Seizing Opportunity:
Developing Quality STEM Learning for Summer and Afterschool

What makes a high-quality summer or afterschool STEM experience – one that will not only spark a child's interest, but teach the skills required to permanently increase the ranks of Americans qualified to compete in STEM fields? Gil Noam, founder and director of the Program in Education, Afterschool & Resiliency (PEAR) and an associate professor at Harvard Medical School and McLean Hospital, offers research-based guidance on next steps for the field.

President Obama has called the critical need for improved education in the STEM fields (science, technology, engineering, and math) a "Sputnik moment" for our time. At the same time, there is an increased demand for high-quality summer and afterschool learning opportunities, fueled by growth in the number of working parents and a strong research base that recognizes the power of those programs to boost student achievement. Although 25 percent of children (an estimated 14.3 million) currently participate in summer learning programs, up to 56 percent of children who are not enrolled would be likely to take part, based on parent interest, a 2010 Afterschool Alliance report found.

Summer and afterschool programs offer the opportunity to create a blended approach of both academic learning and youth development activities to foster critical 21st Century skills, including collaboration, innovation, creativity, and communication. In particular, the unique summer weather and the length of the summer break from school would seem to make summer learning a prime venue for the advancement of STEM education. But what makes a high-quality summer or afterschool STEM experience – one that will not only spark a child's interest, but teach the skills required to permanently increase the ranks of Americans qualified to compete in STEM fields?

Gil Noam, a clinical, developmental, and educational psychologist and founder and director of the Program in Education, Afterschool & Resiliency (PEAR), conducted a three-year study on Informal Science Learning in After-school (ILSA). The study, funded by the National Science Foundation, sought to learn more about the characteristics of effective informal science learning in typical after-school and summer learning settings. He and his team continue to explore what infrastructure is required to support and sustain these characteristics at scale. They are also developing various assessment strategies for informal science and youth development.

We engaged Noam in a conversation about his research, the challenges facing the field, and the steps needed to increase the availability of quality STEM learning opportunities in summer and afterschool programs.

What encouraged you to focus your research on STEM learning in summer and afterschool programs? Why does STEM learning have such great potential for success during out of school time (OST)?

GN: As I delved into this research, I became deeply aware of the linkages that exist between youth development philosophy, which underlies a lot of summer and afterschool learning, and that of informal science education. When you think about it, there really is much in common with their beliefs, vision, and practices.

Mentoring, for example, focuses on a youth's assets: growing strengths in kids, promoting voice and choice in their learning and what they commit themselves to, and exploring their own identity. If you look at those principles and superimpose informal science ideas – choice learning, the questioning process, discovery and hands-on learning, a project-based mentality, and seeing the learner as an active, science-pursuing identity– it struck me that it's really a 'marriage made in heaven,' if you believe in such things.

Informal science needs to find delivery places to get science in an engaged way to millions of kids. Traditionally, science learning occurs in school, but, while important, it is often, by definition, more formal. In addition, cultural institutions and museums have provided great settings. These organizations have made a tremendous contribution to reach young people and help them discover STEM learning. But that's not enough. Opening of the doors to many youth in many localities across the country to explore science and get interested in science careers needs to be a very high priority.

Afterschool/summer learning programs and informal science education have a natural place to meet. Summer, in particular, provides the opportunity for sustained engagement that combines the outdoors and adventure to create a powerful intensity [that] can also feed into the school year. Given the demand for a greater focus on academic learning, summer and after school programs provide an important space to integrate STEM education, incorporate strategies of cultural institutions and museums, and, ultimately, engage youth in fun and meaningful ways.

Tell us a little bit about your research.

