STEM Six-Year Strategic Plan

An Integrated K-12 STEM Approach for Indiana

Indiana Department of Education, Office of Workforce & STEM Alliances | November 2018

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Indiana
DEPARTMENT OF EDUCATION

Dr. Jennifer McCormick
Superintendent of Public Instruction
Working Together for Student Success

August 23, 2018

Dear Indiana Stakeholders,

STEM education encompasses four academic disciplines - science, technology, engineering, and mathematics - in an interdisciplinary and applied approach. On behalf of the Indiana Department of Education and the Indiana STEM Advisory Council, it is my honor to present the Indiana STEM Strategic Plan. This plan guides our vision of ensuring all K-12 Indiana students graduate with critical thinking skills. Indiana students must have access to a world-class STEM education necessary to compete in an innovation-driven economy. The objectives of this six-year strategic plan include improving STEM instruction, scaling evidence-based STEM curriculum in classrooms, and fostering early STEM career exposure. The recommendations outlined within this plan will equip students with 21st century skills, preparing future generations of Hoosiers to thrive in STEM-related businesses and industries. This human investment will contribute to Indiana's overall economic success.

As you read through the Indiana STEM Strategic Plan, please recognize our focus to create a sustainable platform for K-12 STEM exposure, instruction, and learning. Through this plan, we will provide our educators with vetted STEM professional development opportunities and our students with integrated STEM practices. As a result, Indiana will be an innovative force in an ever-changing technological global economy. I look forward to partnering with you and working together for student success.

Sincerely,

Dr. Jennifer McCormick
State Superintendent of Public Instruction

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Executive Summary

As one of the national leaders in innovative public education strategies focused on future talent development, Indiana is positioned to create a sustainable, collaborative strategy for K-12 Science, Technology, Engineering, and Mathematics (STEM) instruction, curriculum, and career exploration and exposure. To provide a comprehensive, coordinated, progressive, and responsive plan for STEM learning expansion, IDOE has created this Indiana STEM Strategic Plan. This plan provides guidance to all stakeholders in developing and actively creating a thriving, interactive, and relevant K-12 STEM focus.

Under the direction of the Indiana Department of Education, this Strategic Plan supports the **vision** of the Indiana STEM Advisory Council. This plan will lay the foundation for a future where: *All Indiana students in grades K-12 will graduate with critical thinking skills and be prepared for an innovation-driven economy by accessing quality, world class STEM education every day in the classroom by 2025.*

Achieving this vision requires a strong commitment to coordinating and reorienting resources across the state to implement our **mission** to*: Ensure Indiana teachers are prepared to provide every student in grades K-12 with an evidence-based, effective STEM education by 2025.*

Two key components of evidence-based, effective STEM instruction are problem/project-based learning and inquiry-based instruction.

Problem-based and/or project-based learning (PBL) is a pedagogy that anchors the teaching of disciplinary content in the context of solving a real-world problem or challenge. PBL curriculum generally spans one to several weeks of instruction that should be delivered in an integrated manner including science, mathematics, and other disciplines to show the authentic connections. The problem or challenge is introduced on the first day of the unit and is followed by the teaching of content through discussion, investigation, exploration, research and students apply their knowledge in real-time as they develop potential solutions and other deliverables.

Inquiry-based instruction is a pedagogy that can be used to deliver lessons on a daily basis in the primary disciplines and beyond. Inquiry begins with the teacher presenting the students with a question to explore or having students develop their own questions. As the students investigate the question, they give priority to evidence that is gathered through research and exploring and formulate explanations to describe their findings based on evidence or data

collected. Students connect explanations to their knowledge and current understandings in the discipline and then communicate and justify their explanations.

Central to the success of this Strategic Plan is moving toward a new approach to coordinating State investments and invoking the assistance of innovative STEM stakeholders to reach K-12 classrooms. By designating initial lead and collaborating agencies in some of the priority STEM education investment areas, the Strategic Plan encourages a more deliberative focus among new and existing efforts, the expansion of existing collaborations, and the creation of new partnerships. The intent is to establish a coordinated, coherent portfolio of STEM education investments across the State, so efforts and assets are deployed effectively and efficiently, for greatest potential impact. To do so, state agencies and STEM stakeholders will strive to achieve sets of high-reaching, long-term goals to last through future administrations.

The Indiana STEM Advisory Council also developed time-bound, shorter-term impact goals and strategic objectives to address the full integration of STEM education in K-12 learning over the course of six years. These strategic objectives and aligned impact goals are as follows:

1. Improve STEM Instruction: 100 percent of Indiana K-12 teachers will be trained in problem/project/inquiry-based approaches to learning by 2025. As of Fall 2018, school corporations reported only 32% of their staff were prepared in these areas (STEM Innovations, 2018).
    a. Year 1 milestone - 40% of Indiana teachers will report use
    b. Year 2 milestone - 55% of Indiana teachers will report use
    c. Year 3 milestone - 65% of Indiana teachers will report use
    d. Year 4 milestone - 75% of Indiana teachers will report use
    e. Year 5 milestone - 85% of Indiana teachers will report use
    f. Year 6 milestone - 100% of Indiana teachers will report use
2. Scale Evidence-based STEM Curriculum in Classrooms: 100 percent of Indiana K-12 schools will implement integrated, evidence-based STEM curriculum by 2025. As of Fall 2018, school corporations reported use of PLTW (76%). However, other STEM resources were much less utilized with the highest being CODE.org at 52% (STEM Innovations, 2018).
    a. Year 1 milestone - 50% of schools will report use of STEM curriculum
    b. Year 2 milestone - 60% of schools will report use of STEM curriculum
    c. Year 3 milestone - 70% of schools will report use of STEM curriculum
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e. Year 5 milestone - 90% of schools will report use of STEM curriculum
f. Year 6 milestone - 100% of Indiana teachers will report use

