Success

ED3a. During the first year, at least one organization from each of the seven Alabama workforce regions applies for the Governor's Seal of Approval for a STEM program offered by that organization.

ED3b. Within three years, the Governor's Seal of Approval has been awarded to at least one program within every workforce region.

ED3c. Initiatives that receive the Governor's Seal of Approval experience positive follow-on impacts, such as greater community awareness, increasedn participation, additional external sources of funding, etc.

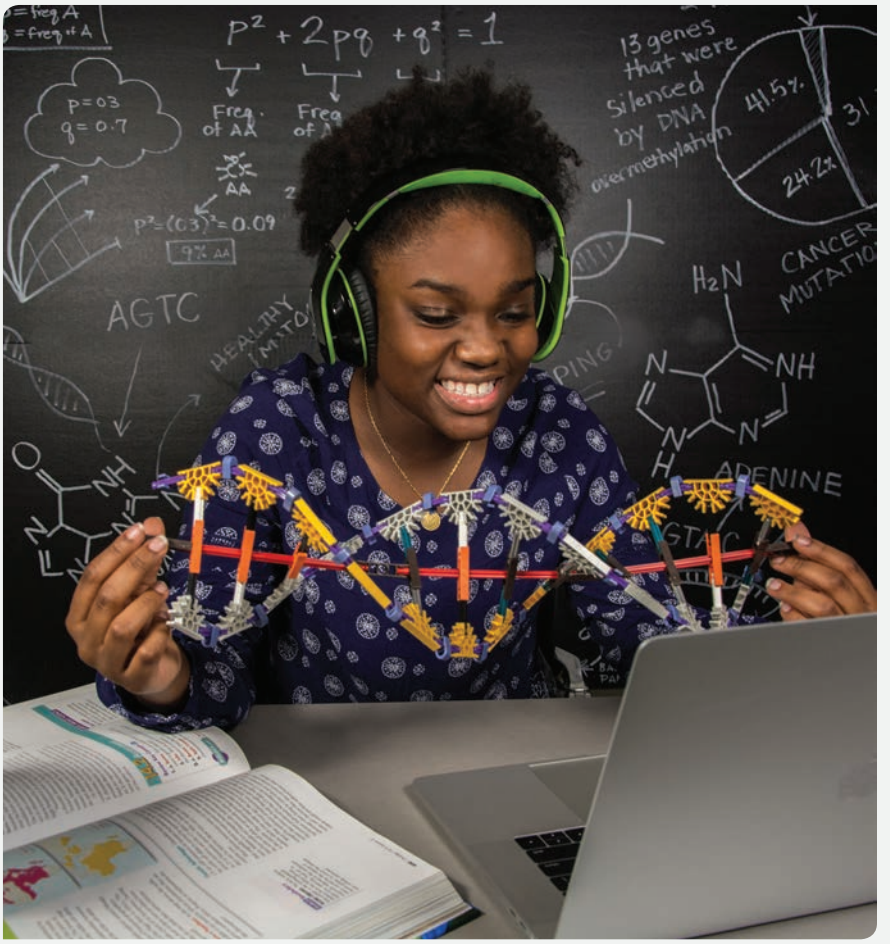
ED4. Continually measure attitudes and career interests of P-20 learners to identify activities and experiences that positively shape perceptions about STEM.

- Identify validated, age-appropriate instruments that measure learner attitudes toward and interests in STEM and STEM careers.
- As appropriate, survey students using these instruments. These could be used before and after a STEM experience to test for differences in learner interest. Additionally, a very modest number of STEM attitude and interest questions could be added to end-of-year summative assessments across various grade bands. This would provide an aggregated snapshot of overall state trends.
- Consider incorporating this attitudinal/interest information, together with a digital portfolio of student participation in STEM initiatives, into the Alabama College and Career Exploration Tool (ACCET) or the forthcoming Alabama Terminal on Linking and Analyzing Statistics (ATLAS) on Career Pathways.

Indicators of Success

ED4a. The STEM Council uses interest data to identify and prioritize programs and program characteristics that positively influence student perceptions about STEM.

ED4b. Student interest in STEM and STEM careers increases as students progress through secondary and post-secondary experiences.



ED5. Braid funding from the Every Student Succeeds Act (ESSA), the Carl D. Perkins Act (which provides for career exploration from fifth grade and above) and the Workforce Innovation and Opportunity Act (WIOA) to expand access to immersive career exploration and discovery activities (e.g., project-based learning, field trips, workplace tours, etc.).

Indicators of Success

ED5a. All Alabama students have opportunities to explore STEM content and career options.