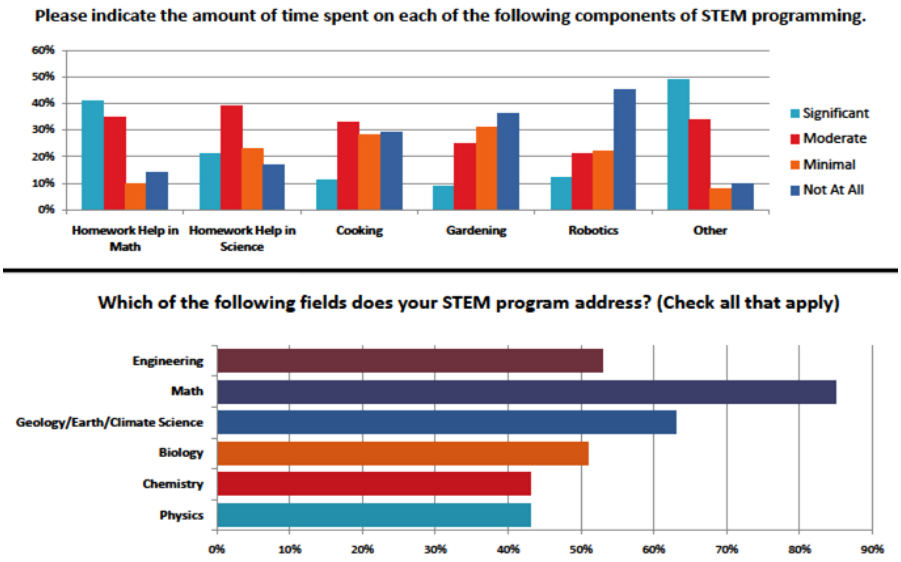
GN: We surveyed a diverse group of over 1,000 "typical" summer and afterschool programs from across the country, with 86 percent of programs reporting having a summer program component. The participating programs engaged in a variety of activities, with frequency of STEM activities ranking 6th out of 7. Our research looked at what generic programs that incorporate STEM learning across the country look like, what types of partnerships, professional development, and evaluation they have in place, and how equipped they are to do this informal science work.

What did you learn?

GN: The call for summer and afterschool programs to provide significant learning opportunities for the 21st century including STEM is relatively young. To show, with rigorous design, that kids are doing significantly better on academic lines is still hard. Intuitively it makes sense. But it's hard, because kids who aren't in programs might not just be sitting at home, and those that do attend might, for example, have more motivated parents, among other things. For those programs who offer some science, we found that:

- *Program staff often did not have sufficient professional development, and were called upon to do something the programs couldn't support***.** Informal science learning can require some of the most difficult pedagogy and teaching. Even well-trained teachers can have a tough time with methods of choice, questioning, project-based learning, and finding ways to support their discovery. Most programs had to train their staff without much regional support.
- *The majority of programs were developing their own curricula.* Since published curricula can be expensive, many were self-created. While there can be great self-developed curricula, it is not certain that many of the surveyed programs were promoting engaging and meaningful opportunities for informal science.
- *Only about a third of the programs (38.3%), often programs working with older youth, were engaged with outside partners to implement a science component.* Those programs that created their own curriculum were less likely to partner with outside groups.

Survey on Science, Technology, Engineering and Math (STEM) in Afterschool
Afterschool Alliance and National AfterSchool Association, 2011*



*About 1,000 afterschool program directors and staff from nearly every state in the country responded to a survey about the state of STEM in afterschool.

Your research also helped to shape a deeper understanding of what quality looks like in STEM OST programs. How do you define quality STEM OST learning?