3. Foster Early STEM Career Exposure: 100 percent of Indiana's K-12 schools will create and sustain robust STEM related business and industry partnerships in order to inform curriculum, instruction, and student experiences to foster college and career readiness. As of Fall 2018, only 16% of Indiana school corporations reported devoting time each week for students to learn about STEM-based careers (STEM Innovations, 2018). However, 33% of school corporations reported having at least one robust STEM-related business/industry partnership (STEM Innovations, 2018).
    a. Year 1 milestone - 25% of schools include focus on STEM careers and 50% of schools have at least one robust STEM business/industry partnership
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Projected Indiana and national workforce demands are directly connected to rigorous STEM education. Therefore, the Indiana Department of Education (IDOE), the Commission for Higher Education (CHE), and the Department of Workforce Development (DWD) will work together to ensure Indiana students explore and experience STEM and STEM-related careers throughout their K-12 education.

This plan calls for all Indiana K-12 students to receive daily STEM instruction and access to appropriate resources in order to develop the necessary 21st Century STEM skills for application in a post-secondary setting and the future workforce.

Educators will receive opportunities to further develop their STEM pedagogy by obtaining professional development in the areas of problem/project/inquiry-based approaches to teaching and learning. These approaches will allow for educators to assist Indiana students in

the development of problem solving and critical thinking skills. The IDOE will also continue to assist schools in developing partnerships with local, state, and national industries to provide authentic experiences for students and teachers to learn and develop STEM skills.

This STEM Strategic Plan provides comprehensive guidance enabling quick response to changes in workforce demands, educational strategies, legislative directives, and other influencers impacting STEM education program development. Ultimately, the success of this Strategic Plan will be based upon state and local education agency implementation, and this success will be measured by student achievement in utilizing STEM skills to attain academic and career success. This will be evidenced through an extensive research and evaluation effort to coincide with the implementation of this Strategic Plan.

Introduction

Indiana is enhancing the success of its students through greater access to high quality STEM instruction, curriculum, as well as STEM career exploration and exposure. These disciplines and STEM-associated skills are the building blocks of Indiana's current and future economy. Unquestionably, STEM has been identified as a priority by Governor Eric Holcomb, Superintendent of Public Instruction Dr. Jennifer McCormick, and the Indiana General Assembly. To this end, the General Assembly approved STEM Alignment Funds for the Indiana Department of Education in the 2017-2018 state budget. This funding is the first of its kind in Indiana designed to foster development of a statewide strategy providing consistent and equitable access to daily STEM education in grades K-12.

To date, state agencies specifically the Indiana Department of Education, Commission for Higher Education, and the Department of Workforce Development have programs and objectives to support STEM learning, but now all are coordinating on the common STEM plan strategy. Until the state legislature approved $2 million in STEM Alignment Funds for the Indiana Department of Education, the only direct STEM funding was $10 million biannually provided to CHE to further STEM teaching in Indiana. IDOE has also spearheaded an unfunded STEM school certification program. In four years of awarding certifications, 60 schools have been identified as certified STEM schools. Furthermore, STEM is embedded in many Career Technical Education (CTE) career pathways and course sequences. Disciplines are present and hands-on activities exist, but STEM pedagogy is not comprehensively or intentionally practiced in a large majority of CTE classrooms. The IDOE has gathered and promoted strong tools from leading national and state STEM organizations around best practices in STEM programming, but it has not previously developed a STEM strategy inclusive of other state stakeholders.

This Strategic Plan requires significant collaboration with multiple state agencies involved in education, workforce, policy, and economic development. A broad range of other critical stakeholders will assist in student preparation for STEM opportunities that will be available at all levels of educational achievement. The Indiana Department of Education took immediate action with the awarded funding to develop this Strategic Plan. An Indiana statewide STEM Advisory Council was formed to advise the development of this Strategic Plan for STEM education in Indiana in the fall of 2017. The STEM Advisory Council met at regular intervals over the course of a year to craft and approve this plan and make funding recommendations for the 2019 budget session.

Indiana and the National Context

Indiana is in the midst of a STEM talent crisis in cultivating a highly-developed, technologically-advanced workforce and, as a consequence, is facing a rapidly growing STEM workforce deficit. The health and longevity of Indiana's citizenry, workforce, and educational advancement depends in large part on the acceleration of scientific and technological innovations, such as those that improve health sciences, inspire new industries, protect natural resources, and safeguard against national harm. Maintaining Indiana's historical preeminence in our nation's advanced manufacturing, biomedical, agriculture, and information technology sectors, requires a concerted and inclusive effort to ensure the state's STEM talent is equipped with the skills and training needed to excel in these and various other fields. Exposing all K-12 students to STEM will provide the preparation necessary to pursue a career in a STEM field via direct entrance into postsecondary or the workforce. Students will develop critical thinking and problem solving skills from exposure to quality STEM curriculum during their K-12 years, regardless of what career path is pursued after high school.

Rapid technological advancements have propelled world labor markets and society from traditional industry to an innovation-based economy, and as a result, have created an environment in which all people must be "...equipped with a new set of core knowledge and skills to solve difficult problems, gather and evaluate evidence, and make sense of information they receive from varied print and, increasingly, digital media" (U.S. Department of Education, 2016, p. i). These capacities can be developed through the process of learning and practicing the science, technology, engineering, and mathematics (STEM) disciplines. High-quality STEM learning experiences have been shown to foster students' abilities to work in teams, persistence in the face of challenges, and abilities to draw on gained knowledge to navigate new situations (Bailey et al., 2015; Bertrus, 2015).