Priority Area 2

Numeracy and STEM Fluency

Priority Area 2:
Numeracy and STEM Fluency

Current Landscape

- Math proficiency for Alabama students is among the lowest in the nation. Proficiency on state assessments fluctuates with test type, but recent findings suggest approximately only 50% of fourth graders and 35-44% of eighth graders are proficient[16]. National assessments paint an even more dismal picture. The most recent NAEP assessments find that 30% of Alabama fourth graders and 20% of eighth graders achieved math proficiency[6]. Similarly, while the entire 2018 high school graduating class took the ACT, only 23% achieved a benchmark score of 22 in math[7]. Both NAEP and ACT trendlines have remained fairly consistent for several years.

- State-funded initiatives that focus on reading, science, math and other content areas may lack the required supporting infrastructure, are not evaluated for improved impact on student performance and work in an atmosphere of competition rather than cooperation. Due to funding constraints, schools – many in rural districts and socioeconomically challenged regions – are on "waiting" lists for training and support.

- Local Education Agencies (LEAs) in Alabama choose and fund formative assessment tools at the local level. Some LEAs do choose a variety of formative assessment digital platforms, but there is no common measure to validate available formative assessment tools.

- While advanced course-work in STEM (like Advanced Placement) and taking STEM courses in specialized areas (like Computer Science or Engineering) broaden student's options for careers, these are not uniformly available across the state. The 2019 Computer Science for Alabama Act (HB216) helps address access issues by mandating that computer science is taught in all high schools by the 2020-2021 school year and across all Alabama schools by 2022–23.

- AMSTI and ASIM are Alabama's nationally-recognized STEM initiatives and have been serving students for 19 and 25 years, respectively. Both utilize a regional structure to provide resources and services to local systems and schools. Each of the 11 regional sites provides services in the three key areas of professional learning, equipment and materials and onsite support. Of the $29 million provided to AMSTI during FY2019, approximately $5.7 million was expended for foundational educator learning, $5.7 million allocated to equipment and materials support, and $17.7 million for ongoing, side-by-side teacher and administrator support in the classroom and school setting.

- AMSTI is currently partnering with Cognia to develop a continuous improvement plan (CIP), which will detail the improvement efforts of the Initiative over the next three-year period. The improvement plan contains the following strategic themes: Student Learning, Educator Effectiveness, Organizational Effectiveness (to include warehouse operations) and Stakeholder Relations. Additionally, the plan will include all of the measures of evaluation that will be used to determine effectiveness of the improvement efforts.
A draft of the CIP will be available in Fall of 2019.

Recommendations

NF1. Strengthen the quality of K-5 mathematics instruction by placing a math coach in every Alabama elementary school to provide classroom-embedded instructional support for teachers. Train and support these coaches and their school leadership with a team of regional math specialists. Evaluate the impact of this initiative through a multi-level framework assessing knowledge acquisition, changes in instructional practice and shifts in attitude for students, educators and school leaders.

Indicators of Success

NF1a. All K-5 schools in Alabama have a math coach. By the end of Year 2, coaches are embedded in 20% of schools. Full implementation is achieved during Year 6.

In K-5 schools supported by a math coach:

NF1b. One hundred percent of educators teach math using effective instructional strategies advocated by their coaches by the end of Year 6.

NF1c. The number of students performing at proficiency level in math significantly increases. By the end of Year 3, there is a 15% increase from baseline. For Years 4, 5 and 6 the increases are 20%, 25% and 30%, respectively.

NF1d. Teacher confidence, measured as self-efficacy in mathematics and mathematics teaching, increases by 50% by the end of Year 5.

NF1e. Student confidence, measured as self-efficacy in mathematics, increases by 50% by the end of Year 5.

NF1f. The performance gap in math narrows among the various ethnic student subgroups. By the end of Year 3, gaps narrow by 15%. For Years 4, 5 and 6, the gap narrows by 20%, 25% and 30%, respectively.

NF2. Identify and/or develop a system of validated high-quality formative assessment tools for P-12 schools that provide teachers and administrators real-time opportunities to identify gaps in student STEM subject learning. Ensure educators are trained in the use of these tools and equipped to interpret student results and respond with appropriate instructional strategies.

Indicators of Success

NF2a. The assessment on availability of existing formative assessment tools is complete by the end of Year 1.

NF2b. Formative assessment tools previously identified as lacking are developed by the end of Year 2.

NF2c. All P-12 educators who teach STEM and STEM-related subjects are trained to use and interpret the relevant formative assessment tools, and to respond with appropriate instructional strategies by the end of Year 5.

NF2d. These formative assessment tools and follow-on strategies are routinely used in all P-12 schools by the end of Year 5.

NF3. Ensure that rigorous, meaningful STEM courses/curricula and appropriately-trained instructors are available to all Alabama students, regardless of location, socioeconomic background, race or ethnicity. Identify and scale up alternate methods of instruction, where necessary.

