Computational Thinking via Interactive Journalism in Middle School

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ABSTRACT
To address the critical shortage of students entering computing fields, as well as broaden participation in computing, we present a summer and afterschool program in Interactive Journalism through which middle school students and their teachers develop an appreciation for and competence in computational thinking. We report on the outcomes of our first year in which three middle school language arts teachers, a technology teacher and a guidance counselor collaborate with college faculty to publish a school magazine of the future. Students and their teachers research and conduct interviews to develop news stories that are then presented as story packages with text, video, and procedural animations in Scratch. Results of formal data collection show changes in students’ perceptions of what it means to program, as well as their emerging confidence in their ability to design computational solutions and to program.

Categories and Subject Descriptors
K.3.2 [Computing Milieux] Computer and Information Science Education
K. 4.0 Computers and Society

General Terms
Human Factors

Keywords
K-12 CS Education, Computational Thinking, Scratch, Writing and Computing, Broading Participation in Computing

1. INTRODUCTION
Research on the computing pipeline and mathematics education inform the position that women and minorities self-select out of computing related fields because they (1) do not see themselves as "computer types," (2) do not successfully navigate the culture of a traditional computing classroom, and (3) are ill-prepared academically for entry into existing undergraduate programs [2,7]. The profound shift in journalism due to the Internet provides a venue through which to engage these students in computing via writing, information gathering and analysis, as well as a range of digital media from graphics to still images to procedural animation (e.g., Flash [6], Scratch [16], Alice [1]), interactive graphics and enhanced video. Our emphasis on socially responsible activities (e.g., news reporting), rather than consumerist focused activities (e.g., video games and entertainment) provides a foothold into activities deemed appropriate for school. There is also growing evidence that socially relevant activities attract girls.

Jane Margolis et al. [10] present a troubling picture that members of underrepresented groups (e.g., women as well as all people of color) are enthusiastic about pursuing careers in computing but are barred because they cannot obtain the necessary preparation in high school to succeed in the requisite college majors, or to enter college at all. Efforts are underway (e.g. via the CSTA) to change national and state policy.

The program presented here demonstrates how to infuse computer science into the existing culture and curriculum of mainstream public education, rather than attempt to dramatically change it through public policy. It also provides a solution to the most critical challenge facing an over-burdened K-12 curriculum: to add computer science will either require removing something else (probably the arts), or watering down the experience so as to render it meaningless to long term pedagogical goals.

We asked the question: how can we infuse computer science and computational thinking through an existing rather than novel venue? We have found that the school newspaper, with its socially responsible agenda, its need for 21st century technology overhaul, and its isomorphism to the process of software design, has proven to be remarkably effective in communicating the message to young people, their teachers and parents, that computational thinking skills are accessible to anyone, and that computer science offers critical skills for the 21st century workforce that should be actively pursued by students.

2. RATIONALE
We posit that the existing school culture, in its belief systems, processes and support structures, is inadequately prepared to implement the extensive change in curriculum assumed by proponents of broad-based computational thinking. As Margolis et al. describe so eloquently [10], the technology, teacher expertise and technical support required to implement a broad-based computing curriculum in K-12 is in crisis. They focused on the Los Angeles School District and describe three schools ranging from inner city to affluent suburban. Their stories resonate with teachers we have talked to throughout the country: teachers are not empowered or trusted to use technology in a way that models computational thinking or promotes concepts of computer science. Yet there is significant evidence from the last 20 years that genuine buy-in from teachers, school administrators,
technology support staff, parents, and students is necessary for educational innovation, especially technology-based innovation to take place [4, 17].

2.1 K-12 Computing
To attract a broad constituency to even the best high school computing experiences requires consistent exposure to computational ideas beginning in kindergarten. Broadening participation requires exposing young people to computing in sustainable ways. Extracurricular experiences such as summer camps and after school programs (affiliated with school or national organizations) can inspire young people, but there is significant evidence that ultimately career path choice is influenced and motivated by parents and school [7,15].

This presents a particular problem for computer science education because it is currently all but absent from state curricula. We address the problem of classroom instruction in a forthcoming paper. Afterschool programs strongly tied to mainstream curriculum provide a vehicle through which students, teachers, parents, and school policy makers (e.g., administrators and board members) can develop an appreciation for the need to include solid, deep, sustained instruction in computing in the mainstream curriculum, not as a “special” such as art, music, technology or physical education.