Not all young people have access to a strong STEM education; namely, one that "starts as early as preschool, is culturally responsive, employs problem/project/inquiry-based approaches, and engages students in hands-on activities that offer opportunities to interact with STEM professionals" (U.S. Department of Education, 2016, p. 1). Persistent achievement and opportunity gaps in STEM across geographic, socioeconomic, racial, ethnic, and gender groups challenge our education system and result in troubling disparities that can having lasting impact. Recent data indicates that, between 2017 and 2027, STEM jobs will grow 13 percent compared to 9 percent of all other jobs in the U.S., with jobs in the specific fields of computing, advanced manufacturing, and engineering growing by 14 percent, 12 percent, and 7 percent, respectively ("Education Commission of the States"). In addition, STEM jobs, on average, have higher wage earning power. In the U.S., median earnings for STEM jobs are nearly $40 per hour

compared with just over $19 per hour for all other jobs ("Education Commission of the States"). Moreover, labor market data also shows traditional "non-STEM" occupations are now demanding the types of cognitive knowledge and skills typically associated with a STEM educational background (Rothwell, 2013).

In the context of these data, STEM is recognized as an essential component of a well-rounded education and is "the gateway to America's continued economic competitiveness and national security, and the price of admission to higher education and higher standards of living for the country's historically underrepresented populations" (U.S. Department of Education, Office for Civil Rights, p. 2). Even looking beyond the next decade, when the jobs of the future are unknown, the set of mindsets, skills, and habits gained from learning and practicing STEM are likely to better equip our current generation of learners with the academic tenacity and capacity for lifelong learning thus, enabling them to quickly adapt to rapid changes in the workplace (Dweck, Walton, & Cohen, 2014).

In Fall 2018, IDOE partnered with STEM Innovations, LLC to conduct a baseline Indiana STEM Inventory Study (and associated report) to determine the current status of implementation of STEM in the state to inform the development of the Strategic Plan. The 291 school corporations were invited by Superintendent Jennifer McCormick to participate in the IDOE STEM Inventory Questionnaire, which was to be completed by the superintendent and/or their designee. A total of 185 school corporations (64% response rate) participated in the inventory. Findings indicated that within the State of Indiana, high quality, weeklySTEM instruction, specifically outside of mathematics, is sporadic at best, with only 28% of school corporations reporting weekly instructional time for science, technology, and/or engineering. Many Indiana schools (K-8) cite, this is due to the time necessary for mathematics and English remediation in order to prepare students to pass the annual statewide assessment. Although some Indiana practitioners believe that there are schools across the State infusing STEM within the curriculum and across grade spans, there are equally as many practitioners who would disagree.

Experts in the field of STEM education stress STEM learning supports knowledgeable civic engagement and provides opportunities to thrive in the workforce (Volmert, Baran, Kendall-Taylor, & O'Neil, 2013). STEM learning experiences that ask students to apply STEM concepts to real-world problems empower students to be civically engaged in a complex society with local and global challenges. A deep foundation of STEM content knowledge provides students with the ability to critically assess claims related to health, environmental, socio-economic, and many other challenges they will make decisions about each day.

Regardless of the future STEM-heavy occupational outlook and evidenced gains that can be made for students exposed to a rigorous STEM education, schools struggle to obtain and sustain STEM resources, specifically in the area of human capital. Although Indiana recently increased flexibility within teacher licensing requirements for STEM related subjects, including cybersecurity and computer science, access to STEM-trained educators remains a barrier to high quality STEM instruction in Indiana. Additional considerations regarding alternative licensure options and recruiting non-traditional participation within the field of STEM education will be necessary in order to fulfill the need. Indiana does not have enough participation from the business and industry sector within our STEM classrooms, not only as mentors and guest lecturers, but as educators. The maintenance of flexibility regarding curriculum choices at the local level is necessary to continue to allow districts to make the decision on curricular best fit for their students. Although there is no seat time requirement in the State of Indiana there are instructional time regulations regarding literacy instruction at the elementary level as well as a prescriptive list of secondary courses students must successfully complete in order to graduate. Flexibility within the graduation requirements for mathematics and science coursework must be considered when looking for ways to integrate additional STEM coursework into Hoosier students' course experiences. Indiana has led the way, however, in flexibility related to creative learning experiences and alternative participation of our students. Students and schools have gained flexibility within their schedules through the use of digital learning platforms for use during weather-related cancellations, in order to meet the required number of school days.

Research indicates schools experience challenges related to geographic isolation, having fewer numbers of experienced teachers, and limited resources in their efforts to foster school improvement and promote student success (Boyer, 2006). Indeed, children in rural communities, many of whom come from lower-income families, often start kindergarten with lower mathematics achievement and make less progress during elementary and middle school than their suburban and urban peers (Graham & Provost, 2012). Consistent with this trend, Indiana students from low-income families have consistently performed lower on state standardized science and mathematics assessments across the State.

Vision, Mission, and Belief Statement

In an effort to take the lead in coordinating across government agencies and external STEM stakeholders, IDOE included the aforementioned agencies on the Indiana STEM Advisory Council to collectively define a cohesive vision and mission.

