GeorgiaComputes!
Final Report and Summative Evaluation
2006-2011

The Findings Group, LLC

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GeorgiaComputes! Final Report and Summative Evaluation Plan

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Project Summary

The central goal of GAComputes!, an NSF "Broadening Participation in Computing" alliance program, is to increase the number and diversity of computing students in the state of Georgia. To improve the computing education pipeline across the state of Georgia, GAComputes! has worked toward the following efforts:

1. Attract girls into computing with activities in camps and afterschool programs.

2. Offer computer camps to middle and high school students.

3. Teach high school teachers how to teach computing using motivating examples in cooperation with the Georgia Department of Education.

4. Offer workshops to University System of Georgia Computing faculty on new approaches to improve computing education.

5. Support USG computing faculty in offering their own summer camps with training, curriculum, and seed funding to recruit students into their computing programs.

The current report is designed to provide objective feedback of both formative and summative measures.

During the summer of 2006, GAComputes! contracted with The Findings Group, LLC, to conduct an external evaluation. The evaluation team adopted a formative-summative approach to the investigation of the impact and sustainability of the program. This approach has allowed us to study how GAComputes! works and whether it works as intended and also to determine any impact that GAComputes! has had on outcomes at various levels (e.g., teacher, student). This report describes the research activities undertaken to date, findings and recommendations that have resulted from our research, and suggestions for further research in the future.

Methods

Evaluation Questions

A set of core questions drives the evaluation of GAComputes! . The six questions that fueled the evaluation examined whether, how, and under what conditions GAComputes! exerted a meaningful impact on computing education across the state of Georgia:

1. **Resources:** To what extent are the resources (robotics kits, day camp curriculum, funds to support local workshops) being used?

2. **Implementation:** Are middle and high school teachers and USG faculty applying what they have learned through this program?

3. **Attitudes:** Do students participating in camps express positive attitudes toward computing, contextualized computing, and careers in computing?

4. **Community:** How many women and minority students participate in the Cool Computing community and weekend? How active is the community and to what degree does it create positive attitudes toward pursuing computer-related disciplines?

5. **Influence & Impact[1]:** How has the program influenced and impacted individual institutions and the larger computing community?

6. **Enrollment & Retention:** How many women and minorities are enrolled in computer-related disciplines in USG institutions? What is the retention rate at each stage toward their degree? Has the program generated an increase in the number of high schools offering AP Computer Science and is there a larger diversity (diversity = gender, race) of students pursuing and passing the AP Computer Science test?

Evaluation Activities and General Approach

Our evaluation activities were designed to integrate data across multiple sources in order to address the areas stated in the original GAComputes! proposal and extention proposal. Our integrated research methods allowed us to generate a summary of findings that calls on several types, sources and levels of data. Such methods include a tracking tool for tracking recruitment and participant data, surveys, classroom observations, face-to-face interviews, and statewide data gleaned from The College Board. This approach increases the validity of our findings while also raising additional research questions for future evaluation activities.

The evaluation questions and activities emanate from the logic model presented on the next page. The logic model is at the center of the GAComputes! program and displays the sequence of actions that describe what the program is and will do – how program activities link to results.

[1] Evaluation question was modified from its original version; original evaluation question read: *What influences have outreach activities had on computing-related instruction in middle and high schools? What influence have these activities had on student perceptions of computing-related disciplines?* These questions were addressed by evaluation questions 2 and 3.

<table>
<tr><th>Resources</th><th>Activities</th><th>Outputs</th><th>Outcomes</th><th>Impact</th></tr>
<tr>
<td rowspan="4">**Primary:**
• Mark Guzdial
• Maureen Biggers
• Barbara Ericson
• Amy Bruckman
• Susan Cotter
• Female graduate and undergrad students
• STEP Fellows
• Aspiring CS AP teachers

