

## **STEM Education in Action: Local Schools, Non-Profits, and Businesses Doing Their Part to Secure America's Future**

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Subcommittee on Research and Science Education

Committee on Science, Space and Technology

*Testimony provided by Neil E. Lamb, Ph.D.*

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### **Questions and Answers:**

*1. What makes HudsonAlpha unique and why did you choose to locate in Huntsville? What goals does the institute hope to accomplish by promoting STEM education, and how are these goals useful to the Huntsville area, Alabama, and the nation as a whole?*

The HudsonAlpha Institute for Biotechnology is a nonprofit research institute with a strong focus on both the advancement of knowledge in genomics (the branch of science associated with the study of the total genetic information for an organism) and the application of that knowledge. HudsonAlpha has a three-fold mission of conducting genomics research to improve human health and well being, sparking economic development, and providing educational outreach that inspires youth to pursue careers in science. HudsonAlpha's tagline, *The Science of Progress*, represents our collective realization that advancement results from this three-fold approach:

- building a team of well-networked researchers with complementary skills in a non-profit setting;
- attracting established businesses and budding entrepreneurs to translate discoveries from the lab into services and products; and
- establishing strategic avenues of educational outreach that fill the workforce pipeline and address deficiencies in public knowledge.

Led by Dr. Richard Myers, formerly the chairman for the department of genetics at Stanford University, HudsonAlpha's research faculty focus on using genetics and genomics to understand the normal function of organisms, to inform and improve patient care and to assist in development of new and sustainable energy sources. This research takes place under the same roof with more than 20 biotechnology-related companies, demonstrating our belief that proximity between research and industry builds collaboration and moves discovery into application at a faster, more efficient pace.

Jim Hudson and Lonnie McMillian, the founders of HudsonAlpha, have strong roots to Huntsville, having each created and matured successful businesses in the area. Huntsville offers both the culture of innovation and the emphasis on strong STEM education that is necessary to create the "Ah-ha!" moments that move research forward and turn ideas into products.

HudsonAlpha's educational programs for teachers and students are organized around two guiding principles: preparing the future biotechnology workforce and cultivating an

awareness of the influence of genetics and biotechnology on the lives of all citizens. Our support of STEM education is beneficial to both the institute and the country. Advanced scientific and technological achievements require a workforce that has committed to continuous learning and the understanding of complex concepts and relationships. This requires that learners become engaged in the pursuit of knowledge early in their education and build on that knowledge throughout their lifetime. HudsonAlpha seeks to contribute to this continuum of learning.

*2. Please describe HudsonAlpha's STEM education activities. How do you measure the results of these initiatives? Does the institute partner with any other organizations to further STEM education? If so, what organizations?*

By collaborating with educators, policy makers, civic groups and corporate funding partners, HudsonAlpha's educational outreach team connects academic learning with real-world application. We develop and implement hands-on, inquiry-based activities for students, host in-class and online student discussions, provide summer camps and intern opportunities, and offer professional development sessions for educators. During the 2010-2011 academic year, these activities reached over 50,000 Alabama students, teachers and members of the public. Based upon these accomplishments, HudsonAlpha has become a leader in genetics education at the national level. We are routinely invited to present at national education meetings and public policy discussions related to genetic education.

In general, our programs can be divided into several clusters, based loosely around the target audience or the type of activity developed.

**1. Hands-On Classroom Activities** – In partnership with the Alabama State Department of Education, HudsonAlpha developed a genetics and biotechnology module for middle school students. The activities associated with the module have been implemented statewide through the Alabama Math, Science and Technology Initiative (AMSTI) and will be used by more than 8,000 students during the current academic year. We have also designed and implemented five genetic-based laboratory activities for high school classrooms. Each activity meets state-mandated course of study requirements for multiple classes; for example, an inquiry activity on DNA extraction can be used for an introductory biology class and a biotechnology career tech course. These have been incorporated into Alabama Science in Motion (ASIM), the high school component of AMSTI. During the 2010-2011 academic year, more than 10,000 Alabama high school students from over 270 classrooms used these kits.

**2. Teacher Training Opportunities** – HudsonAlpha has crafted a summer educator workshop, Genetic Technologies for Alabama Classrooms (GTAC), for Alabama high school biology instructors. This two-week immersive experience provides training in both content and pedagogy (*i.e.* the practice of teaching), using hands-on modules to incorporate genetic concepts into the biology classroom. The goal for GTAC is to help an educator become comfortable

discussing genetic concepts and terminology, as well as the ethical, social and legal issues associated with these concepts. The educator can then reinforce those concepts through hands-on laboratory modules. All activities link to state course of study standards for biology. In this way, teachers can build the foundation students need to understand genetics as well as the application of the content. By incorporating hands-on activities, students gain the skills required to succeed in the global marketplace for careers in research, healthcare, agriculture, defense and information technology.