This Strategic Plan is aligned with the **vision** of the Indiana STEM Advisory Council. Our coordinated effort will lay the foundation for a future where:

All Indiana students in grades K-12 will graduate with critical thinking skills and be prepared for an innovation-driven economy by accessing quality, world-class STEM education every day in the classroom by 2025.

Achieving this vision requires a strong commitment to coordinating and reorienting resources across the state to implement our **mission** to:

Ensure Indiana teachers are prepared to provide every student in grades K-12 with an evidence-based, effective STEM education by 2025.

Two key components of evidence-based, effective STEM instruction are problem/project-based learning and inquiry-based instruction.

Problem-based and/or project-based learning (PBL) is a pedagogy that anchors the teaching of disciplinary content in the context of solving a real-world problem or challenge. PBL curriculum generally spans one to several weeks of instruction that should be delivered in an integrated manner including science, mathematics, and other disciplines to show the authentic connections. The problem or challenge is introduced on the first day of the unit and is followed by the teaching of content through discussion, investigation, exploration, research and students apply their knowledge in real-time as they develop potential solutions and other deliverables.

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If we are able to achieve our intended outcomes in this Strategic Plan, driven by our vision and executing our mission, Indiana students will be better prepared for global competitiveness, to develop into a STEM-literate population, and to ensure the longevity of a highly qualified, Hoosier workforce.

State agencies, postsecondary institutions, businesses, and philanthropists represented on our STEM Advisory Council will be critical to leverage and coordinate aforementioned resources to make significant state gains, both inside and outside the public sector systems. All Council members support STEM education, either directly or indirectly, and their continuous involvement in the implementation of this plan will be critical to achieving these ambitious goals.

Indiana STEM Belief Statement:

To achieve the intended outcomes in this plan, all stakeholders must work from the same definition of STEM. The state of Indiana believes STEM is defined as the following:

STEM education is the integration of the science, technology, engineering and math disciplines with the goal of deploying problem-based and inquiry-based approaches to teaching and learning in the classroom, while developing critical thinking skills and creating pathways to postsecondary readiness and career opportunities.

Our Strategy to Close the STEM Deficit in Indiana

The Indiana STEM Advisory Council, chaired by State Superintendent of Public Instruction, Dr. Jennifer McCormick, developed this Six-Year State Science, Technology, Engineering, and Mathematics Education Strategic Plan in response to the urgent need to implement a statewide, collaborative approach to tackle Indiana's STEM deficit. **Interagency coordination and innovative STEM stakeholder collaboration** is our cornerstone approach to achieving the impact goals suggested in our strategy to tackle Indiana's STEM deficit. This Strategic Plan provides a strong foundation for a state approach to accelerate STEM education, careers, and workforce training across Indiana to meet the demand of a highly-trained, technologically-advanced economy. This statewide initiative is an intentional workforce strategy to assist Indiana in providing highly skilled future talent for Indiana STEM industries. By strategically focusing on this initiative, the state will make significant gains in K-12 learning environments to better prepare rising generations of students and future Hoosier talent.

Interagency Coordination: This term refers to the collaboration between two or more state government agencies to solve a public problem. To implement Indiana's STEM strategic plan, the following state agencies will work together to achieve intended outcomes: 1) Indiana Department of Education; 2) Indiana Department of Workforce Development; 3) Indiana Commission for Higher Education; 4) Office of the Indiana Governor.

Now is a time of urgency and opportunity. Through this plan, Indiana is building a true "all hands on deck" effort to move the state forward and address Indiana's STEM deficit. Ensuring a whole government approach and driving Indiana towards a collaborative interagency structure requires investments to fully source the following government agencies:

- **Indiana Department of Education (IDOE): Implement Indiana's newly created STEM plan to increase science, technology, engineering, and math opportunities, with a priority on K-5.**

- **Indiana Commission for Higher Education (CHE): Setting ambitious but achievable goals for Indiana's postsecondary institutions.**

- **Indiana Department of Workforce Development (DWD): Investing in and better training the future STEM workforce pipeline.**

- **Office of the Indiana Governor: Develop a 21st Century Skilled & Ready Workforce.**

With these agencies working in concert, this Strategic Plan will set the groundwork for Indiana to achieve a number of high-reaching, long-term goals that will remain relevant and aspirational for future administrations. These goals include the following:

- Demand state STEM efforts reach an increased number of students and teachers more effectively by reorienting rules on practices to meet the needs of those who are delivering STEM education statewide: school districts, state agencies, non-profit organizations, private sectors, and colleges and universities;

- Support organizing efforts and redirecting resources around more clearly defined priorities with accountable lead government agencies;

- Invest in the rigorous research and evaluation of state-funded STEM education programs;

- Increase the impact of state investments in important areas, such as elementary STEM education, by expanding resources to a limited number of strategically defined programs, while recognizing capacity issues;

- Define resources needed to meet specific strategic objectives and impact goals, such as preparing all of Indiana's K-12 teachers with problem/project/inquiry-based approaches to teaching and learning, recognizing and rewarding excellence in STEM instruction, and fostering early career exposure in Hoosier communities; and

- Engage K-12 stakeholders and State agencies including the Indiana Department of Education (IDOE), the Department of Workforce Development (DWD), and the Commission for Higher Education (CHE) to build a strong pipeline of educators needed to close the educator deficit in STEM content disciplines in K-12 schools.

Innovative STEM Stakeholder Collaboration: This term refers to collaboration and partnership with a broad range of external (outside of government) stakeholders - businesses, foundations, local school districts, non-profit organizations, after school programs, instructional providers, universities, libraries, museums, etc. - to develop innovative solutions to solve our STEM deficit problem and to accelerate and scale evidence-based impact.