Secondary:
• Georgia Department of Education
• University System of Georgia</td>
<td>Workshops:
• Annual one week **workshop for middle school teachers** to learn:
o Simulations in Squeek
o Robotics with Lego Mindstorms
o Virtual 3-D storytelling in Alice
• Annual spring workshop showcases contextualized computing applications created by teachers across various curricula.
• Three-day workshops train 60 USG faculty to teach contextualized computing.</td>
<td>Provide training in contextualized computing and follow-up showcase opportunities to:
• X middle school teachers (impacting 1500 students/yr)
• X high school teachers
• 60 University System of Georgia faculty
• 44 teachers are trained and qualified to teach CS AP</td>
<td rowspan="4">• Double the number of High School teachers in Georgia capable of teaching AP computer science.
• 50% increase in the number of high schools offering CS AP.
• Double the share of CS AP seats now going to women and minorities
• Double the percentage of women and minorities taking undergraduate computing courses.
• Contextualized computing courses are offered at other USG institutions
• Expand the pipeline of female and minority students pursuing undergraduate and graduate computing degrees</td>
<td rowspan="4">Change the perception of computing to increase the number of women pursuing computing.

Other states adopt Georgia's model to increase the number of women and minorities pursuing computing careers.

Increase the number of women and minorities in other STEM disciplines.</td>
</tr>
<tr>
<td>Camps:
• Female undergraduate and graduate students **teach and mentor girl scouts** in Squeek, Mindstorms and Alice.
• Middle school **summer day camp** provides contextual computing for Atlanta area students.
• High school and undergraduate faculty throughout the state offer **local middle and high school day camps**.</td>
<td>• 240 girl scouts receive contextualized computing instruction
• X middle and high school students engage in contextualized computing via local summer day camps</td>
</tr>
<tr>
<td>Community-Building:
• The Cool Computing On-Line community invites female and minority middle and high school students to collaborate and share their work. Four undergraduate and four graduate students keep the community active.
• Annual Cool Computing Weekend showcases female and minority student work.</td>
<td>• X middle and high school students participate in Cool Computing community
• Female and minority students express excitement about their contextualized computing work in a vibrant, active community.</td>
</tr>
<tr>
<td>K-12 Outreach:
• Four undergraduate STEP Fellows work in schools to initiate AP computer science courses.
• A robotic lending library makes **50 robotics kits** available to interested teachers.</td>
<td>• Step Fellows influence school decisions to offer CS AP
• X middle and high school students use robotics kits.</td>
</tr>
</table>

Executive Summary of Findings

Here, we call upon the multiple data sources and findings described in the methods and findings sections to present integrated commendations and recommendations for GAComputes!. Each statements has been carefully crafted from a comprehensive and quantified approach to understanding all data collected during the fall of 2006 to the summer of 2011, and is organized by the evaluation questions set forth.

Commendations

1. **Resources**

   Across its lifespan, GAComputes! provided Georgia high schools and higher education institutions with computing tools in an effort to make computing appealing to a diverse range of students. In total, 1,983 robotics kits were borrowed from 38 unique institutions from 2007 to 2011. The number of kits available grew by 207% (from 2007 to 2011) in response to demand and requests for variety.

   GAComputes! pioneered a successful model for running summer computing camps for K-12 students. GAComputes! broadened the number of K-12 students who participated in summer computing camps through seed money. In total, 9 University System of Georgia (USG) institutions have received seeded funding to host summer computing camps for elementary, middle and high school students. Thus, a broader and more effective impact on the state's computing education pipeline is developed by helping other USG institutions to offer their own middle and high school student summer camps. In addition to seed money ($5,000 per site, per summer), GAComputes! invited USG institutions to attend workshops on "How to run a summer camp" which provides information pertaining to the logistics (e.g., advertising) of running a computing camp.

2. **Implementation**

   Georgia computing teachers report being more confident in their pedagogical skills in part due to the resources and teaching techniques offered at GAComputes! teacher workshops. The majority of teachers reported that the best things about the teacher workshops were the hands-on instruction, the ability to network and share pedagogical techniques with other teachers, and the resources and materials provided by the workshop. In a comprehensive follow-up survey with 55 teachers who participated in the workshops, it was evident that **the teacher workshops provide critical computing experience and training which contributes to an increase in the number of teachers teaching programming.** Participating in teacher workshops significantly increased the number of teachers teaching programming by 27%. 35% of participants were teaching programming before attending the workshop compared to 62% who are currently teaching programming. Before attending the workshop, 39% of participants cited "lack of experience/training" as being primary reason for not teaching programming.