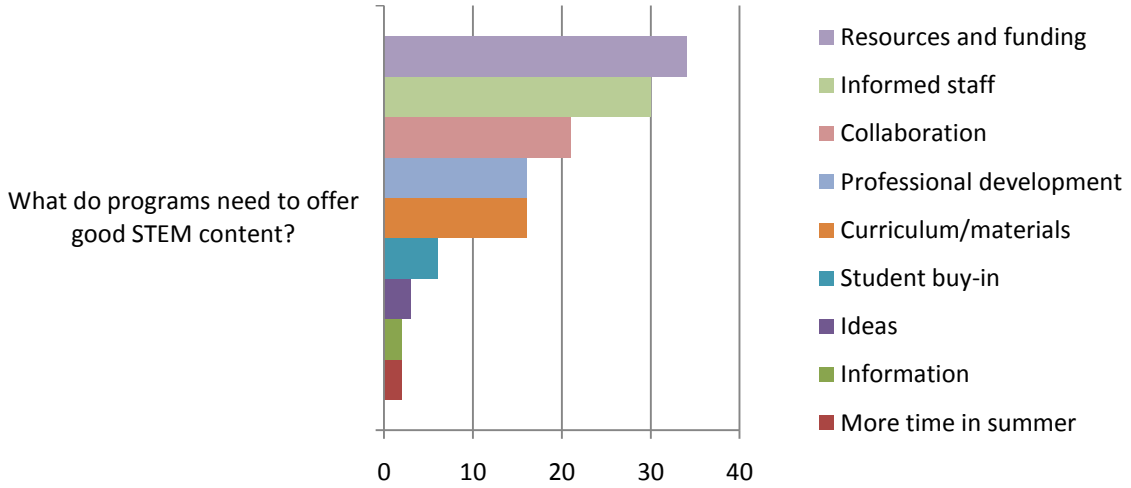
GN: Based on research, we developed assessment tools for STEM learning that align with our work in general quality programming. Our Dimensions of Success tool is currently being revised with the Educational Testing Service. The tool allows people to observe a program on any STEM topic using 12 rubrics that focus on management, materials, preparation, relationships, engagement, relevance, etc. and supplement them with rich descriptions of what observers see.

The tool looks for the following essential ingredients of quality STEM summer and afterschool programs:

- Engagement – How involved are youth? Do they get excited and have fun with the activities? Is the material age and developmentally appropriate?
- Hands-on Exploration – Does the curriculum encourage exploration and engage kids' curiosity?
- Relevance – Does the science process relate to the real life of kids? Does it ask a question or require experimentation that is relevant to the participants?
- Content Knowledge – Is there new knowledge being conveyed?
- Reasoning Abilities – Do participants gain ways to understand, question, and apply knowledge using the scientific method?
- Relationships – Are productive and positive relationships fostered between peers and with adults around science learning?

What started as a research and evaluation tool has turned into a training approach – allowing programs to observe each other, at first with our coaching, and promote positive, professional, collegial support to update their strategies. Quality observations by staff and trainers provide a continuous feedback loop that supports quality improvement.

The National Summer Learning Association asked participants at its 2010 *Summer Changes Everything*™ conference to answer questions about what elements would help them improve their STEM programs. Each table of 10 filled out a questionnaire together. Here are the results:



What was different about the summer setting related to quality and evaluation?

GN: Summer programs dedicated to science, at least part of the time, tend to be better prepared. And that makes sense. If you know you have a large number of children and adolescents that need to be engaged for a number of weeks for a sustained period of time, you tend to focus on the task of making it an important part of the day. I've been impressed how programs with the funding, means, and leadership to explore science have effectively used the outdoors to promote intense and meaningful STEM learning. Summer can also be an easier time to access science-oriented staff such as college and graduate students. But I have been equally impressed with what many afterschool programs can do to get students excited in science questions and content.

Where does the field need to move to bring STEM learning fully into the summer and afterschool realm?

GN: It takes time and support to develop staff ability to question, and understand when to guide and when to be quiet and let youth explore. We need trained and coached staff. It takes time to build and sustain interest, funding, and evaluation in a way that effectively integrates informal science education and youth development approaches. We have an incredible opportunity to bring these two fields together.

What are three things that can be done to immediately help strengthen STEM learning in summer and afterschool programs?

- *Access existing curricula and training.* Quality curricula, particularly those providing sequential activities over a period of days and weeks, are available at a range of price levels. There's no need for each program to develop their own. (See the Resources box for ideas.) Staff also needs to become familiar and engaged with the content through hands-on professional development and learning of informal science pedagogy. A starting point for this might focus on inquiry-based learning – helping youth to ask questions that get them thinking like a scientist.