Great ideas come from everywhere and the most intractable educational challenges require capabilities that no one sector alone possesses. As a result, Indiana will support innovative, educational STEM collaboration and partnerships, both nationally and statewide, with a range of stakeholders and organizations to create cost-effective and results-oriented STEM education solutions to some of our state's most pressing problems. Our STEM stakeholder's solutions will support the sustainability of our workforce, generate growth of our innovation-driven economy, and stimulate ingenuity from our communities. This Strategic Plan challenges all stakeholders to assist state efforts by ushering in a new era of collaborative problem-solving, advanced innovation, and entrepreneurship while using the scientific method and design process to solve some of our greatest challenges within STEM education. This Strategic Plan also recognizes the need to support STEM ecosystems that unite all stakeholders across communities and regions in our state.

Similar to the interagency goals mentioned above, when STEM stakeholders collaborate to drive innovation, Indiana will achieve a number of high-reaching, long-term goals that will

remain relevant and aspirational for future administrations and be in support of projected federal STEM priorities. These include the following:

- Foster STEM ecosystems that unite all stakeholders across regions to drive toward STEM career preparation, which will in turn support economic development;

- Support the continuum of STEM education in the classroom to out-of-school and after school opportunities and activities for students and teachers;

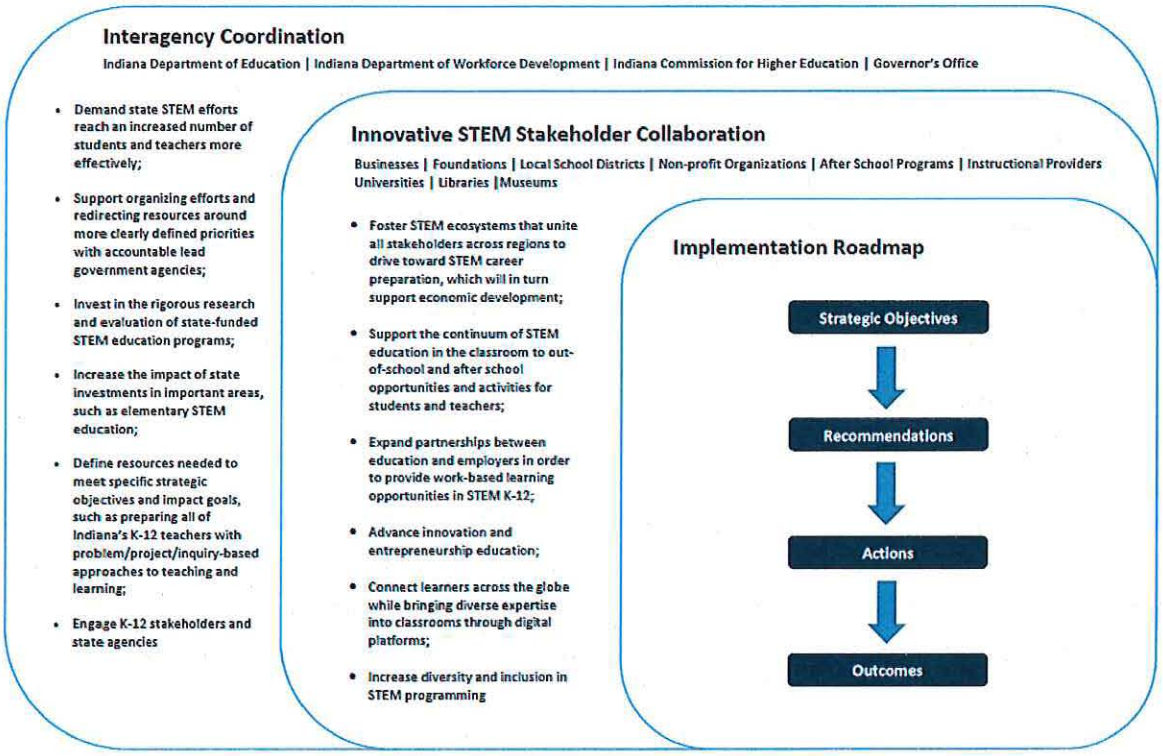
- Expand partnerships between education and employers in order to provide work-based learning opportunities in STEM K-12;

- Advance innovation and entrepreneurship education;

- Connect learners across the globe while bringing diverse expertise into classrooms through digital platforms;

- Increase diversity and inclusion in STEM programming.

Figure 1 (See Appendix A for larger image)



The aforementioned high-reaching, long-terms goals for interagency and innovative STEM stakeholders (Figure 1) can only be achieved if the State of Indiana collectively invests in three key areas for STEM education in the short term: 1) Instruction, 2) Curriculum, and 3) Career Exploration and Exposure. The key areas identified by the Indiana STEM Advisory Council were selected on the basis that enhanced and coordinated State investments in these areas will accelerate progress toward our mission and vision as outlined within this Strategic Plan. These key areas will serve as **strategic objectives** to drive a roadmap of implementation activities to achieve the agreed upon **impact goals** of this Strategic Plan.

Indiana Strategic Objectives and Impact Goals for STEM Education

This plan presents three strategic objectives with corresponding impact goals where a coordinated state implementation plan will be developed and designed to lead to major improvements over the course of six years in key educational areas.