In addition to providing valuable resources and materials, the GAComputes! teacher workshops encourage teachers to cultivate higher-order cognitive skills in their students. Observations of classroom implementation of GAComputes! resources and materials revealed that teachers are integrating more problem-solving techniques instead of relying on step-by-step manuals for students to follow.

3. **Attitudes**

Students who participated in GAComputes! workshops experienced statistically significant (p<.05) growth in their positive attitude towards computing. Specifically, students made significant gains from pre to post in their reported self-efficacy in computing ("I am good at computing" and "I know more than my friends about computing"), their perception of computing as fun and likeable, and their view that computing is less difficult than they initially conceived. Both female and underrepresented minority students demonstrated statistically significant increases in the abovementioned areas.

Partnering with organizations that are focused on enhancing the life and educational outcomes of females (e.g., Girl Scouts) was an effective avenue for recruiting this target population into computing. Overall, 3,944 students (2184 females; 1672 underrepresented minorities) participated in computing camps. It is important to note that while 87% of the students who participated in the 4 hour weekend and after school programs were female, only 25% of the students who participated in the summer camps were female. This was accomplished in part to the partnerships GAcomputes! formed with YMCA, YWCA, Boys and Girls clubs, Cool Girls (an award-winning early intervention after school program dedicated to the empowerment of low-income girls), and Girl Scouts of Atlanta.

Preliminary evidence suggests that students gain significantly more content knowledge in computing as a result of participating in the computing camps. In general, students are significantly more likely to correctly identify and apply several programming concepts following their participation in summer computing camps at Georgia Tech:

- Loops: repeated execution of specific code
- Conditional Executions: if-then statements
- Variable modification: manipulation and modification of data blocks
- Handling Events: responses to environmental cues
- Sending a message: activating a block of code
- Tracing: interpreting a block of code and identifying the outcome

4. **Community**

Cool Computing events have reached over 632 students from 38 high schools and middle schools in Georgia and introduced them to computing education, industry and research. Each event included a student panel, a corporate panel, research speakers, campus tour and lunch on the Georgia Tech campus. 26% of the participants at the Cool Computing events were females and 43% were underrepresented minorities.

Single-day events provide minority students with an important life experience which piques their interest in a computing career and eventual pursuit of a computing degree. Feedback from several female high school students indicate that the Cool Computing Day made a dramatic impact on their interest in pursuing computing.

5. **Influence & Impact**

GAComputes! has a strong presence in the computing community, both regionally and nationally, and been instrumental in bringing together faculty from computer science departments in colleges and universities across the United States with the aim of providing them with tools to draw women and minority students into computing. In total, over 120 computing faculty from 21 states have been represented at GAComputes! faculty workshops.

GAComputes! served as the catalyst for at least two projects supported by NSF: 1. Developing Regional Communities of Computing Educators (DCCE), and 2. Glitch- Games Testing. DCCE, is aimed at connecting undergraduate and high school computer science teachers in order to develop a community focused on common goals and activities to revitalize undergraduate and high school computing education in Georgia. Glitch-Games Testing seeks to leverage low-income African American teenage boys' love of video games to encourage their participation in computing education and introduce them to the idea of pursuing computing careers. This is accomplished by offering youth a contextualized computing curriculum coupled with real-life games testing.

6. **Enrollment & Retention**

Female and underrepresented minority students are more likely to persist in computing science courses at the undergraduate level if they come from high schools where their computing teachers received professional development training at GaComputes! teacher workshops. High schools who have sent teachers to GAComputes! teacher workshops produce more female introductory CS college students than high schools who have not. Likewise, schools with teachers who have been trained by GAComptues! send more under-represented minorities to intro CS courses.

GAComputes! successfully increased the number of schools offering AP CS by 61% (from baseline, 2004), thus exceeding its goal. In 2004, approximately 44 schools offered AP CS A. In 2007-2008, 81 schools offered AP CS A. In 2008-2009, 73 schools have the AP designation, and in 2009-2010, 71 schools have the AP designation (College Board, n.d.).

