

## Executive Summary

United InnoWorks Academy  
Science Education Division

### What Is InnoWorks?

**I**nnoWorks is an innovative science and engineering initiative “By Students, For Students,” designed and implemented by college volunteers for middle-school students from disadvantaged backgrounds.

It is the flagship program of United InnoWorks Academy (UIA), a 501(c)(3) non-profit educational organization founded in 2003. The primary goals of InnoWorks are to (1) provide students from underprivileged backgrounds with an opportunity to explore the real-world links among science and engineering disciplines, (2) promote teamwork, enthusiasm for learning, and career interests in science and engineering, (3) utilize cutting-edge neuroscience and educational research to develop mentoring and pedagogical methods that build problem-solving skills and student confidence, (4) harness higher-education expertise to benefit youth and foster the development of synergistic relationships between universities and communities, and (5) develop opportunities to inspire volunteerism, passion for service, and entrepreneurship in college students to prepare them as tomorrow’s educators, leaders, and role models.

InnoWorks is organized to leverage the grass-roots energy of university students to benefit local communities. It is unique among extracurricular educational programs for several reasons.

First, InnoWorks programs are offered entirely free of charge for all underprivileged students nominated by local school systems, including program materials, books, transportation, food, and awards.

Second, InnoWorks programs are developed and conducted by passionate college volunteers from around the country. Students bond well with their mentors and staff, looking up to them as older brothers and sisters. The mentors also felt InnoWorks helped them develop significantly as leaders, teachers, and communicators.

Third, InnoWorks curricula are created and tested by the volunteer leaders to “turn-on” middle-school students to learning and the “scientific” mindset. They are exceptionally modular, scalable, portable, and interdisciplinary, enabling students to understand connections among different scientific fields and how they relate to their own lives. We have published books (separate staff and student editions) capturing two curricula, “Making Sense of Senses” and “Explorations,” and are working on a third entitled “Dare to Discover.”

Finally, to optimize and personalize pedagogical methods, InnoWorks develops and evaluates novel adaptations of cutting-edge research by cognitive neuroscientists and educational psychologists as the foundation for creating versatile curricula and mentoring techniques that allow mentors to accommodate and challenge the specific learning preferences of each and every student. By helping students harness their learning strengths to overcome difficulties, learning becomes more profound and enjoyable.

In the low-stress, collaborative InnoWorks environment, students are very willing to take intellectual risks and open their minds. The exciting experience of being on a college campus with their mentors

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and the can-do learning attitude generated by InnoWorks inspired many to enthusiastically express a new desire to go to college—remarkable considering their family backgrounds.

InnoWorks provides an innovative method of bringing higher-education expertise to middle-school youth and fosters development of synergistic relationships between universities and communities. Moreover, the program offers a valuable opportunity for undergraduates to become involved in mentoring, teaching, and community outreach. InnoWorks aims to help remedy the shortfall in future STEM-educated (Science, Technology, Engineering, and Mathematics) individuals to enable continued science and engineering innovation.

Our vision is for InnoWorks to provide exciting educational opportunities for all students across the world. We intend to maintain relationships with InnoWorkers for life, inviting them to join as junior and then full mentors. If our mission is achieved, InnoWorks communities everywhere will be self-perpetuating, with each generation nurturing the next, connected by a common goal to improve society.

## Motivation

As many as fifty percent of black and Hispanic teenagers in the US will never graduate from high school—a substantially higher drop-out rate than that of their white and Asian counterparts.<sup>1</sup> Studies have shown that the so-called achievement gap increases substantially with age,<sup>2,3</sup> suggesting that environmental influences play a major role in the development of this gap. We believe that InnoWorks can increase enthusiasm and confidence in learning science and engineering for youth who otherwise lack access to exciting educational opportunities outside of the classroom. These experiences can help young students gain an awareness and appreciation of these fields and even consider them as potential career paths. A clear scholastic achievement gap creates a substantial need for programs of this nature; indeed, prior research suggests that summer learning opportunities may be the most important difference between students who continue to excel in school and those who steadily fall behind.<sup>4,5</sup> According to Ron Fairchild of John Hopkins Center of Summer Learning, there have been many different studies over the past century that show that the learning loss experienced by poor children in the summertime accumulates to an overwhelming degree, such that “by fifth grade there is almost a two-year gap in achievement scores that can be traced directly to summer learning loss.”<sup>6</sup> Recognizing the importance of quality summer learning opportunities, Senators Barack Obama and Barbara Mikulski have sponsored a bill called the STEP UP Act that seeks to establish public funding for educational summer programs.\*