With our high reaching, long term goals setting forth a long term vision for Indiana, the Indiana STEM Advisory Council has established a time-bound, shorter term implementation plan around

three strategic objectives for six years. This six-year timeframe was decided around the following factors:

- **State Fiscal Calendar.** This Strategic Plan will start and end on budgetary years (biennium) for the State legislature so that bi-annual impact data can be analyzed and communicated to legislators to assist with future funding and programming decisions.
- **School Calendar.** The Strategic Plan begins in the 2018 -2019 school year. We recognize that school district level implementation plans will likely not be developed or deployed until 2019, with planning stages beginning in the fall of 2018.
- **Setting Expectations for Impact.** A six-year time frame recognizes that our impact goals cannot be achieved in just a couple years, therefore we need to set the course for enough time to see significant impact in the short term.

Under the direction of the Indiana Department of Education, the Indiana STEM Advisory Council developed the following objectives, goals, and recommendations to address the full integration of STEM education in K-12 learning. High-level impact goals will drive the implementation of our recommendations to achieve these strategic objectives. These strategic objectives and aligned impact goals are as follows:

1. Improve STEM Instruction: 100 percent of Indiana K-12 teachers will be trained in problem/project/inquiry-based approaches to learning by 2025. As of Fall 2018, school corporations reported only 32% of their staff were prepared in these areas (STEM Innovations, 2018).
    a. Year 1 milestone - 40% of Indiana teachers will report use
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2. Scale Evidence-based STEM Curriculum in Classrooms: 100 percent of Indiana schools will implement integrated, evidence-based STEM curriculum by 2025. As of Fall 2018, school corporations reported use of PLTW (76% of districts). However, other STEM resources were much less utilized with the highest being CODE.org at 52% (STEM Innovations, 2018).
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3. Foster Early STEM Career Exposure: 100 percent of Indiana schools will create and sustain robust STEM related business and industry partnerships in order to inform curriculum, instruction, and student experiences to foster college and career readiness. As of Fall 2018, only 16% of Indiana school corporations reported devoting time each week for students to learn about STEM-based careers (STEM Innovations, 2018). However, 33% of school corporations reported having at least one robust STEM-related business/industry partnership (STEM Innovations, 2018).
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    f. Year 6 milestone - 100% of schools include focus on STEM careers and 100% of schools have at least one robust STEM business/industry partnership

The preparation of STEM educators and leaders is multifaceted and involves both pre-service preparation and continuous professional development opportunities throughout their professional careers. Comprehensive training in problem/project/inquiry-based approaches to teaching and learning is an essential component to deepening the understanding and abilities of educators. Developing educators and leaders within these approaches will enhance their ability to integrate STEM educational approaches into their classrooms while enhancing students' abilities to solve problems and think critically about our world.

The recruitment, training, and retention of STEM educators and leaders should be approached through a holistic and collaborative strategy involving school, district, state, and national resources. Professional supports, meaningful community-based engagement and initiatives, and expansive opportunities for educators and leaders are also critical to providing engaging STEM experiences and authentic, statewide STEM research. High-quality STEM educators will recognize effective STEM instruction and have the capacity to develop Indiana students into problem solvers and critical thinkers who appreciate, better understand, and are interested in STEM subjects. Indiana's identified stakeholders play a vital role in providing resources and

supports needed to recruit, develop, and retain highly effective STEM educators and leaders who will educate Indiana students in ways that will prepare students for future endeavors.

An investment in vetted, evidence-based, and integrated STEM curriculum aligned with supportive professional development is critical in creating a learning environment rich in rigor and supportive of initiatives expressed in this Strategic Plan. The research base to support learner-centered instruction is identified in *How People Learn* (Donovan & Bransford, 2005), which outlines a metacognitive approach to instruction. This instruction, can help students learn to take control of their own learning by defining learning goals and monitoring their progress in achieving them. This research is reflected in the work of the Committee on Highly Successful Schools or Programs for K-12 STEM Education as part of the National Research Council that recognized the strong evidence base for STEM instruction and school-level practices. Research in STEM teaching and learning over the past two decades characterizes effective STEM education instruction that capitalizes on students' early interest and experiences, identifies and builds on their background knowledge, and provides them with experiences to engage students in the practices of the disciplines that sustain their interest.

STEM Education is critical for preparing students for postsecondary and career success. The third strategic objective to foster early STEM career exposure will expand partnerships between educational entities and employers, and support work-based learning, including pre-apprenticeships, apprenticeships, internships, and mentorship in K-12 STEM.

The National STEM Coalition shares important statistics around the need to re-skill and upskill the current workforce. They are as follows:

- One job in the high-tech sector leads to 4.3 jobs in local goods and services industries - which results in positive ripple effects across the entire economy.
- Between 2014 and 2024, the number of STEM jobs will grow 17 percent, as compared to 12 percent for non-STEM jobs.
- At all levels of educational attainment, STEM job holders earn 11 percent higher wages compared to their same-degree counterparts in other jobs.
- Almost all of the 30 fastest-growing occupations in the next decade will require at least some background in STEM.