- Champion full implementation of the 2019 Computer Science for Alabama Act (HB216), encouraging all students to gain Computer Science skills, broadening access to Computer Science coursework and providing professional learning opportunities for P-12 CS educators.

Indicators of Success

NF3a. All students in P-12 schools across Alabama have equitable access to rigorous STEM courses that lead to college preparation and or career readiness, taught by well-prepared instructors.

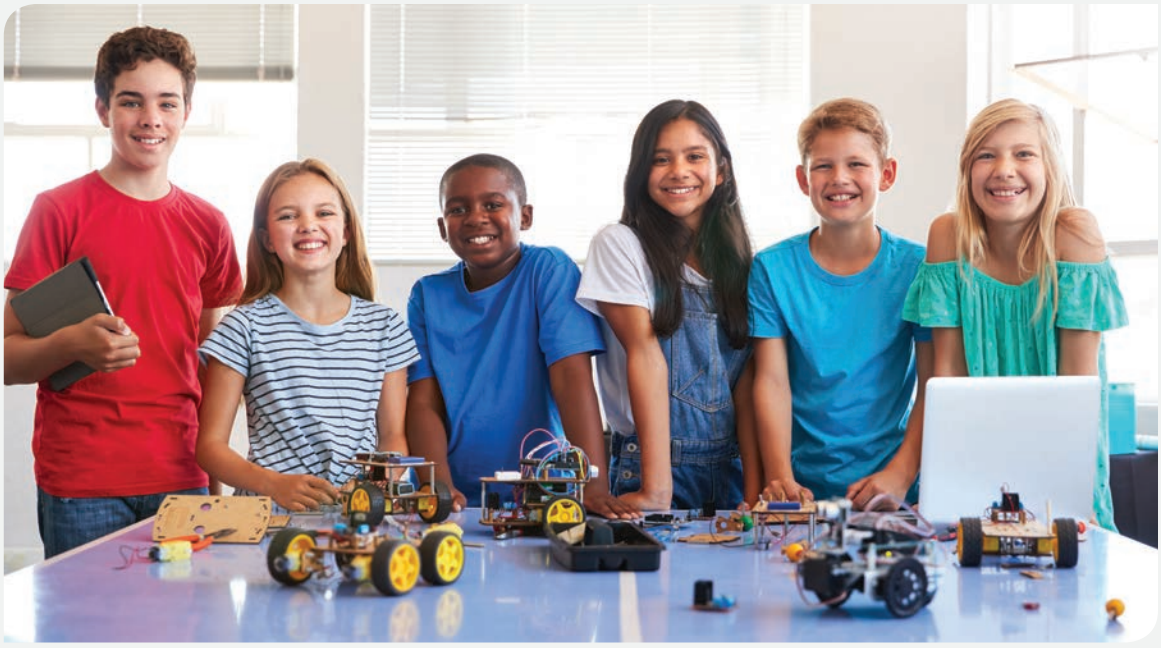
NF4. Conduct a multi-year comprehensive, external evaluation of the Alabama Math, Science, and Technology Initiative (AMSTI) and Alabama Science in Motion (ASIM) program that tracks the implementation of their continuous improvement plan (CIP). The evaluation is overseen by the STEM Council (recommendation SC1), and uses criteria developed by AMSTI and other Alabama STEM stakeholders (i.e., assessing the effectiveness of human capital and organizational performance, the model of resource storage/delivery, the impact on student learning, consistency across sites, etc.)

Indicators of Success

NF4a. Assessment findings are reported throughout the evaluation lifecycle, including a pre-improvement baseline measure of data, as well as yearly progress reports across the continuous improvement plan's timeframe.

NF4b. AMSTI/ASIM incorporates the feedback and recommendations into the existing improvement plan within three months of receiving each annual report.

NF4c. In subsequent years, other state-supported STEM initiatives undergo similar external evaluations.



Priority Area 3

Pre-Service STEM Educator Preparation

Priority Area 3:
Pre-Service STEM Educator Preparation

Current Landscape

The problems facing teacher education programs in the STEM fields are largely the same problems that face teacher educators in general. It is clear that a major feature is recruitment into the profession. What can be done to renew interest in the upcoming generation of students to pursue a college degree that includes a comprehensive experience in teacher education?

- Significant educator shortages persist in Alabama and across the nation, especially in mathematics, science, foreign language, ESL and special education. Key influences on turnover include a lack of administrative support, working in districts with lower salaries, dissatisfaction with testing and accountability pressures, lack of opportunities for advancement and dissatisfaction with working conditions[17].

- Interest in teaching has declined. The number of students formally admitted into Alabama teacher education programs has dropped by about 30% since 2010. The number of students graduating as licensed teachers has also declined.

