Evaluating the Impact of Supplementary Science, Technology, Engineering and Mathematics Educational Programs

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A Report By

The Connecticut Academy of Science and Engineering

For

The Connecticut General Assembly
Education Committee

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This study was initiated at the request of the Education Committee of the Connecticut General Assembly on May 19, 2006. The project was conducted by an Academy Study Committee with the support of Richard C. Cole, Project Study Manager and Terry Clark, Project Assistant of the Connecticut Academy for Education in Mathematics, Science & Technology, Inc. The content of this report lies within the province of the Academy's Human Resources Technical Board. The report has been reviewed by Academy Members Andrew G. De Rocco, PhD, and Alan C. Eckbreth, PhD, Academy President. Martha Sherman, the Academy's managing editor, edited the report. The report is hereby released with the approval of the Academy Council.

Richard H. Strauss
Executive Director

MEMBERS OF THE CONNECTICUT ACADEMY OF SCIENCE AND ENGINEERING STUDY COMMITTEE ON EVALUATING THE IMPACT OF SUPPLEMENTARY SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS EDUCATIONAL PROGRAMS

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Chairman
Principal Scientist
Applied Physical Sciences Corporation

Stephen Coan, PhD
Chief Operating Officer, Mystic Aquarium/
Institute for Exploration
President, Immersion Presents

David G. Haase, PhD
Director, The Science House
Professor of Physics
North Carolina State University

James C. Hogan, Jr., PhD (*Academy Member*)
Section Chief, Biomonitoring
Connecticut Department of Public Health

Michael Meotti
President
United Way of Connecticut

Kathleen O'Keefe, PhD
Education Program Manager
The Medtronic Foundation

Richard D. Pinder, PhD (*Academy Member*)
Director, Controlled Substances/
Toxicology Laboratory
Connecticut Department of Public Safety (ret.)

Brenda Shumate Wojnowski, PhD
President, Inventive Education, Inc.
National Inventors Hall of Fame

RESEARCH TEAM

STUDY MANAGER
Richard C. Cole
President & Chief Executive Officer
Connecticut Academy for Education in Mathematics, Science & Technology, Inc.

PROJECT ASSISTANT
Terri Clark
Vice President & Chief Operating Officer
Connecticut Academy for Education in Mathematics, Science & Technology, Inc.

EXECUTIVE SUMMARY

STUDY OBJECTIVES

The Education Committee of the Connecticut General Assembly asked the Connecticut Academy of Science and Engineering (CASE) to conduct a study to identify the best practice characteristics of supplementary science, technology, engineering, and mathematics (STEM) programs outside the formal education environment, or Out-of-School Time (OST). The Education Committee also noted an interest in learning about existing cost-benefit analysis procedures and teacher training activities for OST STEM-related programs. OST programs and activities represent a critical set of supplemental learning assistance — non-school support for children and families that can enhance and promote learning and development by complementing school-day efforts.

At the initial Study Committee meeting on June 26, 2006, the Committee agreed that to achieve the goals of this study it would develop a framework from which the General Assembly can reliably measure the effectiveness of programs seeking funding, rather than to develop a program and cost-benefit analysis for any specific program. The Committee decided to look at "indicators" in a broad, generalized sense and then consolidate them into what is feasible with a "Connecticut Context."

The study's "Findings and Suggestions" are based on a review of the relevant evaluation and continuous improvement literature, and interviews with Michelle Doucette Cunningham, Project Administrator, Connecticut After School Network; Elizabeth Brown, Legislative Director, Connecticut Commission on Children; Dr. Agnes Quinones, Unit Coordinator, Child/Family/School Partnerships, Connecticut State Department of Education; Dr. Kathleen O'Keefe, Education Program Manager, The Medtronic Foundation; Dr. Brenda Shumate Wojnowski, President, Inventive Education, Inc., National Inventors Hall of Fame®; Dr. David G. Haase, Director, The Science House and Professor of Physics at North Carolina State University; and other key professionals involved in the design and use of evaluation and continuous improvement strategies in after-school programs.

While there is an emerging body of research about what does and does not work in OST STEM-related programs, there are several important caveats. Most studies and publications in these areas are not empirical; they simply summarize recommendations provided by expert panels and individuals, termed "proxy research" by Elizabeth Brown. Research conducted at colleges and universities, as noted by Dr. Haase, has revealed that it is very difficult to establish specific cost-benefit comparisons for OST STEM-related programs that have a great degree of reliability and predictability. The results from two cost-benefit analysis studies included in this study reinforce Dr. Haase's observation. Finally, while there are national standards for training OST leaders and personnel generally, expert training in STEM-related programs is for the most part nonexistent. Specific organizations, such as Inventive Education, Institute for Exploration, and others do provide personnel training for those OST organizations that "purchase" their self-contained curricula or program offerings, but not for generalized, OST STEM educational programs.

