Why STEM matters to all of us?

By Moses Lee • March 2016

Science, technology, engineering, and mathematics (STEM) are everywhere, affects every aspect of our lives, and are vital to our future – the future of our region, our country, our world, and our children. The U.S. has developed as a global leader, in large part, through the genius and hard work of its scientists, engineers, and innovators. In a world that's becoming increasingly complex, where success is driven not only by *what* you know, but by what you *can do* with what you know, it is more important than ever for our citizens to be equipped with the knowledge and skills to solve tough problems, gather and evaluate evidence, and make sense of information. These are the types of skills that can be learned by studying STEM subjects.

Scientific and technological issues increasingly dominate the national discourse, from environmental debates on climate change and economic threats from invasive species, to concerns about cloning, genetically modified food, and the use of vaccines. New advances in areas such as medicine, genetics, communications and energy all directly affect our lives, and not to mention the impact of STEM in finding solutions when a pandemic hits or addressing issues of national security and defense. Not surprisingly, the attention on STEM has come from all levels in our society, including the White House, in which President Barrack Obama declared, "Science is more than a school subject, or a periodic table, or the properties of waves. It is an approach to the world, a critical way to understand and explore and engage with the world, and then have the capacity to change the world." (1) Many thinkers, including a writer at Science Pioneers, echoed the significance of this statement. The author wrote, "STEM is important because it pervades every aspect of our lives. STEM is our children's future – the technological age in which they live, their best career options, and their key to making wise decisions." (2)

According to Nicole Martin at STEMJOBS, "These STEM disciplines no longer stand alone as separate career fields, and in fact, many real-world situations require problem-solving strategies that include integrated solutions from each of these four fields. As global competition increases, more STEM-literate workers are vital to the U.S. and our ability to lead innovation, increase productivity, and compete effectively in a growing global economy." (3) As a result, STEM workers are in demand. According to the U. S. Department of Commerce, from 2008 to 2018, STEM occupations are projected to grow at 17 percent, while others are estimated at 9.8 percent. (4) Closer to home, a February 19, 2016 article in the *Puget Sound Business Journal* reported that 90 percent of the 50,000 jobs in the State of Washington that go unfilled in 2017 will require STEM skills. Thus, for the U.S. to achieve economic growth and remain competitive on an international scale, these jobs must be filled. This situation is, however, challenged by the current reality. In an article published by the *U.S. News & World Reports* in 2012, it examined the problem of why, at a time of high unemployment, there were so many jobs that went unfilled. The answer was simple. American workers lacked the necessary skills for those jobs, which required training in STEM fields. (5) This situation is exacerbated by a weak performance of U.S. students in many academic surveys. For example, in a 2013 survey, American students' scores remained relatively stagnant in math, science, and reading, while other countries slowly crept ahead. Of the 64 nations scored, U.S. students ranked 28th in science, 36th in math and 21st in reading. (6) Thus, to maintain our competitiveness as a global leader it is paramount for the U.S. to build a pipeline of qualified STEM graduates. As a result, following the *Excel to Engaged* report from the White House in 2012, the 100Kin10 project was formed to prepare 100,000 well-trained teachers in STEM fields by

2021. (7) The ultimate goal of this project is to impact the education of 10 million students through the lifetime of these teachers. Currently, 100Kin10 works with over 28,000 teachers and 230 stakeholder organizations, from federal agencies and nonprofits to corporations and universities. The M. J. Murdock Charitable Trust is a member of 100Kin10 and our Partners in Science Program is making an impact.

In addition to STEM education, funding from federal and private sources needed to fuel cutting edge and transformative research is a crucial piece for maintaining and growing the vitality of the U.S. scientific enterprise. By far, the dominant sources of funding for R&D have been private industry and the federal government; together, they accounted for 93 percent of R&D spending in 2009, which is still true today. (8) A recent decline in the federal budget for R&D, from about $160 billion in 2010 to about $140 billion in 2015, has made the research climate much tougher for scientists and engineers to pursue "out of the box" and potentially revolutionary projects. Exacerbating this condition is stiff competition and low success rates researchers face when applying for federal grants. Take for example, the current success rate for new principal investigators in getting an NSF grant is about 18 percent compared to 26 percent for someone who had previous NSF funding. The NIH is equally challenging. In spite of concerted efforts, the average age at which an investigator first obtains major NIH R01 funding has remained at 42. These are daunting challenges researchers must overcome to have a chance in making major discoveries and inventions to meet the needs of the nation and society.

To expound on the question of "why STEM matters?" imagine this: what would life be without lasers? What if, in the 1950s, Dr. Charles Townes was unable to secure funding to carry out the experiments needed to build the microwave-emitting devices, called masers, and their light-emitting successors, lasers? (9) Lasers have transformed modern communications, medicine, astronomy, weapons systems, and daily life in homes and workplaces. It would be hard, if not impossible, to imagine life without lasers especially for the millennial generation. Of course, one could make the same case for other monumental discoveries and inventions that have transformed our lives, such as the light bulb, airplane, computer, penicillin, and many others.

