Making Contact with the Forgotten K-12 Influence: Are You Smarter Than YOUR 5th Grader?

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ABSTRACT
This paper is an experience report that describes a computer science based workshop titled Are You Smarter than YOUR 5th Grader? and targeted at fourth through sixth grade female students and parents. The novel approach of including parents as a pair programmer with the student is highlighted. Additionally, the paper probes the impact of this workshop and plans for revision and replication of future workshops.

Categories and Subject Descriptors
K.3.1 [Computer Uses in Education]: collaborative learning.
K.3.2 [Computer and Information Science Education]: computer science education.

General Terms
Design, Human Factors, Theory.

Keywords
K-12 instruction, computer science education, pair programming, workshops, parent involvement.

1. SUMMARY
After years of soaring enrollments in Computer Science at Purdue University, the last seven years have shown a 52% decrease in the number of high school students interested in pursuing CS as a major and career. The number of women choosing CS in our department has dropped from 13% to 7% [10]. A similar picture is reflected across the nation and is problematic for companies trying to recruit students with CS degrees. The Department of Computer Science at Purdue University has a number of interrelated initiatives that are designed to increase the awareness of computer science among girls in the K-12 environment. Most of the current programs focus on supporting teachers and inspiring students through summer camps, professional development workshops for K-12 educators, and in-class presentations throughout the state of Indiana.

Anecdotally, many of our current CS undergraduates have shared that it was a parent who first encouraged individual interest in computing beyond general computer use. Likewise, Margolis and Fisher have documented similar stories in Unlocking the Clubhouse. To quote the authors, “Parents impart their computer enthusiasm and skills to their children, and through early mastery acquired at home children gain a competence and confidence they carry with them into school” [6]. Toward this effort, the Purdue University Department of Computer Science K-12 Outreach Program has developed a workshop designed to engage this influential layer. Through funding received from NCWIT’s Academic Alliance Seed Fund Grant Program, we developed the program we are calling Are You Smarter Than YOUR 5th Grader? The program seeks to engage parents alongside their children, thus creating a support system beyond the walls of school. We recognize in today’s society, many students are often more skilled at general computer tasks than their parents due to the emergence of technology use in schools. This program uses activities that level the playing field for all involved, and allows the child and parent to develop understanding and experience success alongside each other, no matter the skill level of either party. In turn, we hope mutual respect and encouragement will continue throughout the years as the parent and child become more enthusiastic about computing opportunities.

The Are You Smarter Than YOUR 5th Grader? Program is targeted at girls in grades 4-6 and their parent or guardians. The pilot workshop consisted of six sessions during the Fall 2008 semester. The children experience pair programming with their adult counterpart while participating in activities such as the Alice [1] storytelling challenge and PicoCricket [9] design studio. Additionally, children partake in CS Unplugged [4] activities while parents are offered special sessions on topics such as college admissions or encouraging technology use in their children.

This paper will discuss the details of the workshop as well as the outcomes discovered from the program and attitudinal surveys. We will share information discovered about the value of including the parents in the child’s education experience and any obstacles we encountered in trying to make this a true pair programming experience.

1.1 Related Work
There are countless studies detailing the benefits of using pair programming in the post-secondary environment, especially CS0,
CS1, and CS2 level courses in collegiate settings. Most concur with the findings of McKinney and Denton that using pair programming is beneficial in that it provides for deeper learning, desirable career skill development, fun learning environments, higher retention, higher interest in CS, higher success rates in courses, higher achievement, and a sense of belonging [8]. Additionally, Brought et.al. conclude that pair programming has a positive effect on students with lower SAT scores and that these students are more likely to have significantly improved individual programming skills after participating in a collaborative setting [2].

Just as there are many studies highlighting the effects of using pair programming, there are also many reports on the effect parents have on children’s interest and eventual career choices in STEM (Science, Technology, Engineering, and Mathematics) based disciplines [3,7,11]. Messersmith et.al. further suggests some of these interests and career choices are developed through experiences in homes, schools, and other contexts such as early interactions with parental social networks and the provision of key experiences involving computing.