The number of female, Hispanic, and Black AP CS test takers has dramatically increased as a result of the efforts of GAComputes!. The number of female, Black, and Hispanic test takers increased by 69% (+48), 3%((+2) and 233% (+21), respectively, from baseline(2004-2005) to 2010-2011 school year.

Recommendations

In addition to our commendations, we recommend the following:

1. **Additional effort to recruit and sustain females in computing is essential to enhancing their success across multiple points in the pipeline.**

   Only 20% of high school teachers indicate that they are using materials provided by GAComputes! (e.g. videos, presentations) to recruit females to their computing courses. Likewise, demographic data suggests that a greater number of male middle/high school students participate in Cool Computing events than females. Teachers interviewed noted that they have difficulty engaging female students into computing due to negative gender stereotypes that their female students have absorbed. Teachers acknowledge that they struggle to find a clear strategy to undermine these stereotypes. Providing teachers with specific strategies or lesson plans to break gender stereotypes may be an important way that GAComputes! can expand the computing pipeline to include more female students. Similarly, while the program has tried to engage school leaders, the program may consider continuing this effort to reach out to education leaders especially in the light of potential policy changes which include Career, Technical and Adult Education (CTAE) courses and calculations of adequate yearly progress (AYP).

2. **Female and underrepresented minorities need additional support in order to bridge the gender and racial gap in achievement.**

   While the number of female AP CS test takers has increased over time, their scores on the AP CS exams suggest that they are underperforming compared to their male counterparts: approximately 48% of females pass the AP CS exam with a score of 3 or higher compared to 58% of males. A similar pattern is found with Hispanic test takers: their numbers are steadily increasing over time yet they continue to underperform on the AP CS exam compared to White and Asian test takers. In general, female, Black, and Hispanic test takers are scoring a 3 or higher on the AP CS exam at comparatively lower rates than male and White test takers. Among Black test takers, the number of students taking and passing the AP CS exam with a 3 or higher fluctuates considerably from one year to the next experiencing gains and losses of between 50% to 100% over the course of a year.

3. **Addressing discrepancies in instruction in computing courses between high achieving and low achieving schools in Georgia may help level the playing field between the races.**

   It was observed in a predominantly African-American Computing in the Modern World classroom that the teacher failed to emphasize programming concepts and did not challenge her students to utilize problem solving methods in computing. In fact, students were observed creating PowerPoint presentations as part of their core requirement for the class. This lack of emphasis on higher-order thinking skills in computing may contribute to the lack of preparedness among underrepresented minority students to effectively tackle advanced computing courses (e.g. AP Computer Science).

4. **Stronger relations between computing teachers, school administrators and counselors may be needed in order to clarify the academic currency of computing courses.**

Teachers indicated that one of their challenges to engaging students into computing is the perception among counselors and administrators that computer science courses are dumping grounds for students who need elective credit. Because computer science courses are not seen as holding as much academic currency as other courses (e.g., English), counselors and students fail to understand how the problem solving skills that they learn in a programming class could be helpful across a variety of careers and disciplines. Likewise, such 'buy-in' from administrators may curtail the cuts to computer science courses that many schools have been facing in Georgia.

5. **Long-term tracking of students through each phase of the computing pipeline is imperative to demonstrate that the program has a direct impact on the recruitment, retention and transition of students in computer science.**

One of the particular challenges with the assessment of GAComputes! has been the difficulty in tracking students as they progress from the computing summer camps to high school courses (e.g. AP Courses) to obtaining an undergraduate and/or graduate degree in computing. While some effort has been made in surveying college students to assess the impact that the summer computing camps had on their decision to pursue computing, it is also understood that program implementation can take many years in order to 'trickle down' to student-level change that could be detectable by surveys. Other methods of tracking students through the pipeline should be discussed and pursued. For example, repeated mixed measures deployed through multiple observations over time and involving carefully chosen comparison groups would be necessary to assure any causal relationship between GAComputes! summer camps and students' intent to pursue computer science in college.