Unless computing becomes mainstream, computer science will remain marginalized as the domain of an elite, for example those predisposed to and academically successful in traditional STEM disciplines. While we wholeheartedly support the robotics movement as supplementary to standard curriculum, it is still not sufficiently in the mainstream to dispel the prejudices of a generation of policymakers. Video game design is even less likely to find its way into the mainstream curriculum. Broadening participation in computing requires casting a wide net and abandoning stereotypes about who is and is not cognitively capable of computational thinking. This requires thinking beyond traditional STEM disciplines and considering applications in media, journalism and the arts. It also requires thinking about the community and culture of the classroom [14, 18].

2.2 21st Century Journalism
Evidence is mounting that a 21st century journalist will require a strong computing background [8, 11], and 21st century computing professionals will increasingly apply their skills to information dissemination through an as yet to be imagined collection of venues, processes and media. Underlying both disciplines are foundational principles of information access and dissemination, fact analysis, process description and decision-making for results presentation. These neutral terms are equally embraced by journalists and computer scientists to describe how to construct a news item and a software artifact respectively. Consequently, we ascribe to a broad view of computing: one that embraces both the creator of software to support journalism as well as the journalist programmer who can competently embrace emerging digital media. This viewpoint reflects the growing recognition of the importance of computing within the news industry [13]. Journalists are increasingly expected to create and extract information from databases. They construct social network maps to unearth relationships and patterns of behavior. News presentation is also increasingly computer-driven, in the form of content management systems, procedural (e.g., Flash) animations, and user-customization tools. Fundamentally, as programmer-journalist Adrian Holovaty has observed, journalism and computing are both concerned with gathering, organizing and presenting structured data [8].

To attract young people into such careers we need to start early, because they will need well-established skills in writing, computational thinking and quantitative reasoning. By the time they reach college, many students have segregated themselves into “good writers” or “good mathematicians.” Women traditionally will gravitate toward the former. Keeping them, as well as minority boys in math and science is a national problem [2, 7]. We address the computing pipeline problem by focusing on the critical point of middle school (particularly 8th grade), when students make career dependent decisions on high school course selection based on preconceptions and misconceptions about computing careers and requisite preparedness for those careers.

3. THE IJIMS PROGRAM
The Interactive Journalism Institute for Middle School (IJIMS) is a yearlong demonstration project funded by the National Science Foundation Broadening Participation in Computing program (CNS 0739173) [9]. We recruited middle school teachers through their principal, Ms. Barbara Brower, who emphasized the technology and writing components of our project. Our student recruiting procedures explicitly identified the students who are not the school “math stars,” but rather those who have a creative bent in visual media and writing or whose talents do not necessarily predict success in the traditional math and science classroom. In other words, we recruited ordinary kids rather than those self-selecting into computing disciplines. In the second year we invited a cohort of students nominated by their teachers to an information meeting at the middle school that was led by members of our teacher cohort and current IJIMS middle school participants. At the behest of the teachers we included 7th graders to develop a stronger sense of community through a two, rather than one-year experience.

3.1 Pilot Program in the First Year
In its first year, we offered a one-week institute for five teachers (all white women, three language arts: Laura Fay, Suzanne Gallagher, Jean Gardner; one technology: Mary DiSimone; one guidance counselor: Jill Schwarz), followed immediately by an identical institute for 16 rising 8th graders at which the teachers participated as mentors to the students. The demographics of the middle school students was 2/1 female/male, with almost half identified as Latina/o or black. Through NSF and College of New Jersey support we also recruited five undergraduate research assistants (3/2 male/female, 2/1 white/non white) for an 8-week undergraduate research program that culminated in the two weeks with the middle school teachers and students.

During the subsequent academic year the teachers and students, with our active support, developed an afterschool program to run a 21st century, online school newspaper. Approximately two thirds of the students continued to attend throughout the year (maintaining both gender and ethnic/racial proportions of the summer program.).

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1 This new professional description was first used by Adrian Holovaty [8].
The afterschool program began as twice monthly, 45-minute meetings. By mid-year we increased contact to once per week. At the insistence of the teachers and students, we invited students who had not participated in the summer program to attend as well. One language arts teacher dropped out of the program in late February due to an emerging leadership role in another program. The remaining teachers supported and gradually took ownership of the afterschool program. Our guidance counselor did not participate during the school year because of a scheduling conflict.

3.2 The Second Year Revised Program
To date we have completed the summer program of the second year with 29 middle school students (18 girls, 11 boys, 12 7th graders, 17 8th graders) with approximately the same ethnic/racial composition as the first year. This past summer (July 2009), the remaining three teachers recruited two new teachers, a female language arts teacher (Marcy Tucker) and a male math teacher (Rober Kohut), both white. We held a weeklong informal preparation session where we worked one-on-one with all the teachers to prepare for the second summer session with the students. This year through NSF funding we again supported six undergraduate research students (5/1 male/female, 5/1 white/Hispanic.)