A unique paper highlights an attempt to bring parents and students together in Taiwan much in the way we have attempted in the Are You Smarter Than YOUR 5th Grader? workshop. Parents and children attended a computer camp and used MSWLogo programming. This research randomly chose three participating pairs to observe and recorded behaviors and attitudes during the camp. Findings from this research indicate that parents and children naturally take on the assumed roles in pair programming, parental involvement helped children spend more time on analysis and design rather than just trial and error, program output was more well-structured, reflection on actions and problem-solving was emphasized, and children tended to proceed with caution because of parental supervision and interaction [5].

2. WORKSHOP LOGISTICS

2.1 Recruitment and Design

Participants were recruited via brochures and poster placement at local schools as well as through local press releases. Due to lab constraints, we were only able to accommodate 26 pairs. Of these 26 students, 22 were female. Our university allows us to target a specific group, however we cannot limit enrollment to that group. Therefore, we had 4 male students also enroll in the program. The workshop was offered free of charge, families were asked to submit a $25 refundable deposit to hold their spot. Originally participants were asked to commit to coming to six sessions- two each month for each of three months. Realizing this may not be realistic, we loosened that requirement to attending 4 sessions- two each month for each of three months. Realizing this, we had 4 male students also enroll in the program.

Pairs were then dismissed to the labs and given some general instruction for the day. Lab sessions were led by local teachers, current Purdue computer science students, and other departmental employees. Two sessions focused on PicoCrickets, two sessions focused on Alice, and in the final two sessions, pairs were given an open challenge where they could choose to use either option (or both) to design a project around a given theme.

Each session ended with a lunch and learn session. Lunches were provided for the families. Some of the activities during these lunches included: student presentations of created works, university admissions presentations, CS Unplugged activities, viewing of a short version of Randy Pausch’s last lecture for the parents, and tours of the departmental visualization lab.

2.2 Workshop Staff

We were fortunate to have a variety of skills and interests among our staff. Knowing that we would have approximately 50 participants each week, we needed to have sessions in two separate labs with parallel instruction. To do the parallel instruction, we hired a local teacher who was familiar with the programs and has used them in her classroom and partnered her with the K-12 outreach coordinator to design and plan the sessions. Two concurrent and identical sessions were then conducted in two labs. Additionally, students from the CS 290- Service Learning in Outreach course volunteered time as a service learning activity and acted as lab assistants. A few additional college students were hired to help as lab assistants when the CS 290 students were not available. Having 5-6 staff members available each week helped develop rapport with the families and ensured that pairs were able to get the support they needed when questions arose.

2.3 Cost of Delivery

The original NCWIT Seed Fund Grant was for $15,000. We came in just a few dollars under that budget. A large portion of the funding was spent on PicoCrickets kits for the families. The other large portions of the budget came in the form of staff wages and lunches each week. It is possible to do the workshop for less if using another project other than the PicoCrickets and limiting the amount spent on food. We felt strongly about giving the students something that they could take home with them and continue to use after the workshop was completed, hence the purchase of the PicoCricket kits.

2.4 Workshop Activities

Each week, participants were asked to be available from 9am-1pm. There was considerable variance in the actual arrival time since many families were traveling considerable distances to attend. The interactive quiz at the beginning allowed for the families to arrive within a reasonable time frame and lab instruction to be given all at one time. Some weeks included a theme and participants were encouraged to dress in the theme and create their projects around that theme. Table 1 shows the schedule of each week’s activities. Alice and PicoCrickets were chosen because of the ease of use with this age group and potential interest to girls, but could easily be replaced with other programs or activities more readily available.

Week 1 and 2 focused on programming using Alice. The promotional materials indicated that participants would engage in an Alice Storytelling Challenge. The Alice Storytelling Challenge
was designed to give students an avenue to express their imaginative side. This activity combined the use of creativity and programming with the Alice 3D graphic design program. In this challenge students created their own digital world to tell a story. The exercise taught programming with a drag-and-drop interface which allowed students to see the relationships between the animation they created and the programming statements. In week 1, participants were given a general introduction to the program and then were guided through the built-in tutorials. At the end of each tutorial, participants were given time to explore the concepts learned and practice using them. The session ended with participants being encouraged to work within the parent/child pair to create a commercial. Week 2 encouraged the pairs to retell a common story with a twist using Alice. Time was given for presenting each project at the end of the session.