Findings

1. **Resources:** To what extent are the resources (robotics kits, day camp curriculum, funds to support local workshops) being used?

a. Robotics Kits

To enhance classroom demonstrations and lesson plans, robotics kits (e.g., LEGO NXT) were available to be lent to schools from the GAComputes! program. Each school could borrow up to 10-15 of the robotics kits at a time for a time period of up to 3 weeks. Table 1 indicates that, in total, 1,983 kits were borrowed from 2007 to 2011. 38 unique institutions (e.g., Brookwood High School) borrowed robotics kits. As GaComputes! matured over time, the number of kits lent and the number of institutions requesting to borrow the kits increased. For example, from 2007-2008, the number of kits lent grew by 206.8% (308 kits in 2007-2008 and 945 kits in 2010-2011; 945-308=637/345=2.068 or 206.8%).

Table 1. Number of kits lent by year and institutions borrowing kits

Years	# of Kits Lent	# of Institutions	Institutions	Type and # of Available Kits
2007-2008	308	9	Georgia Tech, Wesleyan High School, Northeast Science Magnet HS, Campbell HS, Devry University, Fulton County, Columbia HS, Redan HS, Norcross HS	24 Lego NXT; 36 PicoCrickets
2008-2009	333	7	Georgia Tech, Brookwood HS, Creekside HS, Georgia Gwinnett College, Girl Scouts of Greater Atlanta, Shannon Forest Christian School, Wesleyan School	24 Lego NXT; 36 PicoCrickets
2009-2010	397	14	Georgia Tech, Georgia Gwinnett College, Girl Scouts of Greater Atlanta, Loganville HS, Mount Pisgah Christian School, Mountain View HS, Norcross HS, Northview HS, Riverwood International, Shannon Forest Christian School, South Gwinnett HS, Devry University, Duluth High School, Georgia Gwinnett College	24 Lego NXT; 36 PicoCrickets; 15 Pleo Robots
2010-2011	945	20	100 Black Men of Atlanta, Alexander HS, Alpharetta HS, Georgia Tech, Carroll County, Cedar Grove HS, Creekside HS, Dunwoody HS, Girl Scouts, Grayson HS, Heard County HS, Kennesaw Mountain HS, Lanier HS, River Ridge HS, Sprayberry, The Walker School, Towers HS, TriCities HS, Woodstock HS, Yell Academy	24 Lego NXT; 36 PicoCrickets; 15 Pleo Robots; 15 WeDo tilt and distance sensors; 24 LEGO WeDo kits
Total	**1,983**		**# of unique institutions= 38**	

In 2011-2012, Georgia Tech increased the number of kits to include 38 Android Cell Phones and 15 Finch Robots (in addition to all of the kits offered previously). The addition of the Android Cell Phone kits came in response to the frequent requests by teachers to integrate phone application activities into their curriculum. In general, this indicates that GAComputes! provided Georgia institutions with computing tools across its lifespan in an effort to make computing appealing to a diverse range of students.

b. Day Camp Curriculum

Faculty at local University System of Georgia (USG) institutions were invited to attend workshops on "How to run a summer camp" which provides information pertaining to the logistics (e.g., advertising) of running a computing camp. 10 USG institutions attended these workshops. See Table 2 for a list of participating institutions.

Table 2. USG Institutions who attended the work on "How to run a summer camp."

Columbus State University
Armstrong Atlantic State University
Darton College
Gainesville State College
Georgia Southern University
Georgia Southwestern State University
GT Savannah
Kennesaw State University
Paulding County Schools
Southern Polytechnic State University

Feedback data from these institutions obtained at the conclusion of the workshops indicate that the faculty at local USG institutions found the workshops to be highly informative, engaging and useful. Likewise, the data indicates that all of the learning objectives were met. Participants indicated that the workshop 1) helped them to determine the next steps that they can take to begin the summer camp workshop process, 2) increased their commitment to implement a summer camp, 3) increased their understanding of what is required to run a summer camp, and 4) provided them with materials and resources needed to both plan and market a summer camp workshop. See Table 3 for more information.