InnoWorks makes an effort to recruit students from underprivileged backgrounds and female students, groups that are traditionally underrepresented in STEM. We target students that have an interest in learning more about science and engineering, but have limited access to resources. Research suggests<sup>7,8</sup> that this is the population that stands to benefit most from a program like InnoWorks. The reason for working with middle-school students is because we believe that youth of this age have enough maturity and experience to be able to successfully participate in InnoWorks; at the same time, they are young enough to be highly receptive to enrichment opportunities. Moreover, it is in middle-school where most students turn away from math and science.<sup>2,3</sup>

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\* <http://www.theorator.com/bills109/s2149.html>

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Nevertheless, we believe that all students stand to benefit from various elements of the InnoWorks paradigm regardless of background. As such, we will continue to expand the opportunities for *all* youth to attend our programs and share our methods and experience with other providers of educational enrichment opportunities. Our goal is to not only close the achievement gap, but to raise the level of achievement for everyone.

The rationale behind InnoWorks is based on three central principles. First, mentoring is an effective method for inspiring disadvantaged youth to take their educations more seriously. Dubois et al. state, “the strongest empirical basis exists for utilizing mentoring as a preventive intervention with youth whose backgrounds include significant conditions of environmental risk and disadvantage.”<sup>8</sup> Second, youth are full of imagination and enthusiasm, and their creative energies are easier to harness if they are directed towards real-world problems that might positively impact their communities. Hancock et al. came to the conclusion that

Active participation of youth is essential to reenergizing and sustaining the civic spirit of communities. Through skill development in the areas of collaboration and leadership, and the application of these capacities to meaningful roles in community, youth can play a fundamental role in addressing the social issues that are destined to impact their lives and those of future generations.<sup>14</sup>

Third, InnoWorks is structured on the belief that college-age mentors are ideal role models because of their similarities in age and experience with the middle-school students. Their knowledge of and passion for science and engineering can provide InnoWorks youth with positive influences throughout and beyond the program.

The national call for accountability in education has not generally been applied to supplementary educational programs like InnoWorks. In order to improve the program, meaningful evaluations of the educational innovations and program structure are necessary. Feedback from students and mentors as well as other methods of assessment provide invaluable data with which to improve InnoWorks.

## Learning and Rewards

The desire to learn is intrinsic,<sup>9</sup> but many students still resist the opportunity to learn new things. There is substantial support for the idea that students will naturally learn if they believe that the subject at hand matters in their lives.<sup>9,10-12</sup> As such, InnoWorks begins each new topic with concrete experiences and applications so students can immediately relate the subject to personal experience. In addition, emotions are known to have a dramatic impact on learning.<sup>9</sup> In the context of a classroom, fear and stress are likely to result from a discomfort with the power structure and interpersonal relationships with teachers and peers. Since all mentors, and primary staff members of InnoWorks are college students who have diverse interests, and all have a passion for working with kids, we believe that our program has a distinct advantage over other types of “science-camps” in that the students will likely feel less “threatened” by a staff that is composed of students like themselves. This expectation was borne out by the past three years of programs, where several students remarked how this aspect of the program enhanced their enjoyment of InnoWorks.<sup>13</sup>

In terms of motivation and pleasure, there are extrinsic rewards (e.g., prizes) and intrinsic rewards; the latter are intimately associated with the learning itself. InnoWorks provides plenty of extrinsic

