The Need
To succeed in the 21st-century, Arizona students need to acquire the ability to create, design, innovate, and think critically to solve complex challenges that will face them. They need deep knowledge and strong skills and must be exposed to more relevant applications in science, technology, engineering and mathematics (STEM) — and remain excited and ready to use that knowledge in the real world. Our economy and our future depend on the degree to which we can make the leap from incremental improvement in math and science achievement to transformational change. Arizona needs fundamentally different results — and achieving them will require that we work in significantly different ways.

Rigorous and relevant STEM education provides students with the greatest number of options for life and career and bolsters the economic strength of their communities.

- We need all students — not just the top 5 or 10 percent — to graduate from high school with the STEM skills needed to succeed in college or to compete for family wage jobs in the 21st century – whether or not they pursue STEM degrees and careers.
- We need high levels of course and degree completion — not high levels of remediation and drop-out.
- We need math and science teachers with demonstrated effectiveness in every classroom not assigned to a classroom because of convenience, seniority, or personal preference.

We need to bring to our education the rigor of scientific inquiry that is evaluated on evidence that proves its value in not only supporting futures in science and engineering but integrating STEM in the range of degrees and careers needed for today’s constantly changing global economy. We need to learn from what we do and adapt and evolve from what we learn. And perhaps most of all, we need to engage and ignite the imaginations of young people, educators and the public to achieve dramatic improvements in STEM teaching and learning.

Despite initial efforts, it is clear that the majority of Arizona students are not being prepared to become active and engaged citizens in our global community; their overall performance in math and science is poor; the achievement gap between white and minority students is growing; socioeconomic status continues to play too strong a role in whether students are successful; and there is a fundamental lack of alignment across PK12, higher education and workforce systems that forms a barrier to student success.

Job openings in metro Phoenix, particularly those in information technology, semiconductor manufacturing and aerospace and defense, increased nearly 24 percent in July 2010 compared with the same month a year before. “While there are a lot of people unemployed, they’re not necessarily the people that have the skill set that companies need,” (Warren Adelman, President and CEO of Go Daddy)1.

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1 Arizona Republic, July 7, 2010.
Arizona ranks 22nd in the 2007 State New Economy Index\(^2\) which factors in five categories that best capture what is “new” about the New Economy:

- Knowledge jobs
- Globalization
- Economic dynamism
- Transformation to a digital economy
- Technological innovation capacity

Our state is ranked 37th in the use of computer and the Internet in schools, 30th in scientists and engineers as a percentage of the workforce\(^3\), and 43rd in the nation in percentage of high school graduates who go directly to college\(^3\). While the degrees awarded by Arizona’s colleges and universities in STEM-related fields is 49%; the percentage of underrepresented minorities who earn their bachelor degree in a STEM field is 23%, a far lower percentage than the proportion of underrepresented minorities who make up Arizona’s population (39%). There are 22,924 students in Arizona that received a Bachelor’s degree in 2007; just 4% were in Engineering; 4% in Math/Computer Science; and 2% in Science/Engineering Technology\(^4\).

The challenges begin at the K–12 level where too few Arizona students have the necessary math and science skills as measured by National Assessment of Educational Progress (NAEP) Performance standards:

- In 2009, just 28% of 4\(^{th}\) graders and 29% of 8\(^{th}\) graders demonstrated proficient or advanced scores in math.
- In 2005, just 18% of 4\(^{th}\) graders and 20% of 8\(^{th}\) graders were proficient or advanced in science\(^5\).
- Average scores were much lower for low income, African American, Hispanic, and Native American students.
- Even those who pass exit exams and graduate from high school are not adequately prepared for college. Less than half of our public high school graduates qualify academically to enroll in public universities\(^6\).

Research continues to demonstrate that one key factor in student achievement are highly effective teachers\(^7\). Yet, in math and science, Arizona does not emphasize content knowledge for teachers. With Arizona’s new requirement for high-school students to take additional years of math and science, the Arizona Department of Education projects the state will need an additional 400 math and 250 science teachers per year for the foreseeable future. That’s roughly 500 more teachers than the state’s three public universities are currently producing\(^8\).