Table 3. Mean responses to feedback surveys provided at the workshops on "How to run a summer camp."

<table>
<tr><th colspan="3">Workshop Agenda: Planning and running the summer camps, forms and marketing, introduction to the content (e.g. Scratch, Alice)</th><th rowspan="2">Learning Objectives (e.g. "The workshop increased my commitment to implement a summer camp for our region's improvement")</th></tr>
<tr><th>Informative</th><th>Engaging</th><th>Useful</th></tr>
<tr><td>3.92</td><td>3.94</td><td>3.74</td><td>3.80</td></tr>
</table>

Note. Scale 1, not at all to 4, to a great extent

c. Summer Camps and Student Perceptions

GACOmputes! provided funding and training to other colleges and universities in Georgia to host their own summer computing camps for K-12 students; approximately $5K per workshop was allocated in order to help bootstrap these camps. GaComputes! provided curricular materials based on their our own middle and high school summer camps. By offering seed money to local USG institutions (e.g., Albany State University), GACOmputes! was able to broaden the number of K-12 students who participated in the computing camps. Table 3 summarizes the number of USG institutions that have received seeded funding to host summer computing camps for elementary, middle and high school students. Thus, a broader and more effective impact on the state's computing education pipeline is developed by helping other USG institutions to offer their own middle and high school student summer camps. Camps at colleges and universities across the state draw from their own regional school districts which has an added advantage in recruiting those local students into their degree programs. Figure 1 shows a map of the state of Georgia with flags indicating where each USG institution is located. It is evident from Figure 1 that the summer computing camps are being offered in diverse communities throughout the state; both rural and urban communities are being reached which, ultimately, increases the diversity of students being served.

Table 3. Number of institutions participating in GACOmputes! computing summer camps

	Pipeline	Years	n
Summer Camps at Colleges and Universities (Seeded Summer Camps)	USG Institutions: • Albany State University • Columbus State University • Georgia Gwinnett College • Georgia Southwestern University • GT Savannah • Kennesaw State University • Mercer University • University of Georgia- Athens • Valdosta State University	2006	1
		2007	4
		2008	6
		2009	7
		2010	5
		2011	6
	Total		**29**

In addition, The Walker School—a private college-preparatory school for grades PreK-12, located north of Atlanta, Georgia— adopted the computing curriculum and offered computing camps to elementary school students during the summer of 2011. Ddespite not being provided with funding, The Walker School was impressed with the curriculum and encouraged by the results that GACOmputes! summer camps had generated in previous years to offer it to interested students. Also, the computing camp curriculum and resources were adopted by 100 Black Men of Atlanta—a coalition of Atlanta's most influential men organized to provide academic support and improve the quality of life for African-American youth. Former IT Workers, who are transitioning into a career as a computing educator, facilitated the computing camps that were offered to African-American elementary, middle, and high school students at 100 Black Men of Atlanta. This is strong evidence that the computing camp curriculum and resources are being utilized un-solicitously by schools and organizations in the computing community at large.