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rewards such as trophies, memorabilia, and other prizes to motivate the youth to work hard and explore everything the program has to offer. We strongly emphasize teamwork, integrity, and dedication through special recognition and awards. Trophies are awarded to all participants who complete the program, and top-performing teams receiving special prizes to encourage all students to work collaboratively. To determine the top teams, points are given throughout the program for performance on competitive missions, group presentations, and reflective questions. Nevertheless, the program is founded on the belief that learning for its own sake (i.e., intrinsic motivation) can be encouraged and nurtured. Our premise is that an understanding of basic science and engineering gives people the freedom to pursue goals and discovery of uncharted realms; such experiences should contribute to providing InnoWorks students with enduring intrinsic motivation.

## **InnoWorks By the Numbers: Past and Present**

The year 2007 marks the fourth year of InnoWorks. We have successfully conducted five summer programs for over 200 students and benefited from the contributions of over 250 volunteers. We currently have seven chapters: Duke University, University of Maryland College Park, University of Arizona, University of Pennsylvania, University of Maryland Baltimore Campus, University of Michigan, and College of the Bahamas (Nassau, Bahamas). We anticipate having well over 200 students at our programs in the summer of 2007. We are constantly receiving inquiries from people interested in starting new chapters from as far away as Effat College, Saudi Arabia. Officials from Effat College came to the US to meet with InnoWorks representatives and discuss the possibility of starting an InnoWorks chapter there.

InnoWorks has been profiled by CBS, NBC, ABC, PBS, Duke News & Communication, The Herald Sun, Duke Chronicle, UANews, Duke Dialogue, Maryland Gazette, Arizona Daily Star, DukEngineer Magazine, and was featured on the 2005-2006 Duke Basketball Halftime TV Spot.

## **Program Overview**

InnoWorks curricula are designed to maximize the development of problem-solving and analytical skills using methods developed with cutting-edge cognitive neuroscience and educational psychology research. Each one-week to two-week long InnoWorks program consists of three different types of activities: interactive presentations and mixed-team learning activities, team-building activities, and fast-paced competitive missions. Students work in teams of four with a college student mentors. Each theme, e.g., Extraterrestrial Excursions, begins with the students engaging in hands-on, sensory-based presentations and group activities. Since we design the missions for team competition, the group activities involved cooperative pairing between different teams to increase interactions among students. During the midday break, we provide free lunches and drinks to all participants, mentors, and staff. To develop strong friendships and trust, team-building activities such as capture the flag follow lunch.

In the afternoon, we brief everyone on the objectives and scoring rubrics for one or two missions. For each mission, we randomly select two teams to give a capstone, five-minute PowerPoint™ presentation of their approach and solution to their peers, staff, and mentors. The selected teams also discuss the reflective questions that accompany the mission. The goal of the presentations is to develop the students' skills in communicating complex ideas to other people.

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The missions challenge student teams to develop strategies for solving difficult problems, then actively implement and test their ideas. Missions are fast-paced and relatively specific in the task required of the students. Typical mission problems fall into one of the following categories: (1) follow instructions to set up a phenomenon and explain the physical basis for it as accurately as possible, (2) develop a plan to solve a problem given certain constraints (no actual implementation), or (3) use a given set of materials to solve a problem, which may require manipulating materials to discover some scientific results or engineering a final device/product. In missions that involve building, the emphasis is on creativity and resourcefulness rather than tedious construction.

## **Organizational Structure and Future Vision**

InnoWorks aims to serve all students and communities around the world. As the number of chapters continues to grow, it has become clear that establishing an InnoWorks International Headquarters (IH) is essential in continuing the organization on its path of expansion and improvement. The minimum infrastructure we anticipate needing for the IH include the hiring of an International Director, a few full-time and part-time staff members, and office space. The primary goals of the IH are to support chapters in areas such as business and organizational know-how, logistics, and funding, develop and lead organization-wide initiatives such as curriculum development, facilitate effective internal and external communication and knowledge sharing, manage shared resources, and provide a central identity for the organization.