The statistical forecast surrounding the need for STEM background knowledge needed for the fastest growing occupations, per the National STEM Coalition, agrees with the current occupational outlook for Indiana. The top five occupations, as of 2018, for the State of Indiana

according to *Indiana Career Ready*, from the Indiana Department of Workforce Development include:

- Management Analysts
- Medical and Health Services Managers
- Registered Nurses
- Software Developers, Applications
- Plumbers, Pipefitters, and Steamfitters

Given future STEM related career opportunities and the demand for upskilling our STEM pipeline, it is important to be mindful that "content mastery alone is not sufficient for success... the workforce requires 21st century skills." (Next Generation Science Standards). According to *The Partnership for 21st Century Learning* ("Framework for 21st Century Learning.") , 21st century skills include:

- Global awareness
- Financial, economic, business and entrepreneurial literacy
- Civic literacy
- Health literacy
- Environmental literacy
- Creativity and Innovation
- Critical Thinking and Problem Solving
- Communication
- Collaboration
- Information Literacy
- Media Literacy
- Information & Communication Technology (ICT) Literacy
- Flexibility & Adaptability
- Initiative & Self Direction
- Social & Cross-Cultural Skills
- Productivity & Accountability
- Leadership & Responsibility

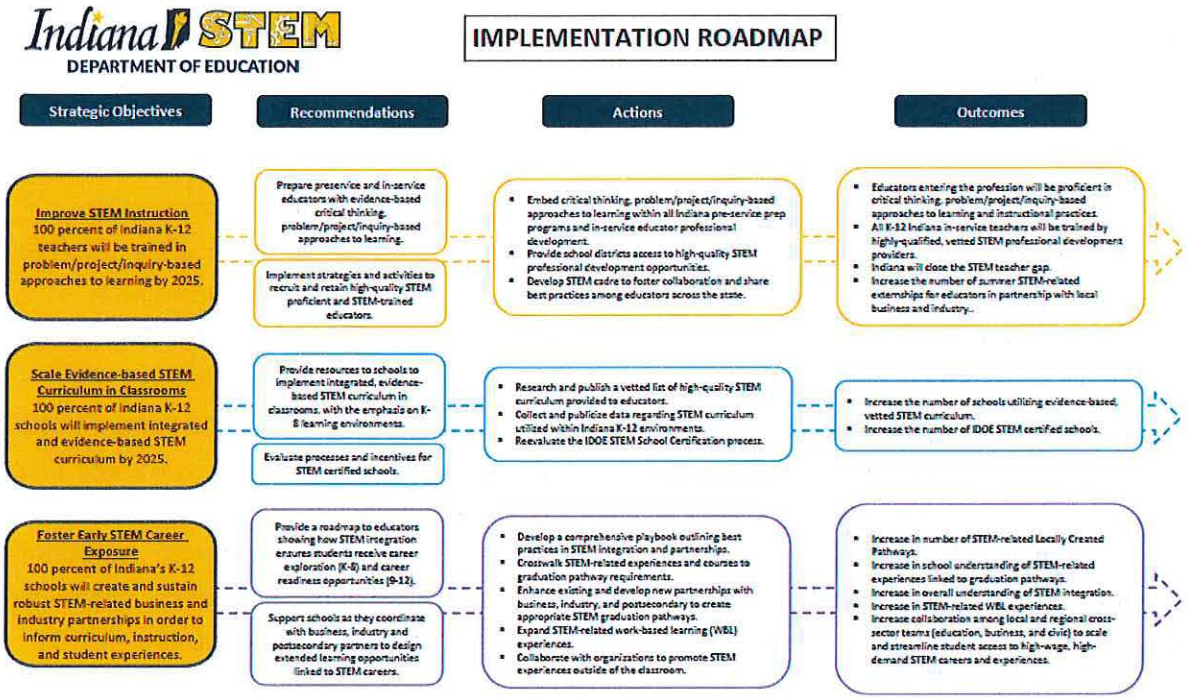
Essential to ensuring 21st century skills are obtained by all Indiana students, career exploration (K-8) and career readiness (9-12) embedded within the integration of rigorous and relevant

STEM-related experiences will be key. Experiences within out-of-school time STEM activities such as robotics and engineering clubs, internships, and apprenticeships are examples of intentional efforts which expose students to careers, connect to industry partners, ignite student passion, and increase future opportunity.

Implementation Roadmap

A preliminary implementation roadmap is provided below for each of the three strategic objectives. This is an evolving roadmap and lays forth suggestions on how to implement activities and recommendations to achieve our impact goals. These recommendations, actions, and outcomes within the roadmap may help guide local programming, budget planning and requests, mechanisms for investment, communication and outreach with stakeholder communities, and reassessment of evaluation plans and practices within each of the strategic objectives. The ability of school districts to implement the strategic objectives will require financial commitments to ensure adequate capacity for design and oversight of staff, programs, training, curriculum, etc.

Figure 2 (See Appendix B for larger image)



Many schools/districts will need a starting point to implement STEM and to know where they are going. The implementation roadmap will provide high-level guidance to school districts through their local STEM implementation process. This implementation roadmap will lead to the creation of STEM playbooks for use by all stakeholder groups to provide specific guidance for local STEM planning and implementation. Throughout the six-year journey of the strategic STEM plan, the playbooks will be living documents that will grow as more schools/districts integrate STEM for student success.

Success, Monitoring and Evaluating STEM Education Strategic Plan

For each of the three strategic objectives within the STEM Strategic Plan, recommendations, actions, and anticipated outcomes have been identified as the focus for the initial implementation of this Strategic Plan. Each component has been developed with several considerations in mind including: (1) they strive to be specific enough for school districts so progress and impact can be measured, (2) they are meant to be aligned with the strengths and assets of the designated lead agency to allow for significant collaboration, and (3) they require

a clear responsibility for involvement of State agencies (IDOE, CHE, and DWD). These considerations are made realizing state investment will play only a part in achieving the intended impact. These have been deemed as "recommendations" as they are just that -a recommended roadmap for stakeholders, agencies and school districts to follow while implementing STEM programming and state-funded STEM initiatives.