3.3 Immersive, Active Learning
The weeklong summer institute is a model for immersive, active skills learning. In teams, referred to in the news industry as “beats,” students and teachers are assigned a topic, research that topic on the Internet, then prepare for, execute and video tape an interview with someone related to the topic. Summary notes are then compiled into a formal news report that includes selecting graphics, still images and editing video clips. The connection to computing, especially programming, occurs when team members develop procedural animations that support the story line as side bars. Students learn about database use, privacy and security via “CAFE” (Collaboration And Facilitation Environment) [3] through which they develop, edit, and ultimately file their stories.

We chose Scratch [16] as the most appropriate vehicle for procedural animation. This syntax-free programming environment supports novice users as they quickly build expertise in telling stories through traditional programming constructs such as statements, control structures, events and expressions. With almost no formal instruction (less than two hours in our summer program) novices can build animations and simple interactive games to support the narrative line of their journalism work. We considered both Alice and Flash, but the steeper learning curve of Alice and Flash, but the steeper learning curve of Scratch (as Alice) meant I:

<table>
<thead>
<tr>
<th>Means</th>
<th>July 08 (N=13)</th>
<th>July 09 (N=27)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work all by myself</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Work with other people</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>Can be creative</td>
<td>10</td>
<td>19</td>
</tr>
</tbody>
</table>

4. PROGRAM GOALS AND OUTCOMES
The primary goal of our project is to demonstrate how expository writing, and journalism in particular, can be used to cast a wide net to broaden participation in computing.

4.1 Goals
By directly engaging students who do not necessarily view themselves as “computing types” our program is designed to change their perspective on career options in the expanding computing disciplines. More specifically we set out to:

1. Change their perceptions about what programming is.
2. Show them that software design (e.g. creating projects in Scratch) is like news reporting.
3. Empower them to feel competent in software design and using their new computing skills.
4. Convince them that programming can be fun.
5. Give them a sense of accomplishment in doing worthwhile, socially responsible work.

A secondary goal was to ignite enthusiasm for computational thinking in their teachers. Outcomes for this goal are summarized in a forthcoming paper. We focus here on the student outcomes and compare our pilot summer project with the more recent summer experience. We will analyze the results of the year-long program after we complete our second academic year.

4.2 Methodology
Throughout the first year and second summer, our independent evaluator, Meredith Stone, developed and administered (a) pretests of computer efficacy, (b) attitudinal surveys, (c) a noncomputer-based media construction assignment. Rubrics are also under development to assess the sophistication of their Scratch programs both quantitatively and qualitatively. We are in the process of validating these instruments. Finally, extensive formal observation and interviews were conducted throughout. Each summer we asked both the teachers and students to comment on the day’s activities and what they did, aligning these questions to our targeted outcomes. We also asked them to rank their sense of accomplishment from 1 (nothing much) to 5 (an amazing amount).

4.3 Results

4.3.1 Change Perceptions about Programming
Our data suggests that we changed the students’ perceptions about programming. Specifically, after the summer institutes in 2008 and 2009 our students did not espouse the generally held beliefs that programmers work by themselves or that working on a computer means you cannot be creative. When students were asked to circle ALL that applied, their responses to the following items were as seen in Table 1. We noted that many who circled “work all by myself” in 2009 also circled “work with others.”

Table 1. Attitudes about working with computers

<table>
<thead>
<tr>
<th>Working with computers</th>
<th>July 08 (N=13)</th>
<th>July 09 (N=27)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work all by myself</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Work with other people</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>Can be creative</td>
<td>10</td>
<td>19</td>
</tr>
</tbody>
</table>

In our second summer (2009) the six teachers prepared for the week with middle school students by each working through a story with informal support from the six undergraduates. During the subsequent middle school institute each teacher partnered with an undergraduate and worked with four to five middle school students. Their work is published as “N.E.W.S.” (New Ewing Web Stories) [12].
4.3.2 Software Design and News Reporting
We believe that the process involved in good writing is the same as the process involved in creating good procedural animations. Our students are beginning to think so too. Table 2 shows the response to a survey question asking them to rank their agreement with the statement “During the past week, I learned that Computer Science and Journalism are a lot alike” on a scale of 5 = Strongly Agree to 1 = Strongly Disagree. Since their rating is going up, we assume our teachers are getting better at showing them the relationship.

