# Science Bytes

## A new approach to increasing public understanding of science


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KIKIM MEDIA

NSTA National Science Teachers Association

# CLIMATE. ENERGY. FOOD. WATER. DISEASE.

Today, we are confronted by a set of daunting global problems. They threaten our livelihoods, health, and even our survival. If we are going to solve them, as we must, we need to make sure we have a well-educated population. And because science is central to so many of these problems, it is especially important that every young person graduate from high school with a thorough understanding of scientific thinking. The National Science Teachers Association, the largest organization in the world committed to promoting excellence and innovation in science teaching for all learners, is dedicated to achieving that goal.

Yet at the moment, when it comes to science and math, U.S. students are lagging far behind their peers in China, Japan and Singapore; even behind kids in Slovenia and Estonia. In 2015, when the Program for International Student Assessment tested 15-year-olds in 71 countries on their understanding of science and math, American students ranked 24th in science and 38th in math. The need for more effective science education is urgent. A recent report by the National Science & Technology Council's Commitee on STEM Education determined that "establishing a path to basic STEM literacy for everyone is vital to preparing a diverse workforce needed for the United States to lead and prosper in an increasingly competitive world driven by advanced technology."

Fortunately, in 2012, a big step toward that goal was taken with the publication of a landmark National Research Council report called *A Framework for K-12 Science Education*. It was based on a growing body of research on teaching and learning in science. The *Framework* argued that the best way to improve science education in the U.S. was for teachers to adopt a completely new way of teaching it: an approach that encourages students to think like scientists, and learn science by doing science, not just by memorizing lists of facts.

## At a time when STEM education is more important than ever before...

This new framework is one of the most fundamental reforms in science teaching in more than a century. It is codified in the Next Generation Science Standards (NGSS), a detailed set of expectations of what every student should know and be able to do by the time he or she graduates from high school. More than 40 states, covering 70% of the nation's students, have adopted standards based on the *Framework*.

But the implementation of the NGSS, the National Science Teachers Association has discovered, has run into a major obstacle. Most K-12 teachers lack direct personal experience with how science is actually practiced. And that means that their understanding of how scientists think and work is often incomplete or inaccurate.

They're not all that familiar with the ways that scientists confront a phenomenon and develop an investigation to explain it, so many teachers have found it hard to adapt to this new or new way of teaching.

*Science Bytes* is an ambitious educational initiative that promises to solve this problem by increasing public understanding of the way scientists think about the world. Spearheaded by the NSTA, *Science Bytes* will create a variety of materials that illuminate how some of the best scientists of our time make sense of the phenomena that spark their curiosity about what makes the world tick.

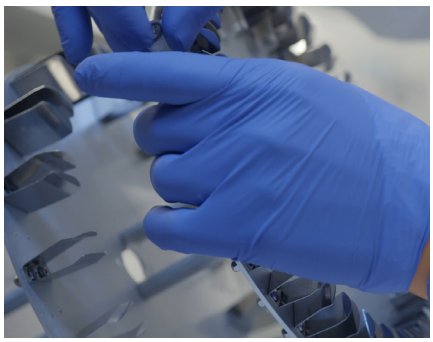
...**Science Bytes** will fill an urgent need.

NSTA's partners in this endeavor are Kikim Media, one of America's foremost producers of documentaries and short videos about science, technology, engineering and math; Dennis Liu, a nationally recognized expert in science education who directed the production of educational media at HHMI Biointeractive from 1997 to 2018; and Knight Williams, Inc., an independent firm specializing in the research, development, and evaluation of media-based STEM education programs.

## Project Elements

*Science Bytes* combines three main elements:

- a series of short videos produced by Kikim Media that feature diverse scientists doing their work in the field and in the lab;
- online guides created by NSTA that draw connections between these real-world examples and science instruction in the secondary classroom, which will be used with the videos in existing professional development workshops designed and conducted by NSTA to improve teachers' understanding of how scientists and engineers think and work;
- and a research evaluation effort by Knight Williams at the beginning, middle and end of the project that will guide its evolution. The research will evaluate the degree to which the materials not only improve teachers' understanding of how scientists and engineers work, but also how much they increase teachers' confidence and ability to implement the new standards.



During the pilot phase of the project, we plan to produce 10 videos and accompanying teachers guides. Targeted initially at middle school teachers, they will spotlight the phenomenon that sparked the curiosity of each of the award-winning scientists and explore the science and engineering practices he or she used to try to explain that phenomenon. We will test the effectiveness of these packages in a limited number of workshops and classrooms for middle school teachers and their students.