HudsonAlpha is in the process of increasing our teacher outreach efforts through shorter-term workshops that will be held across the state. These expanded efforts will impact over 1,000 life science and career/technical education teachers during the coming year. The educational outreach program also produces the annual *Biotechnology Guidebook*, an easy-to-read overview of new findings in the fields of genetics and biotechnology and the connections to high school life science courses. This year's guidebook was mailed to every high school in Alabama and is freely available from the HudsonAlpha website. The guidebook and a presentation of the new genetic discoveries it contains has become a regular feature at the National Association of Biology Teachers annual meeting.

**3. Student Experiences** – Beginning in 2012, HudsonAlpha has developed a series of half-day and full-day field trip opportunities for area middle and high school students. These have proven popular and we will expand these offerings for the 2012-13 academic year, with a particular emphasis on including groups historically underrepresented in the sciences.

HudsonAlpha offers a summer internship program called BioTrain for high school through graduate students, providing experiences that range from in-depth laboratory research to biotechnology marketing and business strategy. Internships are offered through HudsonAlpha's nonprofit research labs, the for-profit associate companies and the educational outreach program. BioTrain internships are a valuable stepping stone that links classwork with real-world experience. Interns gain skills and knowledge that prepares them for the workforce as well as related higher education coursework. Simultaneously, interns learn to work in professional settings, dealing with workplace values like punctuality, respect and time management. In return, BioTrain interns become part of the eligible future workforce and build a relationship with a biotechnology company or researcher.

One of HudsonAlpha's earliest educational outreach programs created a series of laboratory activities to support AP biology classes. A group of scientists and graduate students travel to a high school and help the students work through various laboratory activities required by the AP program. This has expanded to serve nearly every high school in Madison County with a 50+ volunteer base. This past October, HudsonAlpha staff published a description of the program and its benefits in *The American Biology Teacher*. Beginning Fall 2012, the revised AP biology course will be introduced. We are working with area teachers to

provide content support and mentor students through the revised laboratory exercises.

**4. Digital Activities** – In October 2011, HudsonAlpha released an updated version of our popular iCell™ app for Apple® and Android® phones and tablets. iCell™ allows students to explore the inner structure of plant, animal and bacterial cells, learning about the organelles using different levels of complexity. The app was quickly identified by Apple® as a “New and Noteworthy App” and for several days, was in the top five free educational apps. To date, more than 70,000 individuals have downloaded the iCell™ app.

GenomeCache™ is another free app developed by HudsonAlpha. Along with its accompanying website, this app helps teachers assemble a “Genome Walk,” a physical representation of the human genome that includes information on over 150 genes of interest. The GenomeCache™ app uses the Genome Walk as the setting for a genomic scavenger hunt, similar to the way geocaching uses GPS coordinates in the search for tiny treasures. This year, a network of Alabama classrooms hosted Genome Walks as part of HudsonAlpha’s statewide celebration of DNA Day, reaching over 2500 students.

In 2011, HudsonAlpha was awarded a \$1.1M, NIH-sponsored Science Education Partnership Award. With these funds, we are designing and implementing “Touching Triton™”, an online activity to explore risk factors associated with complex disease. Set in the context of a 20 year mission to a distant moon, the activity will help students assess disease risks for crew members based on family history, medical records and genomic data. Touching Triton™ will be introduced across Alabama in 2014, with nationwide expansion to follow.

**5. Public Activities** – Since 2008, HudsonAlpha has offered a public education short course called Biotech101. This five-week series covers the basic concepts of genetics, genomics and biotechnology, and is taught by HudsonAlpha faculty. To date, more than 900 individuals have participated in the Biotech101 course. Once individuals have completed “101”, they are eligible to take “Biotech201”, which highlights a different topic area every winter. This year, the focus was on type 1 and type 2 diabetes. More than 280 individuals attended this year’s series. All sessions are free of charge to the public, thanks to sponsorship by local businesses.

As a first line of evaluation for our initiatives, we seek feedback from educators regarding the quality and utility of our educational kits and modules. At both the middle and high school levels, this feedback has been overwhelmingly positive. Teachers express appreciation for the ability to expose their students to these types of hands-on activities, especially in terms of how they link to both current applications and careers.