Week 3 and 4 introduced the PicoCrickets kits to the participants. Participants were told they would take part in a PicoCrickets design studio. PicoCrickets bring art to life. With a PicoCricket set a student can elicit an action or reaction from their art based on stimuli. This robotic set uses lights, motors, sensors, and other devices to plug into the PicoCricket to create a performance. It involves an art and craft element to actually build and design the devices too. Week 3 was conducted similar to week 1, where participants were guided through some general activities under the concepts of sound, light, and motion and were given time to play with each concept before moving to the next instruction. Week 3 ended with a challenge to create a burglar alarm using two of the three main concepts. Week 4 was an opened-ended challenge using the PicoCricket kit and participants were asked to create an assistive device that would help them in school. Examples of projects include a time test countdown timer and an automatic textbook retrieval and shelving device.

Week 5 and 6 took more of an open lab approach. Participants were given a challenge to create a holiday themed project using Alice or PicoCrickets. Examples included a PicoCricket representation of the New Year’s Eve ball drop countdown and an Alice Christmas tree sale commercial.

3. PARTICIPANT WORK AND ACTIVITY
The students and parents involved in the workshop seemed to be quick learners and pleasantly surprised each other with their abilities after one small session. Below is a sample of student work after exposure to specific programs. The ease of use and cognitive understanding at the 4th-6th grade level were important factors in considering the media chosen for these projects for each pair.

Table 1: Weekly Activities

<table>
<thead>
<tr>
<th>Week 1</th>
<th>Week 2</th>
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<tbody>
<tr>
<td>• Staff Introductions</td>
<td>• Alice Tea Party/ Mad Hatter Theme- Crazy Hat Day</td>
</tr>
<tr>
<td>• Program Description</td>
<td>• Interactive Computer Trivia Challenge</td>
</tr>
<tr>
<td>• Pre-test</td>
<td>• Alice Project Assignment: Retell a Common Story</td>
</tr>
<tr>
<td>• Interactive Computer Trivia Challenge</td>
<td>• Tea Party Luncheon</td>
</tr>
<tr>
<td>• U. of Washington “Power to Change the World”</td>
<td>• Children Participate in more CS Unplugged activities</td>
</tr>
<tr>
<td>• Computer Science Unplugged Activities</td>
<td>• Parents watch abridged version of The Last Lecture</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Week 3</th>
<th>Week 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Interactive Purdue Trivia Challenge</td>
<td>• BOILER UP! Purdue Theme Week</td>
</tr>
<tr>
<td>• Introduction to PicoCrickets Lab</td>
<td>• Interactive Purdue Trivia Quiz</td>
</tr>
<tr>
<td>• Visualization Lab Tour</td>
<td>• Pico Cricket Challenge- “School” Themed Assistive Device Development</td>
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<tr>
<th>Week 5</th>
<th>Week 6</th>
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<tbody>
<tr>
<td>• Interactive Logic Puzzle Trivia Challenge</td>
<td>• Holiday Themed Week- Wear something that represents your favorite holiday</td>
</tr>
<tr>
<td>• Open Challenge- choose either Alice or Crickets to design a ‘Holiday’ themed project.</td>
<td>• Best of the Best Interactive Trivia Challenge</td>
</tr>
<tr>
<td>• University Admissions Presentation</td>
<td>• Project Show and Tell</td>
</tr>
<tr>
<td>• Completion Banquet</td>
<td>• Pico Cricket Challenge- “School” Themed Assistive Device Development</td>
</tr>
<tr>
<td>• Spring Follow-Up Workshop</td>
<td>• University Admissions Presentation</td>
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</tbody>
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Spring Follow-Up Workshop

• Ultimate Spring Break Adventure- Hawaiian Themed
• Create a representation of your Ultimate Spring Break Adventure using either Alice or Crickets