- Educators in Alabama earn 17% less than their counterparts with the same level of education in other states. Students in STEM fields often avoid teaching as a career option, due to the availability of higher-paying jobs outside the classroom. That said, there are substantial benefits for public school teachers, including fewer workdays, higher health benefits and increased job security.

- Nationally, educator attrition rates average 16% annually[18]. Attrition rates for educators entering the classroom without full preparation/certification are two to three times higher than for those who are fully prepared.

- Traditional teacher education programs require students to jump through several hoops on the way to certification. These exact a toll on students, both in terms of effort, stress and expense. The predictive impact of these requirements varies and prospective educators may be spending significant amounts of time completing requirements that do not appropriately prepare them for final certification or classroom success.

Recommendations

PS1. Design and implement a multiyear statewide teacher recruitment campaign that features the advantages and benefits of public school teaching, focusing on benefits, job security and lifestyle conveniences.

- Focus the professionally-designed campaign on both the importance of a teacher's work and the advantages of the profession.
- Utilize social media platforms, television and radio outlets, guiding high school and college audiences to a recruiting website for additional details.
- Include recruiting visits at high school and post-secondary sites. Give special attention to reaching students of traditionally underrepresented populations.
- Use survey instruments to determine whether the campaign affected the attitudes of the target audience towards the selection of teaching as a profession.
- Monitor admission data at teacher education sites, including onsite interviews that ask about the effect of the campaign. Compare the number of students drawn into education programs pre- and post-campaign, including differences between locations that received recruiting visits and comparable schools that were not visited.

Indicators of Success

PS1a. An increase in the number, quality and diversity of students enrolling in teacher education programs during and immediately following the campaign. A 10% increase in enrollment is expected during Year 1, with additional 10% increases over baseline for each of Years 2 and 3. The number of students selecting STEM-subject secondary education sees a comparable increase.

PS2. Refine the Teachers' Retirement System of Alabama plan to reflect a higher retirement factor, a sick leave conversion and an opportunity to retire after 30 years of service, irrespective of one's age.

- Consider "Tier 3" proposals, similar to the bill introduced by Representative Alan Baker in 2018, as they restore many of the retirement benefits in place prior to 2013.
- Involve Alabama Association of Colleges for Teacher Education (ALACATE), deans of Alabama colleges and schools of education and the superintendents of the various school districts in supporting the redesign.

Indicators of Success

PS2a. Passage of a modified retirement package increases the number of students enrolling in teacher education programs.

PS3. Strengthen and widen the state's onsite teacher mentoring program.

- Ensure all new educators participate in a two-year induction period, including orientation, mentoring and in-classroom support under the supervision of a local teacher trained in mentoring. Pay special attention to providing support for novice educators teaching in high-poverty schools.
- Incorporate best practice techniques in inquiry and the ability to develop learning experiences that prepare students to solve real-world challenges.
- Evaluate the existing Alabama Teacher Mentoring program to determine if it positively impacts new teacher performance, confidence and retention. If no impact is found, develop and implement a plan of improvement.

Indicators of Success

PS3a. All new educators in Alabama receive two years of mentoring from experienced mentor educators.

PS3b. Mentored educators experience higher retention and increased job satisfaction. In districts where the mentoring program is fully implemented, six-year attrition rates are reduced by 30%.

PS3c. In terms of student achievement gains, comprehensively mentored educators are more effective than educators who have not participated in mentoring.

PS4. Identify ways to streamline teacher preparatory requirements. Assess the predictive validity of Alabama's standard requirements for licensure to identify good predictors of program completion, performance in the programs and/or performance in the classroom.

- The ALSDE has chosen edTPA as the state's mandatory licensing exam. Conduct a predictive validity study to assess the relevance of the many requirements common to Alabama's teacher education programs. These include a candidate's GPA (incoming and outgoing), grades in methods courses, grades in general education courses, core Praxis test scores, content Praxis scores, writing exam results and dispositions interview results.
- The relative impact of each requirement may be found to vary by content area and by institution, but use the findings to emphasize the best predictors and minimize poor ones.
- The ALSDE and the deans of the colleges and schools of education in Alabama jointly identify variables for study, the study design and select the analysis team.

Indicators of Success

PS4a. A streamlined path to educator accreditation utilizes the most effective milestones and assessments. Poor predictors are removed, reducing burdens on pre-service educators without sacrificing preparations standards.

PS5. Develop incentives to encourage participation in the STEM teaching fields in middle and high schools.