- *Seek out partners.* Identify local or distance learning partners with mutual interests. Partners can range from other local program providers and cultural institutions to universities and corporations.

- *Collect data*. We need to collectively generate data to convince policymakers and funders that informal science in OST is serious and creates real outcomes. But we also need simple tools that provide continuous feedback to programs as to whether they are reaching the outcomes they have set for themselves.

What are the next steps for increasing access to quality STEM out-of-school time learning programs over the longer term?

- *Develop and engage intermediaries*. It is important to acknowledge that program quality is extremely varied between different programs. There is a great deal to build from, but there are also a large (and growing) number of programs in this country. We can't "conquer" it program by program, and therefore need to work with existing and new intermediaries at the local and state level to build infrastructure. Intermediaries have the capacity to bring program staff together with experts in informal science education to create a structure that provides ongoing quality improvement and training opportunities for their networks.

- *Strengthen Connections*. STEM programming in summer and afterschool can weave together potential partnerships from a range of sources including school districts, community-based providers, universities, museums, science centers, cultural institutions, and corporations in an effort to help kids see science in action. Moreover, these partnerships need to come together with publishers to create engaging curricula that are manageable to those without a lot of teaching and/or STEM background. And partnerships can also tap into broader connections through technology and media such as the work at PBS or via online platforms designed to connect youth and scientists through distance learning.

STEM learning is a natural fit for summer and afterschool programming, simultaneously providing academic relevance and engagement. The field is moving, shifting, developing – we're at a good place.

- *Share evaluation resources and incorporate across programs*. Evaluation should be something that is simple and second nature for programs – not just as a requirement by funders. Moreover, programs shouldn't have to do this from scratch. It should be easy to download assessment tools and get support when implementing a new curriculum – without lots of time and money. These assessments should enable programs to collect basic data and be used across programs to determine if the STEM activities are making a difference on indicators such as engagement, content and skill development, and career interest.

  PEAR has created the ATIS website, a searchable database to find tools that link to the NSF evaluation dimensions. Also, with Noyce Foundation funding, a short self-report assessment tool for science engagement was created to learn about program outcomes. Other efforts are underway to develop more high-quality tools to help with program improvement and outcomes measurement.

- *Continue to build momentum to encourage policymaker investment.* We are now in the middle of an exciting time of innovation, new programs, and entrepreneurial efforts by nonprofits, publishers, and others to come out with interesting STEM activities and curriculum for summer and afterschool programs. Using the previously mentioned elements as a foundation, program providers, intermediaries, and youth need to work together to showcase their results and, ultimately, make the case for policymakers to invest in this area.

STEM BEYOND SCHOOL: East End Community House

The East End House Middle School Program in Cambridge, Mass., provides over 70 middle school youth per year with comprehensive afterschool offerings through full-day programming during school vacations and a seven week summer program. The program is free of charge to youth and their families and is operated in collaboration with the Kennedy Longfellow School. STEM activities offered by the program include:

- In the summers of 2010 and 2011, the program received one of five NASA Summer of Innovation awards, allowing 15 youth to work with MIT staff to learn the computer programming necessary to control robots that operate mini-satellites in space. Youth send their programming to the International Space Station, where they race their robots against four other programs. The program also has a partnership with the Biogen Idec Community Lab. This relationship provides a unique opportunity for middle school youth to be introduced to genetics and biotechnology.
- Daily afterschool STEM activities correspond with the Massachusetts Curriculum Framework and national science standards and parallel the Kennedy Longfellow School's annual focus on Life Sciences, Physical Sciences, and Earth and Space Sciences. In one life science activity, youth built a life-size "Operation" game board, with working circuitry, to learn how various diseases affect different parts of the body.

"Cambridge is a great city for doing science with youth," said Caitlin McCormick, Middle School Program Director at East End House. "There's a rich science culture, but lots of kids who are excluded from that."