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\(^3\) NCES; Common Core Data, Private High Schools Survey, courtesy of NCHEMS Information Center, higheredinfo.org


\(^7\) Arizona Community Foundation, Educating Arizona, Assessing Our Education System (Birth – Grade 12), January 2008

\(^8\) Parker, Ray, “Arizona faces severe teacher shortage”, The Arizona Republic, Feb. 20, 2009 12:00 AM.
Addressing Arizona’s STEM Education Crisis

The Arizona STEM Initiative will catalyze improvements in the state’s K–12 education system, transform mathematics and science teaching, and dramatically increase the number of Arizona high school students who graduate ready to enter and succeed in postsecondary degree programs and careers. The Initiative is intended to benefit all Arizona PK–20 students and their teachers, with significant emphasis on low-performing, low-income and other underrepresented student populations.

Through a statewide STEM Network, the Initiative will support and coordinate a proactive, integrated statewide approach for Arizona students to succeed in education, work and life through a multi-faceted strategy (Discover, Develop, Evaluate, Invest, Coordinate, Communicate, Advocate) and maintain strategic focus areas (Pathways, Resources, Technical Assistance and Data).

Science Foundation Arizona will provide the leadership and infrastructure with support from state, private and philanthropic entities to manage the STEM Network for the benefit of all Arizonans. The multi-faceted strategy will:

- Discover and develop promising practices both within Arizona and from across the nation, including the ability to evaluate effectiveness and impacts of various programs, policies and interventions that use evidence to drive decisions.
- Leverage existing investments for greater impact and secure and target new resources toward:
  - Innovative approaches that fill gaps not currently being addressed effectively
  - Scale and replicate proven approaches to the individual needs of schools and districts
- Coordinate and support an expanding STEM Network of practitioners, policymakers and researchers with a shared vision and commitment to improve STEM learning and teaching and ensure that the work is focused on strategic priorities that align with evidence of best practices.
- Engage families and communities more broadly through the STEM Network and utilize existing avenues like Expect More Arizona10 to press the urgency of STEM to build a stronger Arizona.
- Advocate for improved policies and practices at the state and national level that will improve student achievement for all students.

The Arizona STEM Network will focus around innovations that promote effective teaching and leadership to prepare students for success through four major focus areas:

- **Teacher and Leader Support**
  - Attract, prepare, support and evaluate teachers and leaders
  - Help foster a climate and culture of professionalism to support STEM teachers and administrators
  - Support and build innovative and effective programs of education and professional development for Arizona’s teachers
- **PK-12-Post Secondary STEM Pathways**
  - Develop academically rigorous and workforce relevant pathways
  - Make pathways visible, accessible, attractive and attainable to students

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10 [http://www.expectmoreaz.org](http://www.expectmoreaz.org)
• Instructional Resources
  o Develop innovative, engaging and relevant instructional resources to assure every student is provided with effective STEM learning experiences
  o Align to internationally-benchmarked college and career ready standards
• Data Utilization
  o Improve data collection management and analysis
  o Create a results-oriented and outcomes-driven culture

Guiding Principles
As the Arizona STEM Network enters the statewide community of STEM agencies, institutions, programs and people, it is important to define not only the scope of work that the Initiative will pursue, but also the principles that will govern how that work is done. These guiding principles articulate the values central to the Initiative as a dynamic learning organization that is responsive to its partners and committed to achieving its outcomes. We start with the premise that ALL PK-20 students deserve to be STEM literate and well prepared for college and careers.

• Increase student achievement for ALL PK-20 students through effective STEM education and opportunity
• Focus on strengthening STEM teaching and instruction
• Broad stakeholder collaboration is critical
• Objectives must be tied to local and statewide economic development, recognizing that all aspects of 21st century skills are central to STEM literacy and economic competitiveness
• Programs should be scalable, replicable, evidence- and outcome-based
• Investment strategy must reward excellence and results while encouraging innovation

ALL PK-20 students need to be STEM literate and adequately prepared for college and careers. While the Initiative will ensure effective programs are scaled to ultimately serve all students, meeting the needs of students or communities who traditionally have been underserved cannot be underestimated or delayed. Arizona needs to dramatically accelerate the achievement of low-income and underperforming students and strengthen the capacity of schools, districts and institutions of higher education to provide the quality instruction and to foster a culture that embraces a shared responsibility for student success. Grants, programs and policies championed by the Initiative will be framed accordingly.