- Incentive structures could take several forms – a signing bonus, an add-on to the salary schedule (similar to coaching supplements), service scholarships, loan forgiveness, housing stipends, etc. Different options may be more appropriate for certain school settings. Special attention should be given to boosting the number of STEM-subject certified teachers in geographic areas of Alabama experiencing critical educator shortages.
- Develop a STEM credential for Alabama educators. This could be a pre-service STEM credential or an in-service STEM teaching endorsement. Coursework includes interdisciplinary/transdisciplinary approaches to teaching, problem-based and project-based learning, computational thinking, engineering design process, mathematical problem-solving models, the processes of scientific inquiry and the assessment of integrative learning approaches. Holders of this STEM credential are eligible for a one-time bonus or add-on to the salary schedule.

Indicators of Success

PS5a. An increase in the number, quality and diversity of students enrolling specifically in STEM-focused teacher education programs.

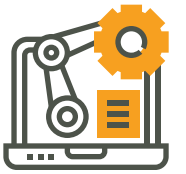
PS5b. Increased number of new teaching graduates, filling the critical shortage in Alabama's STEM-subject classrooms.

PS5c. Increased number of educators using exemplary STEM practices in the classroom.

Priority Area 4

In-Service STEM Educator Development

Priority Area 4:
In-Service STEM Educator Development



Current Landscape

Research shows that students whose teachers participate in ongoing professional learning perform at higher levels than students with teachers who do not[19]. There is an increased focus on students mastering STEM content objectives as well as interdisciplinary practices and processes associated with problem solving and innovative thinking. Educators must be appropriately introduced to these concepts in the context of their subject area as well as the related STEM fields. Effective professional learning opportunities are critical to these shifts in teaching practice.

- School, district and community leaders may not always understand STEM's importance for long-term career opportunities. They may also be unaware of initiatives and strategies in STEM education that can provide students from all populations and backgrounds with a bridge to those opportunities.
- Many Alabama educators have access to quality STEM resources from elementary through high school. These include state-led initiatives, independent programs supported by state funding, federally-funded opportunities and privately-financed experiences. However, these are not uniformly available to all educators and their students.
- Variation exists across Alabama's undergraduate teacher preparatory programs as well as between traditional and nontraditional certification routes. Newly certified educators come to the classroom with differing content knowledge and confidence, personal field experiences and awareness of classroom best practices. They are not always prepared in cutting-edge techniques and methods of a modern STEM classroom, including project-based learning, inquiry and problem solving.
- Alabama educators have access to STEM subject-related professional learning experiences led by a range of state-supported, for-profit and non-profit organizations. These experiences vary widely in their accessibility, facilitator expertise, depth of content, ongoing support and impact on student learning.
- Quality STEM curriculum materials are not uniformly available to teachers and districts. Statewide STEM education efforts, along with the corresponding teacher professional learning, are often compartmentalized and siloed. Groups are not leveraging resources and expertise for maximal impact.
- Educators may not be aware of the STEM career opportunities available to Alabama students and the linkages between classroom content and job application.

Recommendations

IS1. Ensure school, district and community leaders receive professional learning opportunities that highlight the importance of STEM fields and increase awareness of and support for the educational strategies outlined in this roadmap.

- Buy-in from school and district leadership is critical to creating a culture that recognizes, celebrates and encourages STEM-focused learning. Community engagement raises awareness, builds industry-school partnerships and expands STEM learning outside the classroom.
- These professional learning experiences are developed through collaborations between the state's STEM stakeholders — ALSDE, colleges and universities, business and industry and non-profit organizations.

Indicators of Success

IS1a. An increase in the amount of STEM professional learning focused on the importance of STEM fields and local opportunities for involvement. By the end of Year 5, every school district and their surrounding community have received some form of this professional learning.

IS2. Ensure P-12 educators are receiving high-quality professional learning that meets the ESSA definition of professional learning (sustained, intensive, collaborative, job-embedded, data-driven and classroom-focused) and strengthens both content and pedagogy for STEM classroom experiences. Provide special emphasis on educators serving students traditionally underrepresented in STEM fields.