The project as a whole will furnish teachers with the critical support they need by providing them with a range of diverse exposures to the real-world workings of the scientific process, presented in a highly engaging and easily accessible form. It will also help teachers make connections between the ways they try to understand phenomena they encounter in their own lives, and the ways that scientists think about the world—critical insights for anyone teaching the NGSS.

Each package will illuminate one or more combinations of the eight science and engineering practices, and seven cross-cutting concepts, that form the foundation of the NGSS—content that every teacher is now expected to understand. The practices include Asking Questions and Defining Problems; Planning and Carrying out Investigations; Analyzing and Interpreting Data; Developing and Using Models; Constructing Explanations and Designing Solutions; Engaging in Argument from Evidence; Using Mathematics and Computational Thinking; and Obtaining, Evaluating and Communicating Information. The cross-cutting concepts are Patterns; Cause and Effect: Motion and Prediction; Scale, Proportion and Quantity; Systems and System Models; Energy and Matter: Flows, Cycles and Conservation; Structure and Function; and Stability and Change.

> "The success of the Nation demands a STEM-literate modern workforce and Americans adept at navigating an increasingly high-tech, digital, and connected world."[1]

Until now, no one has produced packages like these—built around stories that focus on phenomena and processes in ways that explicitly connect to the practices and concepts of the NGSS. And that's because there was little need for them in lecture-based classrooms where teachers focused on imparting a set of facts. But with the 2013 release of the NGSS and the shift to a fundamentally different way of teaching, there is now an urgent need for these very kinds of materials.

In addition to helping teachers understand the process of science, the videos will be suitable for showing to students, either in the classroom or as parts of homework assignments. As the collection of videos grows, teachers will be able to group multiple videos together in different ways for different emphases, depending on their specific lesson plans. And for the many teachers who are not themselves specialists in the subjects they may be teaching on any given day, the videos will provide valuable introductions to leading concepts and researchers in a

broad array of fields, and in that way help to build teachers' confidence.

The videos will also be distributed to a larger public audience through a variety of online partners, thereby contributing to improved public understanding of science. With more and more people turning to the web as a primary source of information, these videos will fill a critical need for compelling science stories that is not met by nightly news stories, which are inherently superficial, or one-hour documentaries, which demand a greater time commitment than many people are willing or able to make.

## A Brief History of the Project

*Science Bytes* builds on work that began with five videos Kikim Media produced as part of a pilot project funded by the Alfred P. Sloan Foundation to increase public understanding of science through short videos distributed on the web. These initial prototypes were based on peer-reviewed studies published by the Public Library of Science (PLoS).

Kikim subsequently produced three more short science videos for the Gordon and Betty Moore Foundation about scientists whose work the Foundation was funding. Rather than being based on peer-reviewed studies, these videos featured compelling stories of scientists working at the cutting edge of their fields. They tell the stories of Manu Prakash's work on a microscope that can be made from paper for $1; Beth Shapiro's discoveries about climate change and evolution through her work with ancient DNA; and Roman Stocker's research into the mysteries of the ocean.

The broader scope of these subsequent stories—and their focus on compelling individuals who are doing cutting edge work—suggested a promising editorial path for future *Science Bytes* stories. Valentine Kass, Kikim's program officer at the National Science Foundation on two previous broadcast projects, suggested that the pieces might have the most value—and the greatest impact—in the classroom. She suggested that Kikim contact the National Science Teachers Association to discuss the project. David Evans, NSTA's executive director, immediately embraced the idea because of his familiarity with the urgent need for new materials to help teachers implement the Next Generation Science Standards, and our current partnership was born.

## Phase 1 Work Plan

Months 1-2: Front-end evaluation to inform project design and development; review literature, show previous *Science Bytes* videos (which were not produced with teachers in mind) to teachers and seek feedback on how to tailor future videos to focus on NGSS practices; share results of front-end evaluation with advisors and seek comments.

Month 2: In consultation with advisors, identify candidate scientists for first set of videos. Identify specific practices to be demonstrated in each video and develop themes to be explored in the videos' scripts.

Months 3-4: Produce first 3 videos. Share rough cuts with advisors to seek input. Identify additional candidates. Develop guidance material for teachers for each video that identify the practices being illustrated. Begin to include the videos in NSTA's existing professional learning

workshops.

Months 5-6: Gather teacher feedback and conduct formative evaluation of fine cuts based on new videos. Share results with advisors. Continue identification of additional candidates in consultation with advisors. Pilot use of the videos will occur during sessions conducted at NSTA conferences. Conferences occur in September, October, November, April, and July, providing opportunities throughout the year.