SUMMARY OF FINDINGS AND SUGGESTIONS

The following Findings and Suggestions are divided into those that relate to specific conclusions drawn from identified best practices and those that extrapolate research findings into a "Connecticut Context." While some findings are generic to OST programs, all are pertinent to STEM programs.

Findings drawn from best practices research

1. OST STEM programs should makes efforts to coordinate activities and strengths with other after-school environments involving young people, and should not necessarily strive to be "all things to all students."

2. OST programs are not merely extensions of the school day and successful programs do not replicate the school day.

3. OST program gains are greatest and are sustained longest when they are aligned with the school-day curriculum and reinforced with additional help during the regular school instructional program.

4. The time when programs are scheduled—before or after school or during the noon hour—does not appear to have a significant influence relative to the success of a program. However, students who participate in OST programs the most consistently and for the longest period of time experience the greatest gains in math as assessed by standardized achievement tests.

5. At-risk students are helped greatly when they receive intervention with complex mathematics and science concepts and with school- and family-based motivational issues.

6. Programs were more effective at some grade levels than at others. The largest effect in mathematics was at the high school level, followed by middle school programs.

7. OST mathematics, science, and technology programs lend themselves to problem solving because fun, hands-on activities that students already enjoy can easily be incorporated into a less rigid, learning environment. In particular, programs that combine mathematics instruction and social activities show the greatest gains. In addition, the underlying academic content must be paired with effective instructional strategies and delivered by instructors who have a deep understanding of the subject matter.

8. Coordination between OST and formal education is complicated, requiring adequate resources, extensive collaboration between school systems and community organizations, and continuing communication at the highest levels of school and community leadership.

9. Teens are more attracted, in general, to program approaches that infuse technology into all program activities, rather than having a "technology component" in the program which focuses primarily on teaching technology skills.

10. There is no incontrovertible research available about generalized best practices for training of staff for STEM-related OST programs, other than use of highly qualified classroom teachers.

Suggestions from successful programs that should be considered for incorporation into a "Connecticut Context"

1. Policymakers should evaluate the worthiness and characteristics of OST practices based on the context and expectations of existing legislation.
2. The General Assembly needs to be cognizant that at least 15 state agencies have some level of responsibility for Connecticut-based OST programs.
3. Policymakers need to consider establishing a set of clear and measurable expectations, including common data and reporting systems, definitions, eligibility criteria, and accountability. In this regard, the General Assembly should consider the degree to which small- to medium-sized OST program evaluation is cost-effective and realistic.
4. Available evidence (RAND Corporation) suggests that improving quality of offerings in existing OST programs should take precedence over rapid growth in supply.
5. OST STEM-related program support should be connected to and aligned with the **CONN***vene* Initiative, which is a statewide Pre-Kindergarten through baccalaureate degree (PreK-16) initiative to improve student interest and achievement in STEM to better meet Connecticut's 21st century economic development, quality of life, and workforce preparation needs.
6. The state should support additional research to determine the effectiveness of using results-based accountability to achieve state goals and objectives for OST programs receiving state funding.

The Study Committee has developed a Connecticut STEM-Related, Out-of-School Performance Indicators and Performance Measures Matrix to guide Connecticut legislators in making OST STEM-related investment decisions. The matrix tool correlates Connecticut Public Act "performance indicators" with the research-based findings from this study and potential OST STEM "performance measures" (Appendix A).

Note: The OST organization "performance measures" listed in the matrix are derived from Venture Philanthropy Partners work and the McKinsey Capacity Assessment Grid tool designed to help nonprofit entities assess their organization capacity.[1]

CONCLUDING REMARKS

It is suggested that the Education Committee of the Connecticut General Assembly has an opportunity to establish meaningful and realistic standards from which to measure the effectiveness of OST STEM-related programs. The execution of program development, support, and measurement should be undertaken in a "Connecticut Context" that includes the following:

1. knowledge of the best practice characteristics of STEM programs outside the formal education environment as identified in this study
2. use of the Results-Based Accountability framework model currently being piloted by the General Assembly's Work Group to establish population goals, relate program

performance to those population goals, and to use both to inform the budget process for after-school programs

3. consideration of supplementary OST programs as a component of a more comprehensive pre-kindergarten through undergraduate (PreK-20) school improvement initiative to build interest in and understanding of STEM disciplines

The Study Committee strongly supports the implementation of a cogent, multi-year plan that integrates all of the previously identified initiatives with Connecticut's comprehensive STEM PreK-20 improvement proposal, **CONN*vene***. If the "world is flat," as suggested by Thomas Friedman, then Connecticut must be concerned about its place on this new "learning landscape." To meet Connecticut's 21st century economic development and workforce needs, the state must have a talent pool that is world class, with increasingly higher skills and better training in science, technology, engineering, and mathematics. Rather than instituting many various tactics, Connecticut will be better served by a comprehensive strategy to achieve its early childhood/preschool, after-school, and PreK-20 goals.