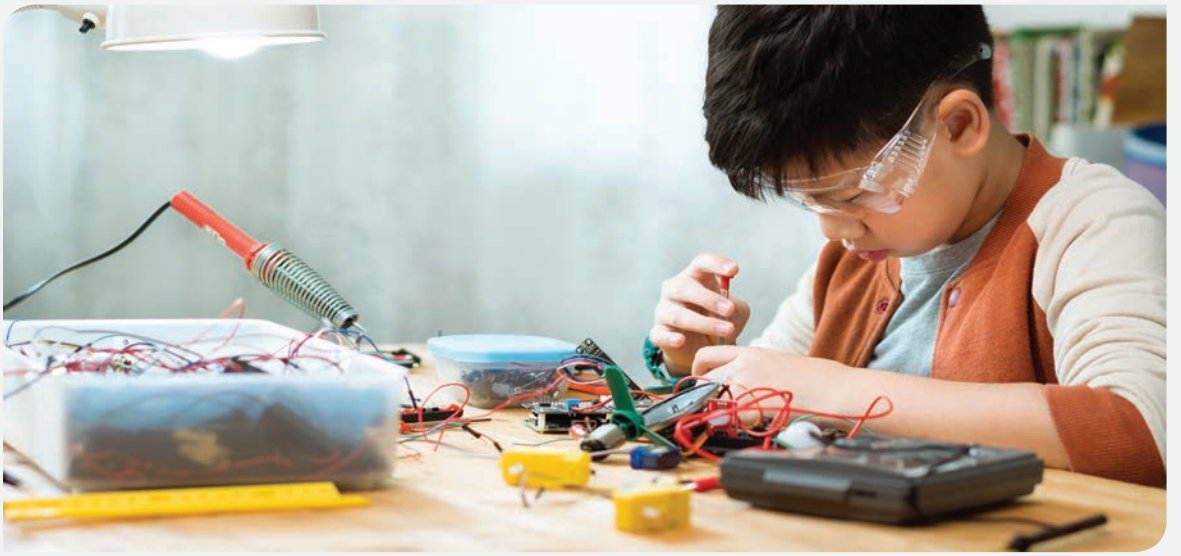
- Where possible, coordinate the efforts of the ALSDE, LEAs, institutes of higher education and other qualified entities to develop and disseminate professional learning that spans the scope and scale of Alabama's educator needs.

Indicators of Success

IS2a. Increased job satisfaction and higher retention among STEM-subject educators.

IS2b. A statewide network of STEM-related professional learning for P-12 educators, including appropriate curricular resources and communication tools.

IS2c. An increase in participation by P-12 teachers in high-quality STEM education professional learning. All STEM-subject educators participate in at least one content-focused program every two years.



IS3. Undertake comprehensive program evaluations to analyze the efficacy of STEM-focused professional learning initiatives currently offered across Alabama — focusing on their impact on educator knowledge and practice as well as student outcomes.

- Identify/develop a rubric, based on state and national standards and best practices for professional learning.
- Assemble a task force, composed of STEM stakeholders, that utilizes this rubric to assess the efficacy of all state-supported professional learning programs focused on STEM subjects.
- Disseminate the rubric to allow educators, administrators and funders to assess other professional learning initiatives.

Indicators of Success

IS3a. Professional learning programs are evaluated according to their impact on teacher knowledge, practice and student outcomes.

IS3b. The state utilizes these evaluations to help prioritize funding for professional learning initiatives.

IS3c. P-12 teachers increase the percentage of their continuing education hours spent in high-quality STEM education professional learning.

IS4. Expand opportunities for Alabama educators to directly experience the STEM work world (partnerships with industry, externships, job shadowing, etc.) and incorporate relevant lessons and career connections in their classroom.

Indicators of Success

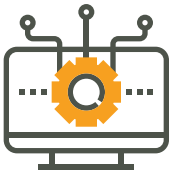
IS4a. An increase in the number of STEM-associated industry partners that offer work-world experiences to educators. By the end of Year 5, every school district has at least one industry partner.

IS4b. An increase in the number of educators that participate in STEM-related, work-world experiences. By the end of Year 2, 100 educators have participated, rising to 500 educators by the end of Year 5. Special attention is given to educators serving underrepresented student populations.

Priority Area 5

Career Pathways for In-Demand STEM Occupations

Priority Area 5:
Career Pathways for In-Demand STEM Occupations



Current Landscape

Since 1990, U.S. employment in STEM occupations has increased from 9.7 million to 17.3 million[10]. The U.S. Department of Labor predicts that over the next decade, national employment in STEM occupations will grow by nearly 9%, compared to 5% in non-STEM fields[20]. America's STEM workforce spans the educational spectrum but, in general, requires a higher level of education than those with non-STEM jobs. However, across all education levels, STEM workers earn more compared to their similarly educated non-STEM counterparts.

- An inadequate workforce pipeline exists to fill Alabama's STEM jobs. The state is projected to need more than 850,000 STEM-related occupations by 2026, a 12.7% increase from 2016[21].
- There is no single definition of "STEM Occupation." Some lists are very prescriptive and primarily include professions focused on research and development. Other lists cast a wide net and capture any occupation that might use scientific thinking.
- There is a lack of awareness about STEM careers and the pathways to obtain them. A 2017 study by Randstad US found that 52% of American students ages 11-17 said they don't know anyone with a job in STEM[22]. Some STEM-based occupational pathways are very clearly laid out and information is easy to find. Other career pathways have little Alabama-specific information available. This inconsistency makes it difficult for a novice student or job seeker to make an informed choice about STEM careers.
- Several Alabama agencies are working on STEM career pathways (i.e., ALSDE, Alabama Commission on Credentialing and Career Pathways, etc.) but their efforts are not always coordinated.
- The opportunities for STEM-based work experiences are rare even in the most affluent school systems. Alabama schools and employers have not created broadly available pathways for students to learn critical STEM skills on the job.

