Effective Delivery of Computing Curriculum in Middle School – Challenges and Solutions

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1. SUMMARY
The ACM K-12 Task Force Curriculum Committee recognized that the lack of integration of computer science into the K-12 curriculum played an important role in the serious shortage of information technologist at all levels [2]. Much effort from the computing community has been devoted to improve the content and delivery of AP Computer Science. However, AP Computer Science is an elective at the high school level, isolating computer science from the standard curriculum. Jane Margolis argued that this has led to minority students “stuck in the shallow end”, missing the opportunities to engage in a computer science experience prior to college [3]. After-school and summer camp activities designed for underrepresented groups are wonderful venues for students to participate in fun and exciting computer science activities. However, only a limited number of students may be reached by extracurricular programs. This panel brings together principle investigators of three National Science Foundation projects to share their experience of working with middle school language arts, mathematics, science, and social studies teachers. The panelists’ presentations will be followed by open discussion on the challenges and solutions for effective delivery of computing curriculum in middle schools.

2. URSULA WOLZ
Ursula Wolz is the lead PI (with Monisha Pulimood and Kim Pearson) on the NSF funded project “Broadening Participation in Computing via Community Journalism.”[8] (CNS 0739173) The goal is to entice middle school teachers to integrate computational thinking into their classroom instruction via an afterschool program. Pearson is a journalism professor. Pulimood is a computer scientist, who, with Wolz studies problem solving in community [4]. Wolz has written extensively on the teaching of introductory computer science.

Wolz will report on a demonstration program with Fisher Middle School, Ewing, NJ. In the summer of 2008, four teachers (three language arts, one technology) and a guidance counselor spent a week learning interactive journalism, including procedural animation in Scratch [7]). In the following week these teachers led 16 Fisher rising 8th graders in researching, interviewing for and creating news stories for an online magazine. The stories were told via text, graphics, video and procedural animation. During academic year 08-09 the teachers took control of the afterschool magazine. Two of the teachers also integrated procedural animation into their language arts curriculum supplementing expository writing and poetry with Scratch projects.

In summer 2009, three of the language arts teachers returned as did the guidance counselor. They recruited an additional language arts teacher and a math teacher. Twentyeight rising 7th and 8th graders participated in the second run of our program in July and will continue in the second year of the afterschool program. All of the teachers are supporting further research on procedural animation in their curriculum via continued NSF funding.

Our project goal is to infuse computer science into existing curriculum by empowering teachers to adapt our principles and techniques in highly personal ways. Results of our formal study show that both the students and teachers understand the value of computational thinking skills, that they are confident they can master those skills, and that they develop rudimentary computational thinking skills. The primary impediment is access to technology. Our program suffers from the same roadblocks as those described by Margolis. Despite a solid technology framework in the school, teacher expertise is woefully inadequate. The IT staff mistrusts the teachers, who in turn are deeply frustrated at their inability to get both the computing and human resources necessary to adequately support computing in their classrooms.

3. SUSAN RODGER
Susan Rodger is leading the Adventures in Alice Programming project in Durham, NC. Eight universities in six regions of the country are integrating Alice into K-12, funded by an NSF ITEST grant ESI-0624642 and IBM. The NC site specifically focuses on integrating Alice [1] into a diverse set of subjects in Middle School and High school. In summer 2008 Rodger trained thirty-five teachers in Alice in an extensive three week session and ran two one-week summer camps on Alice for middle school kids [6]. In summer 2009 she trained 100 teachers in one-week workshops and met with many of the teachers from the previous year for a 3-day follow-up workshop. Teachers attending these workshops
have included many disciplines: language arts, foreign language, science, math, social studies, business, music, art and media.

Rodger's approach is to teach both computer science concepts such as objects, functions and parameters along with basic Alice animation constructs such as how to glue two objects together, or how to move the camera to follow a moving object. We developed over 40 short tutorials. Some of them are starter tutorials that in 1-4 parts give students enough starting information to create a simple Alice world. The rest of the tutorials are specific about a computer science concept such as Lists, topic specific such as creating a 3D Helium Molecule which includes using lists, or Alice specific such as changing scenes by fading to black and fading back in. Younger students are likely to stick with the starter tutorials, whereas older students could be challenged more with the advanced tutorials. All of our tutorials are available for free on our website [5].

We see the majority use of Alice for K-12 in a course as a project (in place of a poster, model, or report). In language arts a student might create an Alice world for a book report or about a story they wrote. In science, a student might create an ecosystem. In a foreign language such as Spanish, the student might create a story that shows words of objects in the story in Spanish. Teachers from our workshop planned to use Alice in many ways. Some teachers built Alice worlds to show for a lecture (how a hot spot volcano is formed, school safety). Other teachers created an interactive Alice world for students to view and interact with such as a math world on area and perimeters of different shapes. Still other teachers have students build an Alice world either from scratch or using a template world to help them get started.

4. YOUWEN OUYANG

The CyberTEAM and iQUEST projects partner computer science and education experts to deliver learning modules that are rich in both computing and science curriculum to local middle schools. The computing curriculum focused by the projects includes Level I (Foundations of Computer Science) and Level II (Computer Science in the Modern World) of the ACM K-12 Model Curriculum [2]. The design of both projects is based on these guiding principles:

1. Technology intensive science investigations provide great opportunities for deeper understanding of computing and science concepts.
2. Students’ best chance to experience technology-enhanced learning comes from technology-savvy teachers.
3. Technology must be introduced in the context of science curriculum in order to attract teachers and administrators.

Teachers participate in professional development activities that engage them in hands-on experiences that connect Information and Communication Technology (ICT) with their curriculum. Scientists are also invited to demonstrate effective use of ICT in their own research. Teachers then design classroom activities that engage their students in the use of ICT to support their learning of science. As teachers adopt ICT-enhanced learning resources into their curriculum, the projects help teachers understand the appropriate fundamental concepts underlying hardware, software, algorithms, and their adopted ICT-enhanced resources. Such knowledge is then transferred to middle school students as teachers guide their students in related classroom activities. Computer science students are deployed into classrooms as middle school students engage in ICT-enhanced learning activities. Such support is critical for teachers who hesitate to face ICT challenges on their own and who are concerned about technology glitches in the middle of their class activities.

Partner districts for the CyberTEAM and iQUEST projects have high percentages of Hispanic students and students from families of low socioeconomic status. These students have limited access to structured ICT activities beyond classrooms. At the beginning of the project, it is common to see teachers and students who treat technology as magic and simply sigh that “technology just does not like me” when they encounter a problem. Project activities have helped them understand that the magic of technology is created by humans according to certain underlying principles. As a result, they are more willing to trouble shoot technical problems and look for solutions that overcome the limitation of their access to technology. In addition, as students experience how ICT-enhanced resources advance their own learning, they become more motivated to explore ICT related career options.

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6. REFERENCES