Months 7-11: Produce additional 7 videos. Review rough cuts with advisors. Prepare additional teacher materials and incorporate videos into existing NGSS workshops. Launch online videos.

Months 11-18: Continue to use the videos in a variety of professional learning opportunities. Feedback from teachers and instructors will used to improve the use of the videos. With the full set available, subsets will be selected and tested to evaluate their best use. Comments will be solicited from teachers regarding student reactions and classroom use. Conduct summative evaluation.

# Key Personnel

**Dr. David L. Evans** is Executive Director of the National Science Teachers Association (2013-present). He previously served as the Director of the Noblis Center for Sustainability (2007-2012), where he established a consulting practice in Climate Change Adaptation. He was Under Secretary for Science at the Smithsonian, where he developed the institution's first strategic science plan; initiated and secured funding for the "Ocean Hall"; completed the Zoo's "Asia Trail"; and committed to the building of the Giant Magellan Telescope. He also supervised the Natural History and Air and Space Museums, the National Zoo, Astrophysical, Tropical, and Environmental Research as well as Smithsonian's Press and International Affairs operations. He was Assistant Administrator for Oceanic and Atmospheric Research and Deputy Assistant Administrator for Oceans and Fisheries at the National Oceanic and Atmospheric Administration (1993-2002), where he oversaw the modernization of charting and geodesy and led research in tropical storm forecasting and climate change.

**Jennifer Horak** is Assistant Executive Director, Program Integration, at NSTA. In her role overseeing professional learning and NGSS activities, Jennifer has been instrumental in developing a number of projects to support teacher professional development around the new science standards including the NGSS@NSTA Hub and PD program called *Discover the NGSS*.

**Ted Willard** is director of NGSS@NSTA for the National Science Teachers Association. In this role, he supports implementation of the Next Generation Science Standards (NGSS) and three-dimensional learning more broadly by creating resources such as web seminars, conference sessions, workshops, books, and journal articles. He is the editor of *NSTA's Quick-Reference Guide to the NGSS*. In addition, he oversees the content of the NGSS@NSTA Hub, a website that offers dynamic browsing and searching of the NGSS, tools to support curriculum planning, professional learning, and classroom resources focused on the standards.

**Dennis Liu** is a nationally recognized expert in science education who directed the production of educational media at HHMI Biointeractive from 1997 to 2018. His team produced a wide

array of educational products for the classroom and public audiences including lectures, short films, animations, virtual labs, and supplementary materials. Before joining HHMI, Liu conducted research in neuroscience and genetics, earning a PhD in biology from the University of Oregon and completing postdoctoral studies at the University of Washington, where he later assumed a faculty position in the Department of Genetics. Liu has taught courses in neurobiology, genetics, and comparative physiology, and has a passion for explaining science to all audiences. He has also been an advisor on numerous museum exhibits, and he writes a regular feature for the journal Life Sciences Education.

**Michael Schwarz** founded Kikim Media in 1996 after working for many years in public television as an independent producer and then as part of the senior management team at KQED, the PBS affiliate in San Francisco. Schwarz's work as a documentary producer and director has been honored with some of the most prestigious awards in broadcasting—three national Emmy Awards, two George Foster Peabody Awards, the Alfred I. duPont-Columbia University Journalism Award for Investigative Journalism, the Investigative Reporters and Editors Award, four awards for Excellence in Local Broadcasting from the Corporation for Public Broadcasting, the Grand Prize in the Robert F. Kennedy Journalism Awards for Coverage of the Disadvantaged, and numerous CINE Golden Eagles and local Emmys.

**Kiki Kapany**, Kikim Media's CEO, combines a background in media and law (J.D. '86). Her experienced legal sense, paired with a sound creative approach to production on a worldwide scale, adds a key dimension to Kikim's resources. She manages all legal affairs and day-to-day business for Kikim, including overseeing business development, strategic planning, finance and administration. Her expertise extends to the creation and management of production budgets, extensive image research, grant reporting, organizing project deliverables and managing all production and post-production logistics for a wide variety of projects.

**Dr. Valerie Knight-Williams** is Co-Director of Knight Williams, Inc., a California-based corporation which specializes in the research, development, and evaluation of nationally distributed media-based health and STEM education programs. Since 1990, she has directed evaluation and research projects for numerous NSF and NIH funded projects involving the use of media to facilitate STEM learning outcomes from both professional and public audiences, and in formal and informal educational settings. Several of the firm's recent NSF funded projects have focused on the use of narrative in visual media, including: *Latina SciGirls*, *Code SciGirls*, *Amazon Adventure*, *PlayPads*, *The Mystery of Matter*, and *EarthSky en Español*.