Table 2. Relationship between Computer Science and Journalism

<table>
<thead>
<tr>
<th>Average score</th>
<th>July 08</th>
<th>July 09</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 = Strongly Agree</td>
<td>N=16</td>
<td>N=27</td>
</tr>
<tr>
<td>1 = Strongly Disagree</td>
<td></td>
<td></td>
</tr>
<tr>
<td>During the past week, I learned that Computer Science and Journalism are a lot alike</td>
<td>3.6</td>
<td>4.0</td>
</tr>
</tbody>
</table>

4.3.3 Empower Them to Feel Competent
In 2009, we directly assessed student perceptions’ of their ability to program through a survey given the first morning of the institute and the last afternoon. Our data indicate that we increased the students’ confidence in their ability to create computer programs. The results are given in Table 3 below. Note that not only did the number of students who either Agreed or Strongly Agreed with the statement “I believe I can create a computer program” rise from 66% to 88%, but the number who Disagreed or Strongly Disagreed went from 14% to 0%. We believe that the initial 66% is higher than typically would be expected as five of the rising 8th graders (17%) had worked with Scratch prior to the summer program.

Table 3. Beliefs about ability to program

<table>
<thead>
<tr>
<th>I believe I can create a computer program</th>
<th>Agree/Strongly Agree</th>
<th>No Opinion</th>
<th>Disagree/Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Day</td>
<td>19</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>(N=29)</td>
<td>66%</td>
<td>17%</td>
<td>14%</td>
</tr>
<tr>
<td>Last Day</td>
<td>23</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>(N=26)</td>
<td>88%</td>
<td>12%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Further, when asked to rank their agreement with the statement “During the past week, I learned that Interactive Journalism can be a lot of fun,” on a scale of 5 = Strongly Agree to 1 = Strongly Disagree, the students’ average was greater than 4 both years as seen in Table 6 below.

Table 4. Beliefs about competence as programmers

<table>
<thead>
<tr>
<th>Average score</th>
<th>July 08</th>
<th>July 09</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 = Strongly Agree to 1 = Strongly Disagree</td>
<td></td>
<td></td>
</tr>
<tr>
<td>During the past week I learned enough about the Interactive Journalism process that I could teach it to others</td>
<td>3.9</td>
<td>4.1</td>
</tr>
<tr>
<td>I believe I will use the computer skills I learned during the past week in whatever career I choose</td>
<td>4.2</td>
<td>4.0</td>
</tr>
</tbody>
</table>

4.3.4 That Programming Can Be Fun
As seen in Table 5, for both the 2008 and 2009 summer institutes, the majority of the students reported that they had had the MOST FUN during the week working on their Scratch projects. In addition, when asked on another survey “what would you like to continue doing next year in school,” Scratch was one of the most frequent answers both years, tied with “writing news stories and interviewing people.” Note that another option was video production.

Table 5. Most fun activity was Scratch

<table>
<thead>
<tr>
<th>Scratch</th>
<th>July 08</th>
<th>July 09</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOST Fun</td>
<td>9 (56%)</td>
<td>19 (70%)</td>
</tr>
</tbody>
</table>

4.3.5 A Sense of Accomplishment for Work
During both the 2008 and 2009 summer institutes, the students’ sense of accomplishment increased each day with only one temporary downturn due to a server crash on day 4, 2009. Students were asked to rate their accomplishment on a scale of 1 to 5, where 5 was labeled “an amazing amount,” 3 was labeled “Enough,” and 1 was labeled “Nothing much.” The results are in Table 7 below.

Table 7. Sense of Accomplishment

<table>
<thead>
<tr>
<th>Day</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
<th>Day 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>July 2008 (N=16)</td>
<td>3.75</td>
<td>3.87</td>
<td>3.88</td>
<td>4.00</td>
</tr>
<tr>
<td>July 2009 (N=27)</td>
<td>3.96</td>
<td>4.35</td>
<td>4.43</td>
<td>4.18</td>
</tr>
</tbody>
</table>

5. FUTURE WORK AND SUMMARY
The formal results reported here only begin to tell the story of our experience over the past eighteen months. Systematic observation
being casually introduced to Scratch by our collaborating teachers throughout the building are coming year. Each one filed a research proposal with us as part of their continuing project. Teachers throughout the building are being casually introduced to Scratch by our collaborating teachers and their students. Our 8th grade cohort dispersed into five different high schools (that we have been able to track). At least one young person going to each school is committed to continuing to study programming and computer science. We have indeed begun to infuse computational thinking into a middle school in a way that enriches rather than subsumes existing curriculum.

6. ACKNOWLEDGMENTS
A heartfelt thank you to Dr. Janice Cuny, Director of the Broadening Participation in Computing Program at NSF. This work would not be possible without our program manager, Mary Switzer, the 11 undergraduates who devoted their summers to our work and the awesome teachers and staff at Fisher Middle School. This work is supported by NFS CNS 0739173.

7. REFERENCES
[9] The Interactive Journalism Institute for Middle School: http://www.tcnj.edu/~ijims
[16] Scratch: http://scratch.mit.edu