Recommendations

CP1. Establish a formal definition of STEM-based occupations, which evaluates occupations on a spectrum instead of classifying in a binary manner.

- A binary definition of whether something is, or is not, a STEM occupation is insufficient. The STEM nature of occupations exists along a gradient. Some jobs are very heavily dependent on core STEM knowledge and activities while others are less dependent, but still impossible to do without foundational STEM knowledge.

Indicators of Success

CP1a. All Alabama stakeholders use a consistent definition of STEM careers that incorporates jobs centered in the core STEM fields as well as jobs in related fields that typically require STEM knowledge.

CP2. Utilize the expertise within the STEM Council to guide the establishment of the Technical Advisory Committes (TAC) for STEM occupations and to assist other TACs in clarifying/evaluating the pathways for STEM-related occupations present within their clusters (including the identification of in-demand career pathways and credentials of value).

Indicators of Success

CP2a. Technical Advisory Committees (TACs) working through the Alabama Committee on Credentialing and Career Pathways (ACCCP) receive training on identifying the STEM nature of careers in their cluster.

CP2b. The importance of STEM-associated competencies/skills are clear and compelling across all relevant career clusters and educational levels.

CP2c. The appropriate STEM-related subjects are incorporated into recommended coursework for all STEM career pathways — from skilled technical workers to the Ph.D.

CP3. Equip students, parents and teachers with Alabama-specific, STEM-related career information and pathways.

- Enhance the *AlabamaWorks!* landing page to create a simplified and intuitive user interface connecting end-users to career pathway resources, including STEM pathway content.

Indicators of Success

CP3a. Increased awareness and usage of the *AlabamaWorks!* resources by educators, career counselors, students and other stakeholders.

CP4. Increase industry partnerships that expose students to STEM careers and expand the number of work-based learning opportunities available within STEM pathways (i.e., job shadowing, pre-apprenticeships, youth apprenticeships, on-the-job training and internships).

Indicators of Success

CP4a. The number of formal business-school, work-based learning partnerships reported by the ALSDE grows each year, especially in traditionally underserved regions of the state.

CP4b. Each year, Alabama's seven workforce regions report increasing numbers of work-based learning opportunities in STEM-related fields.

CP4c. Enrollment in high school STEM coursework, STEM-related workforce training programs and STEM college majors increases.

CP4d. Employers in STEM-related industries find more job-ready prospective employees.

STEM Coordination Across Alabama

STEM Coordination Across Alabama

Current Landscape

Alabama has a number of STEM education initiatives offered by state agencies, K-12 districts, out-of-school networks, institutes of higher education, informal learning centers and other organizations. Unfortunately, communication between these stakeholder groups is haphazard and opportunities to synchronize efforts are missed. Alabama has pockets of STEM excellence, but lacks a system to weave and expand those opportunities into a coordinated network that reaches all students.

- The uneven distribution of STEM programs and resources divides our state into haves and have-nots.
- The lack of a common communication and organizational network makes advocacy and coordination difficult.
- Students, educators, parents and community leaders are not always aware of the long-term importance of STEM learning and the value of a STEM-based career. Media messages do not always promote positive and engaging images of STEM.
- The lack of common metrics to measure STEM awareness and impact leave Alabama with neither a full understanding of the current status, nor an agreed upon way to measure progress.

Recommendations

SC1. Establish a STEM Council that serves as Alabama's lead organization for STEM education and Alabama's point of contact for interfacing with other state and national STEM initiatives. Council membership should be drawn from a cross-section of Alabama leaders representing STEM education, business and policy interests.

Responsibilities of the STEM Council include:

- Lead the implementation of Alabama's comprehensive STEM strategy, as outlined in this document.
- Implement a marketing/communication campaign to increase STEM awareness, publicly illustrate the value of STEM learning and highlight STEM careers, with particular emphasis on reaching underrepresented segments of the population.
- Ensure awareness, access and funding for STEM initiatives reach all Alabama learners, including those traditionally underrepresented in STEM courses and careers.
- Advocate for a long-term, reliable funding stream for P-20 STEM education across Alabama.
- Collect/aggregate STEM-related data into annual reports that track progress towards meeting strategic goals.

Indicators of Success

SC1a. Increased levels of cooperation and collaboration among the universities, community and private colleges, schools, LEAs, museums, clubs, businesses and other groups.

SC1b. Increased engagement of underrepresented populations in STEM programs, higher education STEM majors and STEM-related careers.