Arizona must also look to its higher education institutions to build innovative models for teacher education that place a premium on content knowledge that recruits quality STEM learners into the profession. Undergraduate STEM courses also must meet the needs of 21st century students with appropriate integration of state-of-the-art technology and real-world relevance consistent with the needs of employers. The Initiative will look for opportunities to bridge the expectations of industry with higher education and advocate for effective policies to incent better linkages to employer needs.

Focus on strengthening STEM teaching and instruction. The focus of all improvements in practice and policy will be instructional effectiveness. Research demonstrates that the interactions between teachers and students around important content, rather than the mere presentation of content, are the major determinant of student success. To that end, the Initiative will identify models of effective instruction and develop systematic strategies to ensure that many educators see and understand these models, direct new and existing resources toward those existing models and support development of new models to fill necessary gaps in the system.
Collaboration is Critical. The Initiative will engage K–12 districts and schools, institutions of higher education, business and industry and policymakers in ways that capitalize on their unique resources and expertise in support of a shared vision of effective STEM teaching and learning. The STEM Network will maximize the potential impact of existing assets and develop new solutions where needed. Indeed, the development of this Initiative already has involved extensive input from hundreds of stakeholders from across the state that have played a critical role in shaping the proposed strategies and outcomes. By “connecting the dots” among practice, policy and research, the Initiative will help ensure that all stakeholders are moving together to implement an aligned agenda of stronger STEM instruction.

Scalable and Equitable. High-quality programs will be identified and designed with the expectation that they can and will be scaled statewide to benefit all students. “Spotlight” schools or even districts may provide proof-of-concept models but are unlikely to produce the number of well-educated STEM graduates the state needs. Therefore, the Initiative will go beyond creating just a few pockets of excellence and generate significant change to positively impact the state’s public education system.

Outcomes Driven and Research Based. STEM Initiative objectives and outcomes must be aligned to the state’s education and economic development priorities. Strategies should be designed with these objectives and outcomes in mind and will be measured by comprehensive performance indicators. The STEM Initiative will regularly collect data, evaluate its programs, and commit to using the information to drive continuous improvements. It is essential to use evidence of effectiveness as a criterion for allocating resources and scaling up programs as well as take into account the local environments that made success possible. By defining clear and measurable goals at the front end and then rigorously evaluating results at every level, the Initiative will put a premium on effectiveness and help break down the walls between research and practice and between practice and policy.

Investments Driven by Results and Innovation. To drive lasting and transformative improvements in STEM teaching and learning, the Initiative will develop effective strategies to invest, expand and scale “proven” innovations that greatly increase the number of children served by school reform models with demonstrated effectiveness. The Initiative will also invest in creating a networked innovation infrastructure that 1) provides relevant data and information in a timely way to teachers, administrators, and policymakers and trains them how to make appropriate decisions based upon that data; and 2) allows effective evaluations of the impact of various strategies. In addition, the Initiative will include in its portfolio of investments carefully selected high-risk/high-gain, early-stage innovations that will break new ground in understanding instructional effectiveness.

Coherent, Coordinated and Comprehensive. Perhaps most important, the Initiative will bring a comprehensive, coordinated approach to improvement. The policy agenda will both drive and be informed by lessons from the field. Transformative goals and the short-, intermediate- and long-term methods for achieving them will be clear and aligned. Effective local and statewide communications support will reinforce both the policy work and classroom practice — shedding light on quality instruction for teachers and school leaders and prompting policymakers to act. By assembling and managing a statewide group of education, business, civic and policy partners, the Initiative will ensure that program and policy changes are coordinated, coherent and focused. The Initiative’s STEM Network will become a statewide focal point for leadership in STEM teaching and learning.