As often as possible, we use more formal assessment methods to measure the impact of our initiatives. For our school activities, we ask if the activity helps students comprehend the objectives it is designed to address. This information may be informally assessed

through student or teacher comments. In an ideal setting, we could determine if the programs improve student scores on high stakes assessment exams, such as the Alabama Science Assessment. Student test scores are impacted by a number of variables, making it difficult to ascribe changes in scores to any one event. Even so, after using the 7<sup>th</sup> grade module developed by HudsonAlpha, our pilot schools noted a significant increase in the percentage of students that correctly answered questions relating to the state genetics and DNA content standards. For example, one school's content standard about "genetics" moved from 30 percent correct to 71 percent and the "DNA" content standard increased from 48 percent to 67 percent. We are working with the Alabama State Department of Education to compare assessment results on a broader scale as the 7<sup>th</sup> grade module is introduced statewide.

In terms of assessing the impact of teacher professional development initiatives, we look for changes in teacher content knowledge before and after the two-week GTAC academy. Based on pre- and post- academy questionnaires, educators increased content knowledge in key areas related to genetics:

- in aggregate, the knowledge of basic genetic concepts increased from 66.7 percent to 79.5 percent
- genetic technologies understanding increased from 53.5 percent to 66.7 percent
- Mendelian inheritance increased from 78.9 percent to 87.7 percent
- content knowledge about complex genetics increased from 78.9 percent to 86.8 percent

An additional, unforeseen but welcome finding showed that attendees increased awareness of themselves as "professional educators" rather than "simply a school teacher." This enhanced role as a teacher leader carried into the school year in tangible ways: two GTAC alumni successfully secured external funding for classroom activities, two have given district-level professional development talks and three presented their work at the Alabama Science Teacher's workshop. In addition, the past two Alabama Outstanding Biology Teachers of the Year are GTAC graduates.

HudsonAlpha collaborates with a wide array of partners, based upon the target audience and content area. Some partners assist in programmatic development and implementation while others provide the necessary funding. Over the past four years, our collaborators have included:

The U.S. Department of Labor  
The National Aeronautics and Space Administration  
The National Institutes of Health  
The U.S. Space and Rocket Center  
The Boeing Charitable Trust  
Lockheed Martin  
The Alabama Math Science and Technology Initiative  
The University of Alabama Huntsville  
Vanderbilt University  
Alabama A&M University

Athens State University  
Calhoun Community College  
Wallace State Community College  
Sneed State Community College  
The SciQuest Hands On Science Center  
Alabama Career and Technical Education  
Madison City Schools  
Huntsville City Schools  
Madison County Schools  
Decatur City Schools  
The Schools Foundation  
A+ College Ready  
The Ben May Charitable Trust  
Jane K. Lowe Foundation  
WesFam Restaurants, Inc/Burger King  
The Alabama Math Science Engineering and Technology Consortium  
The Lawrence County Agricultural Career Initiative  
Servis First Bank  
Maynard, Cooper and Gale, PC  
The Daniel Foundation of Alabama

HudsonAlpha is also an active part of BioAlabama, a statewide organization representing the biology-related industries, research scientists, clinicians and business officials that support life sciences. BioAlabama plays an important role promoting innovation and talent development by creating a favorable scientific, business, legislative and educational environment across the state. This type of network, where stakeholders work together toward common goals, is a key component for success in recruiting and retaining workforce talent to maintains a place at the front of scientific advancement and the application of those discoveries.

*3. What incentives inspired HudsonAlpha to undertake STEM education? How can other nonprofit organizations mirror similar programs, and how would it benefit them and the communities they serve to do so?*

The opportunity to positively impact STEM education was a driving reason why the founders of HudsonAlpha included education as a critical piece of the mission statement. The value of a trained workforce and the benefit of a research-friendly community were other considerations in stepping into STEM education space. There is consensus that skills derived from a strong STEM curriculum are of vital importance to national prosperity, security and the health of our citizens. The United States has long been a recognized world leader in scientific achievement. Equally important, the U.S. is the recognized leader in using that achievement to innovate and build wealth. Disturbing trends reflect a decline in the number of students who train to become scientists and engineers. With fierce competition from nations seeking to overtake the U.S. position in achievement and innovation, sustained support of STEM education at a national level is mandatory. At the same time, states, non-profits and industry must also invest to nurture

budding science and engineering professionals. A motivated and growing workforce pipeline is required to keep pace with emerging human needs and competing nations.

Said another way, on April 23 of this year, Dr. Subra Suresh, director of the National Science Foundation remarked to an audience of community leaders from North Alabama that innovation is a contact sport. He is correct; sitting on the sidelines does not effect change. HudsonAlpha aims to create and sustain an ecosystem of innovation that not only strengthens Alabama's industrial base, but also supports and protects our nation's preeminence in discovery and application.