It is important to recognize that the critical roles that InnoWorks chapters currently play will not change; they will still be the ones that directly interface with their students, communities, and host institutions. We will also continue to require chapters to actively fundraise and participate in curriculum development because we believe that these experiences are invaluable for young leaders and entrepreneurs. Within the next few years, we hope to build the IH to the point that it can help support chapters in the key areas we mentioned above, freeing up valuable time for chapters to deliver better services directly to their students and communities.

To this end, we have built upon our successes over the past four years by developing a three to five year vision for InnoWorks in terms of organizational growth and development. The remainder of this summary discusses some of the initiatives we are currently undertaking or plan to undertake in the near future.

We are currently formalizing the process of chapter establishment, renewal, and the types of support the IH will offer chapters. For example, we will develop “ready-to-go” kits to accompany InnoWorks curricula. We plan on establishing a Summer Internship Program for the IH, formalizing a Chapter Exchange Program in which leaders of new chapters would have the opportunity to assist in an established chapter’s program prior to running their own, and creating a valuable Board of Advisors.

Numerous web tools will be designed to facilitate both internal and external communication. For example, we plan to partner with Google™ and have already developed several Google™ Groups for internal information sharing and collaborative curriculum development. Whereas these online groups are ideal for daily communication, an E-Newsletter published once every two months will highlight the most significant news over longer periods of time. We are exploring the creation of an “InnoNet” website that will serve a purpose for InnoWorks similar to Facebook for the college community. This will provide a

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way for students to communicate with their peers and mentors outside of formal InnoWorks programs and allows us to assist and track their educational development.

We have developed several strategic initiatives for managing the growth and expansion of InnoWorks while increasing service quality. In addition to the passive method of chapter expansion that has worked well so far, we are building a business plan that includes informational packages for distribution to college campuses around the world as part of a campaign to get the word out about InnoWorks. We plan on forming critical partnerships with complementary organizations and developing additional InnoWorks programs to increase our impact. Examples include extending the InnoWorks model to an Afterschool Program and a High School (HS) Bridge Program. The latter consists of three components: (1) Junior Mentor Program that will bring InnoWorks alumni in HS back to the program as junior mentors to facilitate their development as leaders, (2) College Support Program that will provide information, support, and assistance on college life and the application process, and (3) Scientific Research Initiative that involves pairing of InnoWorks mentors with high school alumni to conduct long-term, open-ended research projects that will culminate in student presentations at InnoWorks Research Symposia.

To help InnoWorks alumni learn about career opportunities in science and engineering, we will host an “InnoWorks Opportunities” program that involves special visits to local science- and engineering-based companies and lab tours with prominent researchers at host institutions.

We have harnessed cutting-edge neuroscience and educational research in our programs, curriculum development methods, and evaluation techniques. We aim to fully utilize these tools to encourage students to explore outside their learning comfort zone and become more adaptable, well-rounded, and confident learners. We are creating an Educational Research Committee (ERC) that will lead the future of our educational research efforts and report our results to the educational community.

The IH will organize an Annual Leadership Summit to inspire chapter leaders, discuss progress over the past year, share lessons learned and problem-solving techniques discovered, coordinate new strategic initiatives, and distribute materials. The ERC will also be responsible for creating interactive multimedia training materials that teach the latest pedagogical methods. These materials will be given to chapter leaders to use during their Chapter Mentor and Staff Training Workshops.

All chapters are expected to actively participate in InnoWorks curriculum development efforts, either through improvement and extension of extant curricula or contribution to new curricula. We want to create a Curriculum Review Committee (CRC) that will include experts from various fields of science and engineering as a formal means of ensuring scientific soundness. To increase curricular flexibility, we envision creating an ever evolving online collection of organization-approved thematic modules, activities, and missions. Chapters pick the curriculum elements they want on their own timeline, add them to a shopping cart, and send off a personalized order to a partnering on-demand printer for their customized books and another to the IH for the “ready-to-go” kits that accompany their curriculum.

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