SC1c. Increased media attention and wider public recognition of Alabama STEM activities and endeavors.

SC1d. Increased funding to STEM programming from both public and private sources.

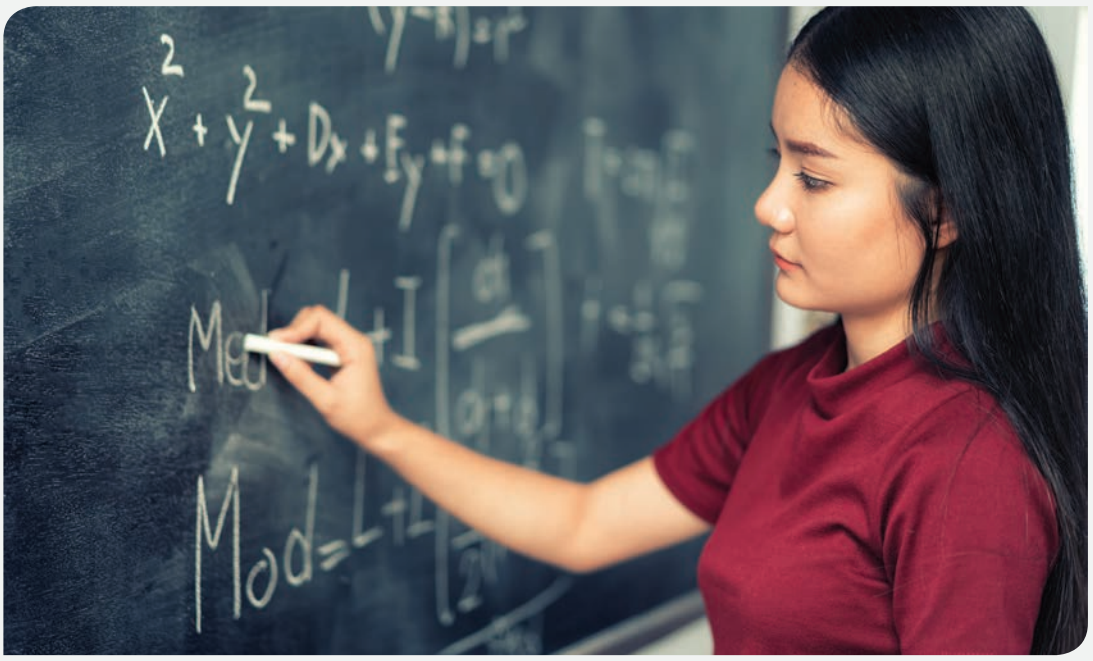
SC1e. An annual report on the State of STEM Education in Alabama. The report will include STEM activities, STEM funding and learner/educator performance data organized around the objectives and indicators of the state's strategic plan.

SC2. Launch a STEM Council Operations Center, led by a full-time Executive Director, with sufficient staff to oversee and assist in accomplishing the work of the STEM Council. Place the Operations Center at a location best suited to bring together Alabama stakeholders and collaborators. Consider establishing a network of regional STEM coordinators who connect school districts, businesses, institutes of higher education and other community partners to cultivate a thriving STEM ecosystem.

Indicators of Success

SC2a. A single unified voice for statewide STEM education in Alabama on behalf of all STEM-associated stakeholders.

SC2b. An organizational structure to oversee the STEM Council's planning, implementation, evaluation and reporting of the STEM roadmap.



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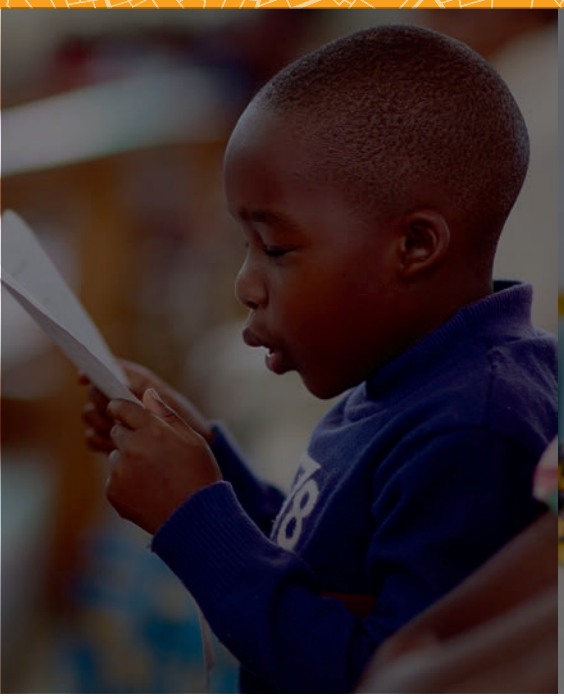

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