A recent study from Georgetown University's Center on Education and the Workforce noted that with the exception of some academia Ph.D.-level researchers, the demand for STEM workers is increasing for individuals with all levels of education. The drive for innovation is critical to the success of a wide swath of America's economy and strong STEM concepts lie at the heart of many of these innovations. Other nonprofit organizations can engage in the STEM educational arena by identifying the logical spaces to provide content support for educators and classrooms. This engagement may simply provide support for one topic in a single classroom or influence an entire state's educational initiatives. In Alabama, the Alabama Math, Science and Technology Initiative (under the state department of education) spearheads efforts to reach K-12 students. Other states have similar hands-on educational programs. The existence of distance learning networks similar to Alabama's ACCESS program offers an additional avenue for groups to create online content that inspires students and promotes STEM achievement. Providing student internships and cooperative education experiences present invaluable opportunities for students to see a future in STEM fields.

In total, these offerings help preserve our nation's standing, continue economic gains and afford a higher quality of life for all citizens.

*4. How do we avoid a disconnect between the jobs we want to keep in the U.S. and our workforce's ability to perform those jobs? How do partnerships with colleges and universities help alleviate that disconnect?*

Historically, the United States has led and benefited from both agricultural and manufacturing-based economies. In the same way, our leadership in the knowledge economies of Information Technologies and the life sciences has produced clear gains. Continued economic growth requires an increasing number of highly skilled workers. A 2009 survey of the Business Roundtable found that 65 percent of surveyed employers now require an associates degree or higher for most positions.

However, in spite of the uptick in training and certification programs, and even in the face of relatively high unemployment, many employers still face job shortages for technically demanding positions. The required set of worker skills has changed as industries innovate and evolve. The entire education system (K-12 and higher education) must prepare the future workforce to understand and competently perform these skills.

Importantly, the relationship between those who develop businesses and those who prepare our workforce requires ongoing and extensive dialog. Without industry involvement, it is difficult for the educational institutions to identify skills and competences and nimbly respond with well-matched training. At HudsonAlpha, we encourage this dialog through both proximity (pushing educators, researchers and industry constituents physically into shared spaces) and structured encounters (seminars, information sharing between teachers, scientists and business leaders, opportunities to collaborate, etc.). Similar efforts that support dialog between business and educators on a larger scale help promote integration and collaboration. Without this dialog, business and education may not only fail to integrate, but may even work at cross-purposes.

HudsonAlpha has partnered with area schools of higher education to provide guest lecturers from among our faculty, introducing undergraduate students to cutting-edge technology and research discoveries. At the graduate level, we have partnered with the University of Alabama Birmingham to bring doctoral students in human genetics into HudsonAlpha's labs for their dissertation research. This collaboration connects the clinical expertise of UAB with the genomic skill set of HudsonAlpha, exposing students to a richer set of scientific experience. A similar graduate student relationship has been established with the University of Alabama Huntsville.

Much of the recent STEM career emphasis has focused on a relatively small population of highly trained scientists and engineers; more than one-third of all projected STEM-related jobs will require a workforce trained at the high school and sub-baccalaureate level. This is a previously neglected portion of our nation's STEM career pipeline. Strengthening student acquisition of STEM skills through the career and technical education programs in high school, trade school and community colleges is an important component that should not be ignored when addressing the disconnect between workforce training and required job skills. One of HudsonAlpha's earliest collaborations was with Calhoun Community College to support the creation of an associate degree program in biotechnology. Now in its fourth year, the program serves as an important entry point for students considering careers in the life science arena. In similar ways, HudsonAlpha works closely with the Career and Technical Education division of the AL Department of Education, providing activities and content support for high school career/tech teachers in health profession, agriscience and forensics fields.

*5. How can we attract, educate and retain the critical mass of talent necessary to keep the state of Alabama, and the nation as a whole, at the forefront of research, development and groundbreaking advances in science and technology?*

Preparing our citizenry to lead in the development and use of advanced science and technologies will continue to be one of our nation's most essential responsibilities. STEM education must be elevated as a national priority in terms of reform, spending and innovation strategies. In particular, student performance in science should rank alongside reading and mathematics as a key component of educational accountability systems. Supporting this emphasis on foundational content, students should be exposed to a broad

range of career exploration opportunities (job shadows, internships, problem-based experiences, service learning projects) which allow students to test drive a career and learn from the individuals who possess the experience the students are looking to acquire.

Our nation needs to ensure all of these opportunities include student groups traditionally underrepresented in science. The pipeline must be expanded to reach a larger population of STEM-interested students. Lastly, it is no longer enough to simply present content and provide skill development opportunities: We need to deliver them in a format that is compelling and engaging enough to win the learner's attention. This must be done while competing with all the entertainment and social attractions of our society. Scientific and technological competence (not to mention innovation) requires a solid education that continually grows over time. As a society, we must support approaches that best facilitate the pursuit of this knowledge. Our citizens need to embrace learning and our society needs to reward those who give their time, effort and passion to that pursuit.