Fast forward to February 2016, both the public and scientific news were buzzed with a landmark discovery that was in the makings for decades and cost over $1 billion. The reports confirmed Einstein's theory about gravitation waves. Basically, the Laser Interferometer Gravitational-Wave Observatory (LIGO) – a duo detectors in Hanford, Washington, and Livingston, Louisiana – recorded the sound of two black holes colliding a billion light-years away, that fulfilled the last prediction of Einstein's theory of relativity and opens the window on the cosmos. (10) Take another example, in the February 19, 2016 issue of the *Science*, the title says, "The next big eye: the pressure is on the builders of the James Webb Space Telescope to ensure that NASA's $8 billion gamble pays off." This is potentially revolutionary research because the Webb telescope will have 100 times the sensitivity of the Hubble Space telescope. It will be able to look into the universe's infancy, when the first galaxies were forming, study the birth of stars and their planet systems, and analyze atmosphere of exoplanets. Neither of these great works of STEM would be possible without the lasers discovered by Dr. Townes. Clearly STEM impacts every aspect of our lives, and to maintain the United State's position as a global leader, STEM matters hugely. Thus, it is imperative for governmental groups, corporations, and private organizations to keep the enterprise strong by supporting transformative scientific research and building a robust pipeline of a well-trained STEM workforce. That is why the M. J. Murdock Charitable Trust invests in a number of programs aimed at supporting scientific research at research universities, medical institutes, and the private undergraduate colleges, such as the Murdock College Science Research Program.

In the final few paragraphs of this article, it is appropriate to describe M. J. Murdock Charitable Trust's vision in supporting STEM research and education. From the very beginning when the Trust was established in 1975 it has maintained a strong and consistent interest in supporting transformational scientific research while simultaneously preparing the next generation of scientists and engineers. As a result of this vision, in the Trust's 40 years history, of the 5,759 grants made totaling about $818 million, about $159 million, or over 19 percent, were directed toward projects in scientific research in the Trust funding region – Alaska, Idaho, Montana, Oregon, and Washington. The programs listed below highlight the types of scientific projects and the institutions supported by the Trust, along with last year's funding. In addition to the programs listed below the Trust also funds projects from non-higher education organizations that engage in STEM education, such as museums, conservation organizations, and K-12 private schools. These organizations typically apply for support as general grants.

General Scientific Research Grants – major core instrumentation: This program provides major instrumentation to support cutting edge and transformative research in the natural sciences, engineering, and medicine. The program is open to a select group of major research universities and research institutes. Comprehensive and predominantly undergraduate public universities and private undergraduate colleges may also apply on a less frequent basis. The applications must be the president's highest priority. Of the about $52 million in grants made by the Trust in 2015, these grants accounted for about $5.6 million (about 11 percent).

Commercialization Initiation Grants: This program is intended to support the commercialization of bench discoveries in natural sciences, engineering, and medicine at a select group of major research universities. The projects must also be the president's highest priority. In 2015, these grants accounted for about $293,000 (about 0.6 percent).

New Faculty Start-up Grants: This program offers grant support to augment start-up research packages offered to new faculty in the natural sciences at private predominantly undergraduate colleges. In 2015, these grants accounted for $240,000 (0.5 percent).

Murdock College Research Program – Natural Sciences Grants: This program supports original research in the natural sciences at private predominantly undergraduate colleges. In 2015, these grants accounted for about $1,300,000 (2.5 percent).

Murdock College Science Research Program Grants: This program supports private predominantly undergraduate colleges with established programs in undergraduate research. The goal is to expand and strengthen such programs to include more faculty and students and to conduct more research and of higher quality. This program is by invitation only and institutions are required to secure a specific endowment to sustain the research program. No grants were made in this program in 2015.

Partners in Science Research Grants: This program provides high school science teachers with an opportunity to work at the cutting edge of science with professors at a college, university, or research institute and thus to revitalize their teaching, and to help translate their research experience into the teaching of science. Secondary goals are to help teachers guide able students toward careers in science, to develop new teaching strategies, and to foster long-term scholarly collaborations. In 2015, these grants accounted for $225,000 (about 0.5 percent).

Partners in Science Supplemental Grants: To bring insights and technologies, gained during the Partners in Science summer research program, back to the high school classroom or laboratory.

Secondary goals is to make high school science teaching more attractive, to help teachers guide able students toward careers in science, to develop new teaching strategies, and to foster long-term scholarly collaborations. In 2015, these grants accounted for $133,000 (about 0.3 percent).

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