**Dr. Barbara Flagg** is Director of Multimedia Research, a national consulting group that she founded 25 years ago after teaching for a decade at Harvard's Graduate School of Education. She focuses on educational technologies for use both inside and outside the classroom. Her recent research and evaluation work deals with public television and radio series, giant-screen and planetarium films, apps and websites, and associated outreach materials

# Board of Advisors

Our advisors include leading scientists and educators who have played pivotal roles in the crafting of both *A Framework for K-12 Science Education* and the Next Generation Science Standards. They have also done pioneering work to increase the representation of women and

underrepresented minorities in science, technology, engineering, and math.

**Bruce Alberts**, Ph.D., is the Chancellor's Leadership Chair in Biochemistry and Biophysics for Science and Education at the University of California, San Francisco. He returned to UCSF after serving two six-year terms as the president of the National Academy of Sciences (NAS). During his tenure at the NAS, Alberts was instrumental in developing the Next Generation Science Standards. He served as Editor-in-Chief of *Science* from 2009-2013 and as one of the first three U.S. Science Envoys (2009-2011).

**Jeffrey Bluestone**, Ph.D., is the A.W. and Mary Margaret Clausen Distinguished Professor of Metabolism and Endocrinology at UC San Francisco and is the Director of the Hormone Research Institute in the Diabetes Center. He is also the President and Chief Executive Officer of the Parker Institute for Cancer Immunotherapy. His research over the past 25 years has focused on understanding the basic processes that control T cell activation and immune tolerance in autoimmunity and organ transplantation.

**George Blumenthal**, Chancellor, University of California, Santa Cruz, is a faculty member in astronomy and astrophysics. As a theoretical astrophysicist, Chancellor Blumenthal made pathbreaking contributions to our understanding of the origin of structure in the universe, including galaxies and clusters of galaxies, and to the role that dark matter plays in the formation and evolution of this structure. He is a co-author of two textbooks, *21st Century Astronomy* and *Understanding our Universe*.

**Dr. Milton Chen** is senior fellow and executive director, emeritus at The George Lucas Educational Foundation (GLEF), a non-profit in the San Francisco Bay Area producing the award-winning Edutopia.org website on innovative K-12 learning. He served as executive director of GLEF from 1998 to 2010. Dr. Chen was the founding director of the KQED Center for Education (PBS) in San Francisco; director of research at Sesame Workshop in New York, where he helped to develop *Sesame Street*, *The Electric Company*, and *3-2-1 Contact*; and assistant professor at the Harvard Graduate School of Education.

**Joseph Krajcik**, Ph.D., is Lappan-Phillips Professor of Science Education and director of the CREATE for STEM Institute. He has worked with science teachers to reform science teaching practices in ways that promote students' engagement and learning. He was principal investigator on an NSF project that aims to design, develop, and test the next generation of middle school curriculum materials to ensure that students understand science content and practices. He served as head of the Physical Science Design Team to develop the Next Generation Science Standards.

**Okhee Lee**, Ph.D., has research interests that include science education, language and culture, and teacher education. Her current research involves the scale-up of a model of a curricular and teacher professional development intervention to promote science learning and language development of English language learners. She was a member of the writing team that developed the Next Generation Science Standards (NGSS) and leader for the NGSS Diversity and Equity Team through Achieve Inc.

**Jose Rivas**, M.P.A., is Executive Director, College Preparation Programs at the Center for Educational Partnership. He manages a collection of federally, state, and privately funded college

access and preparation programs serving first-generation, college-bound youth. José has over twenty years of professional experience helping low-income, at-risk young people pursue their post-secondary educational goals.

**Helen Quinn**, Ph.D., is Professor Emerita at the Department of Energy's SLAC National Accelerator Laboratory and Stanford University. As Chair of the Board on Science Education of the National Academy of Sciences, Quinn led the efforts that produced *A Framework for K-12 Science Education*—the basis for the Next Generation Science Standards.

# Budget

We are seeking $1.4 million to support Phase 1 of the project, which will cover all video production costs, teachers' guides, and research and evaluation. We are not requesting funding for any new professional development workshops because we plan to incorporate the Science Bytes materials into existing NSTA workshops.

# References

1. Committee on STEM Education of the National Science and Technology Council. (2018) *Charting a Course for Success: America's Strategy for STEM Education*. Retrieved from White House website: https://www.whitehouse.gov/wp-content/uploads/2018/12/STEM-Education-Strategic-Plan-2018.pdf