The monitoring and evaluation of STEM programming allows the Indiana Department of Education, Indiana STEM Advisory Council, and the General Assembly to better understand the impact of how implementing and practicing rigorous, integrated K-12 STEM education is contributing to the success of Indiana's students and economy. Without data, it is difficult and irresponsible to effectively make policy or deploy state funding. The STEM evaluation will include various methods and approaches to determine the state's return on investment (ROI) and potential for impact to scale. Through the monitoring and evaluation of this Strategic Plan, Indiana will develop and make available vetted STEM playbooks including resources, practices, and guidance for Indiana districts, schools, communities and other STEM partners. Ultimately, the success of this Strategic Plan will be based upon collaborative and comprehensive state and local education agency implementation and utilization of STEM skills to attain academic and career success.

Conclusion: Future Opportunities

Through the adoption of this Strategic Plan, Indiana will lead the nation in STEM instruction, curriculum implementation, and early STEM career exposure to enhance and strengthen Indiana's position in the national and global economies. This will shape the future both academically and economically for the students and citizens of Indiana. By implementing a fully integrated K-12 STEM education system, Indiana will build sustainable, accessible, equitable opportunities for every child. Consequently, students will successfully exit Indiana schools with the profound skills and capabilities associated with quality STEM education.

References

Bailey, A., Kaufman, E., & Subotic, S. (2015). Education, technology, and the 21st century skills gap. Retrieved from https://www.bcgperspectives.com/content/articles/public_sector_education_technology_twenty_first_century_skills_gap_wef/

Betrus, A. (2015). Through STEM education our future is bright. Retrieved from http://www.fourthcoastentertainment.com/story/2015/08/01/entertainment/through-stem-education-ourfuture-is-bright/242.html

Borman, T., Margolin, J., Garland, M., Rapaport, A., Park, S. J., & LiCalsi, C. (2018). *Associations between predictive indicators and postsecondary science, technology, engineering, and math success among Hispanic students in Texas.* Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Southwest. https://ies.ed.gov/ncee/edlabs/regions/southwest/pdf/REL_2018279.pdf

Boyer, P. (2006). Building community: Reforming math and science education in rural schools. Fairbanks, AK: Alaska Native Knowledge Network, Center for Cross-Cultural Studies, University of Alaska Fairbanks. Retrieved from http://ankn.uaf.edu/publications/building_community.pdf

Dweck, C. S. (2006). Mindset: The new psychology of success. New York, NY: Random House.

"Education Commission of the States." Vital Signs, 1 Oct. 2017, vitalsigns.ecs.org/state/United-States/demand.

"Framework for 21st Century Learning." *P21*, www.p21.org/our-work/p21-framework.

Graham, S. E., & Provost, L. E. (2012). Mathematics achievement gaps between suburban students and their rural and urban peers increase over time. Durham, NH: Carsey Institute. Retrieved from http://files.eric.ed.gov/fulltext/ED535962.pdf

Indiana Career Ready, Indiana Department of Workforce Development, https://www.indianacareerready.com/indemandjobs

Rothwell, J. (2013, June). The hidden STEM economy. Washington, DC: Brookings. Retrieved from https://www.brookings.edu/research/the-hidden-stem-economy/

STEM Innovations, LLC (2018). Indiana STEM Inventory Study. 1-11.

U.S. Department of Education, Office of Innovation and Improvement. (2016). STEM 2026: A Vision for Innovation in STEM Education. Washington, DC: Author.

U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics (n.d.) National Assessment of Educational Progress (NAEP), 2015 Eighth-Grade Science Assessment.

U.S. Department of Education, Office for Civil Rights. (2014). Civil Rights data collection: Data snapshot: College and career readiness (Issue Brief No. 3). Washington, DC: Author. Retrieved from http://www2.ed.gov/about/offices/list/ocr/docs/crdc-college-and-career-readiness-snapshot.pdf

Volmert, A., Baran, M., Kendall-Taylor, N., & O'Neil, M. (2013). *"You have to have the basics down really well": Mapping the gaps between expert and public understanding of STEM learning.* Washington, DC: FrameWorks Institute. Retrieved from http://www.frameworksinstitute.org/ assets/files/PDF_STEM/STEMMTG10-18-13_proofedandformatted.pdf

Interagency

Indiana Department of Education | Indiana Department of Workforce Development | Indiana Commission for Higher Education | Governor's Office

- Demand state STEM efforts reach an increased number of students and teachers more effectively;
- Support organizing efforts and redirecting resources around more clearly defined priorities with accountable lead government agencies;
- Invest in the rigorous research and evaluation of state-funded STEM education programs;
- Increase the impact of state investments in important areas, such as elementary STEM education;
- Define resources needed to meet specific strategic objectives and impact goals, such as preparing all of Indiana's K-12 teachers with problem/project/inquiry-based approaches to teaching and learning;
- Engage K-12 stakeholders and state agencies

Innovative STEM Stakeholder

Businesses | Foundations | Local School Districts | Non-profit Organizations | After School Programs
Instructional Providers Universities | Libraries | Museums

- Foster STEM ecosystems that unite all stakeholders across regions to drive toward STEM career preparation, which will in turn support economic development;
- Support the continuum of STEM education in the classroom to out-of-school and after school opportunities and activities for students and teachers;
- Expand partnerships between education and employers in order to provide work-based learning opportunities in STEM K-12;
- Advance innovation and entrepreneurship education;
- Connect learners across the globe while bringing diverse expertise into classrooms through digital platforms;
- Increase diversity and inclusion in STEM programming

Implementation

Indiana STEM
DEPARTMENT OF EDUCATION

Appendix B

IMPLEMENTATION ROADMAP