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# *Internet Community of Design Engineers (iCODE) Executive Summary*

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## EXECUTIVE SUMMARY

Internet Community of Design Engineers (iCODE) program, which took an innovative approach to structuring self-directed learning – using a collaborative on-line environment to facilitate hands-on activities, was a three year program led by the University of Massachusetts Lowell and Machine Science Inc., Cambridge. The overall objective of this program, which involved after-school and summer sessions and was funded by NSF’s Innovative Technology Experiences for Students and Teachers (ITEST) Program, was to increase the likelihood that participating middle school and high school students will pursue Information Technology (IT) and Science-Technology-Engineering-Math (STEM) careers, by engaging them in intensive, hands-on IT learning experiences.

Goodman Research Group, Inc. (GRG), a research firm in Cambridge, MA that specializes in the evaluation of educational programs and materials, conducted the external process and summative evaluation of the iCODE project. GRG’s evaluation involved collecting data over the three years of the program. During each year of the program, GRG collected data from various sources to examine iCODE implementation and to relate program processes to outcomes. These data collection procedures included pre and post surveys, focus groups, and content quizzes for students, interviews and surveys of educators, and site observations conducted by GRG researchers.

## KEY FINDINGS

**Overall, the iCODE program successfully met the ITEST project goals.**

iCODE program successfully met all the requirements of ITEST project goals (based on ITEST Program Solicitation NSF 07-514) mentioned below.

- Programs should aim at middle- and high-school students, particularly those from disadvantaged urban and rural communities.
- Programs should provide year-round IT enrichment experiences and opportunities through curriculum models for use in after school, weekend, and/or summer settings.
- Programs should include hands-on, inquiry-based activities.

**Students showed substantial gains in engineering process and workforce skills.**

- The specific projects created both during the school year and at the summer camps greatly increased student understanding of computer programming and electronic devices.
- The program offered students ample opportunities to exercise and practice their teamwork, problem solving, and creativity skills.

### **Students learned about STEM-related careers**

- Student ratings indicated that the second year of iCODE was successful at increasing the students' knowledge about careers in science, engineering, and technology. During the third year, the students perceived a significant increase in their knowledge about preparations required for a career in Information Technology.

### **Students entered iCODE with positive attitudes toward STEM subjects and these attitudes were maintained through the program.**

- The students did not show increase in their ratings about their attitudes toward STEM subjects on the pre-post surveys during the three years. Students started the program with positive attitudes towards STEM and these attitudes were maintained every year.

### **Overall, the iCODE project had high appeal among the students and educators.**

- The iCODE students greatly enjoyed the unique hands-on experiences while working on their computer-based projects.
- The educators enjoyed learning engineering concepts themselves and watching students get excited throughout the program as they completed their projects.

### **Hands on activities, outside the classroom events, and teamwork components of the program held high appeal.**

- Throughout the three years, students enjoyed working directly with the technology.
- The online guides, hands-on projects, the collaboration among students, as well as with the mentor, were the most successful aspects of the program.
- The summer camps, because of their intensive nature, were highly successful at achieving the program's student learning goals.
- The events occurring outside of iCODE sessions, such as Robot Sumo competition, also received a high appeal.

### **The mentors played significant roles in the iCODE program**

- A component of the program that was considered highly successful by both the students and the educators was the role of the undergraduate mentor. During the third year, two schools had veteran iCODE students function as mentors for the newer students.

- The undergraduate mentors played various roles from teaching the actual iCODE content to the students to troubleshooting with hands-on projects. They were capable of challenging students depending on their capabilities and providing programming expertise to the educators.

**Implementation of the program occurred, for most part, according to the proposed plan.**

- Starting with 5 sites in Year 1, the iCODE after-school program involved up to 14 sites through the three years, wherein it served closed to 300 students. Successful one and two-week summer-camps ran in two locations each summer.
- The program had a high retention rate from after school program to summer program every year.
- The program retained some students and most of its educators across multiple years.
- Each year, the program was highly successful at attracting students from diverse racial backgrounds.
- Training sessions, which allowed the educators to practice the hands-on aspects of the program themselves, were held every year.

**The most successful year of the program in terms of student gains was year 2.**

The second year was the most successful year in the program for various reasons:

- During the second year, the students showed most gains in their knowledge about STEM careers.
- Also, only during the second year, the program appeared to have contributed to an increase in positive attitudes of the female students toward STEM and IT subjects and careers.
- Finally, student performance on the programming quizzes was better during the second year than the third year.

## RECOMMENDATIONS

Throughout the iCODE program, GRG's annual evaluation reports offered specific recommendations for improving program process and outcomes for the following years. Given that the program is drawing to a close, we offer the following broad lessons learned in consideration of any future iterations or replications of the program.

- Continue to incorporate the successful role of a mentor into future programs. Increase the accessibility of the mentors by making their services available through student or educator online modules.
- Make newer learning challenges available to returning students in the program to sustain their interest and motivation in the program.
- Increase measures to encourage females into the program through strategies such as making the projects female-friendly and using female mentors/role models in promoting the program.
- Take the educator training beyond what the students will learn so that the educators will be better equipped to answer student questions and address any programming difficulties.
- To provide new educators scaffolding throughout the program year, include resources such as an online educational module or a Facebook page where educators can discuss issues and implementation strategies.
- Extend the community building aspect of the program to include more outside-the-school-walls experiences for the students, such as guest lectures and field trips.
- Encourage parent involvement in the program through take-home activities that require parental feedback, like technology questionnaires and interactive games.
- Work with the school authorities and/or the educators to help avoid technical difficulties such as issues with the Internet, network, or computers. An expert could be assigned at the beginning of the program with the task of setting up the computer and internet systems at the program sites.

In summary, the iCODE program can serve as a model for other ITEST initiatives that feature programmatic efforts to make hands-on, inquiry-based engineering and programming experiences available to underrepresented groups in the middle and high schools.

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