Figure 1: Final Alice Project in Week 6
4. WORKSHOP OUTCOMES

Parents and students were given an attitudinal survey during the first and last session of the workshop. Questions centered on general computer use, the potential for a career as a computer scientist, and perceived ability differences based on gender. For the pre-survey N=48, for the post survey N=39. The statements that showed the most change from pre- to post- survey are as follows in Table 1. The survey was based on a 5 point scale where 1= strongly agree, 2= agree, 3= neutral, 4= disagree, and 5= strongly disagree.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Pre-Test</th>
<th>Post-Test</th>
<th>Delta</th>
</tr>
</thead>
<tbody>
<tr>
<td>I like to use computers</td>
<td>3.96</td>
<td>1.33</td>
<td>2.63</td>
</tr>
<tr>
<td>I use a computer everyday</td>
<td>3.98</td>
<td>1.96</td>
<td>2.06</td>
</tr>
<tr>
<td>Computers help me learn</td>
<td>3.98</td>
<td>1.49</td>
<td>2.49</td>
</tr>
<tr>
<td>Computers can help solve problems</td>
<td>4.08</td>
<td>1.38</td>
<td>2.70</td>
</tr>
<tr>
<td>Girls can be computer programmers</td>
<td>4.46</td>
<td>1.31</td>
<td>3.15</td>
</tr>
<tr>
<td>Boys like computers more than girls do</td>
<td>3.98</td>
<td>4.31</td>
<td>-.33</td>
</tr>
<tr>
<td>Computer programming is fun</td>
<td>3.65</td>
<td>1.72</td>
<td>1.93</td>
</tr>
</tbody>
</table>

Additionally, parents were asked to comment on what they liked best about the workshops. Here is what a few had to say:

“The opportunity for my daughter to learn skills she isn't getting in school. I think it broadened her idea of computer science and got her excited about this field. The challenges were open-ended enough to provide brainstorming and creativity.”

5. LESSONS LEARNED

Some of the realizations made by the program staff are as follows:
1) Need to have more formal evaluation process to determine effectiveness of program.
2) We should have coded each participant with a number so we could trace individual change in attitudes on the survey.
3) 6-session format was nice in that it brought about continued contact with families and support for projects.
4) 6-session format was a deterrent for many families to sign up because of too long of a time commitment spread out over three months.
5) Follow-up session the following semester was a good idea and ensured continued use of tools.
6) Additional opportunities for these participants should be crafted to continue to expand the skills and interest of parents and students.
7) Entire families wanted to come to the program; we were only expecting one adult and one child per group. It made for some interesting planning and space issues.
8) Additionally, families with more than one child in this age group had trouble ‘pairing’ with just one child during the activities.
9) Guest speakers need to be coached on how to talk to and interest 4th-6th grade students.

6. FUTURE WORK

The program has been funded by a Motorola Innovation Generation Grant to continue development through the 2009-2010 school year. Plans are being made to repeat the workshop in January and February 2010 with minimal changes to the original format. Additionally, plans are in the works to create a teacher/student version of the workshop for fall 2010.

7. CONCLUSIONS

The intent of this paper is to share this novel program with others such as K-12 educators and university faculty, staff, or students who may be looking for additional ways to engage the K-12
environment in computer science education. All in all, this seems to be a worthwhile idea. Much of the feedback we received from parents was positive in that we were hitting an age group where it was still fun for students to do activities with their parents. Additionally, by making the parent the ‘expert’ on a subject, there was less hassle for a student to want to download a program such as Alice at home and continue to use it. Also, if the child got stuck on something, the parent was able to help troubleshoot more so than if it were just something the child had studied in a traditional classroom.

There was a lack of awareness of the goldmine of data we could be collecting with a program such as this. For future workshops, we are looking into actual research quality data that could be collected and used beyond anecdotal items. The reproduction of this sort of workshop series in other locations could easily be done on a smaller budget and varied timeframe. However, the contact with the families over time vs. a onetime event was desirable and lauded by the parents.

We would be delighted to work with others that may have similar interests and goals.

8. ACKNOWLEDGMENTS
We wish to thank NCWIT’s Academic Alliance and Microsoft Research for the generous funding of this pilot program and Motorola Foundation for continued funding.

9. REFERENCES
[1] Alice Programming Language. Available at: www.alice.org
[9] PicoCricket design kit. Available at: www.picocricket.com