Through extensive use of pertinent field trips and strong community partnerships, the program helps to get youth excited about science, bringing the at-risk youth in the program in contact with the rich science culture in the region. Field trips have included visiting green buildings to learn about green architecture, going to nature reservations to conduct ecosystem exploration, and visiting the MIT wind tunnel to learn about aeronautic testing.

Middle school program staff members are all college graduates, although most do not have science-related degrees. Staff training is based on Harvard's PEAR Dimensions of Success (DOS) quality standards. The inquiry-based science approach allows staff to learn along with the youth – encouraging youth to become experts.

From the program's inception in 2008, East End House has intentionally incorporated basic evaluation elements into its design that allow for process and outcomes assessment using the DOS tool, the Assessment of Afterschool Program Practices Tool (APT), and the Child Attitudes Regarding Science survey. While this will be the first full year when fall, spring and summer assessments will be administered, survey results have already shown exciting growth in participants' interest in science careers.

STEM RESOURCES

The National Summer Learning Association pledged along with the Afterschool Alliance and the National AfterSchool Association to make 2011 the *Year of Science in Afterschool.* This collaborative effort is generously supported by the Noyce Foundation.

Links below will connect your organization to resources that will assist in providing and improving its STEM content:

Activities and Curriculum

- Academic Enrichment in Afterschool Training Toolkit
  http://www.sedl.org/afterschool/toolkits/about_toolkits.html?tab=science
- Conrad Foundation - Spirit of Innovation Award
  http://www.conradawards.org/about
- PBS Parents Exploring Science with Children
  http://www.pbs.org/parents/exploringscience/
- FETCH! PBS Kids Go!
  http://www.pbs.org/parents/fetch/program/index.html
- NASA Summer of Innovation
  http://www.nasa.gov/offices/education/programs/national/summer/education_resources/index.html
- PBS Teacher Featured Classroom Resources
  http://www.pbs.org/teachers/
- PEAR (Programs in Education, Afterschool, and Resiliency)
  http://www.pearweb.org/research/ilsa.html
- Science Afterschool Consumers Guide
  http://www.sedl.org/afterschool/guide/science/
- SMILE (Science and Math Informal Learning Educators pathway of the National Science Digital Library)
  http://howtosmile.org/

National Association Resources

- Afterschool Alliance
  http://www.afterschoolalliance.org/STEM.cfm
- National AfterSchool Association
  http://www.naaweb.org/default.asp?contentID=643
- National Summer Learning Association
  http://www.summerlearning.org/stemresources
- National Girls Collaborative Project
  http://www.ngcproject.org/index.cfm
- NSTA (Informal Science Education Portal of the National Science Teachers Association)
  http://www.nsta.org/portals/informal.aspx
- The Coalition for Science After School
  http://www.afterschoolscience.org/resources/

Publications

- American Scientist, The 95 percent solution
  http://www.americanscientist.org/my_amsci/restricted.aspx?act=pdf&id=40415612093681
- Education Week, A special report on informal science education
  http://www.edweek.org/ew/collections/sciencereport-2011/index.html
- Findings for Year One Data for the Informal Science Learning in Afterschool Study
  http://summerlearning.site-ym.com/resource/resmgr/Publications/findings_from_ILSA_yr_1_data.pdf
- Science, Planning early for careers in science
  http://www.sciencemag.org/content/312/5777/1143.summary

Research and Evaluation

- ATIS (Assessment Tools in Informal Science), a downloadable and searchable assessment database for informal science
  http://www.pearweb.org/atis

Additional *Year of Science* Reports

- Afterschool: A Vital Partner in STEM Education
  http://www.afterschoolalliance.org/Afterschool_as_STEMpartner.pdf
- Afterschool and summer programs: Committed partners in STEM education
  http://www.summerlearning.org/resource/resmgr/policy/stem_jointpositionpaper.pdf
- STEM learning beyond the school day: Initial survey results help determine where we need to go
  http://www.naaweb.org/downloads/STEM%20Survey%20Article.Feb.2011.pdf