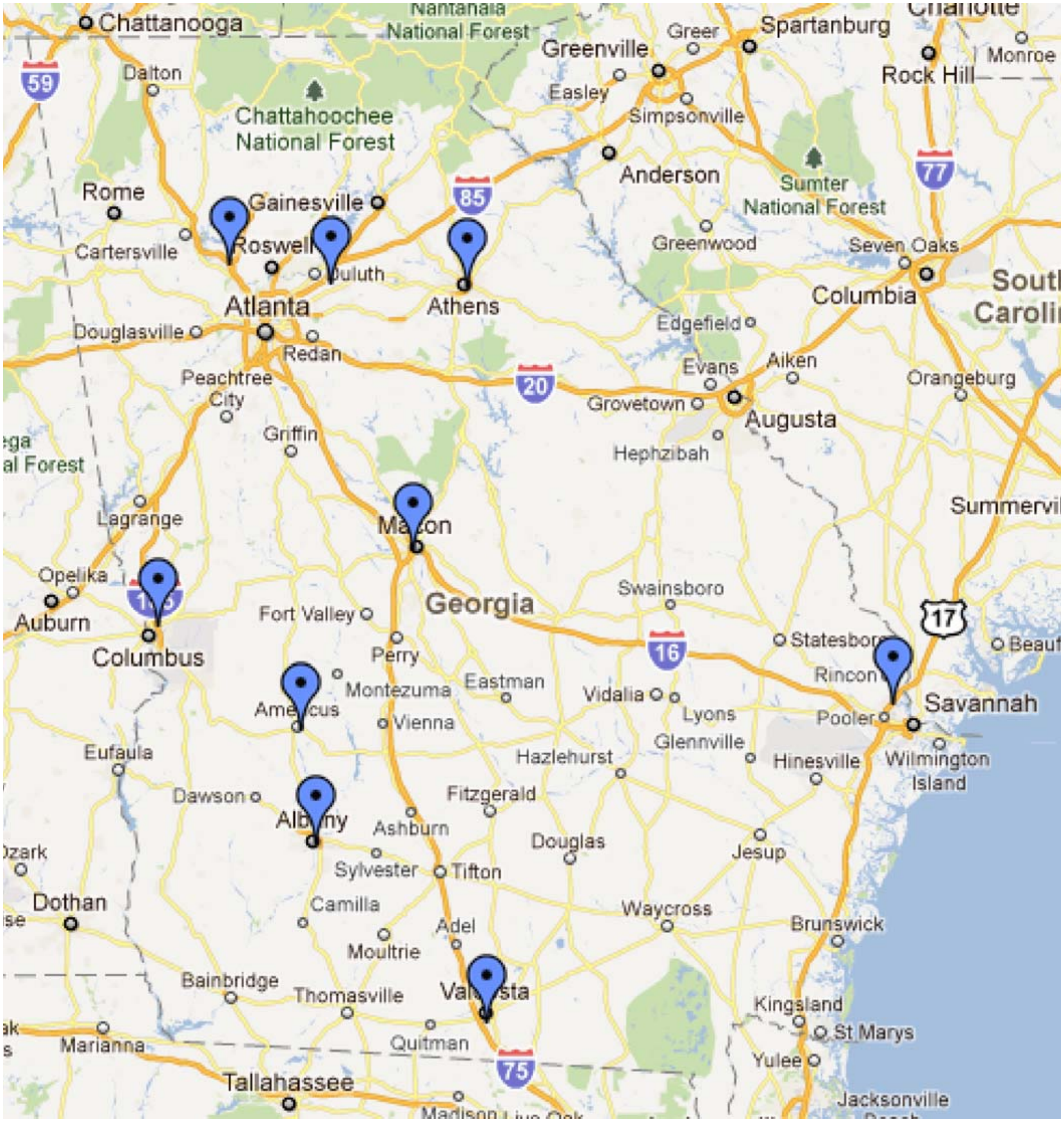


Figure 1. Seeded Summer Camp locations across the state of Georgia

To assess the impact of the summer and seeded summer computing camps on students' attitudes, surveys were administered at baseline (pre; day one of camps) and after the event (post; final day of camps). The attitudinal indicators that were assessed were interest, confidence, and culture. Specifically, these items were:

1. Computers are fun
2. Programming is hard
3. Girls can do computing
4. Boys can do computing
5. Computer jobs are boring.
6. I am good at computing.
7. I like computing
8. I know more than my friends about computers.

Results from these surveys indicate that students who participated in the summer camps at Georgia Tech and/or at the USG Institutions experienced statistically significant ($p<.05$) growth in their positive attitude towards computing. Specifically, students made significant gains from pre to post in their reported self-efficacy in computing ("I am good at computing" and "I know more than my friends about computing"), their perception of computing as enjoyable ("I like computing."), and their view that computing is less difficult than they initially conceived ("Programming is hard"). See Table 4.

Table 4. Student pre/post attitudes by Summer Camps and Seeded Summer Camps

Summer Camps at GT

	Pre/Post	N	Mean	Std. Deviation	t-test	Effect size
1. Computers are fun.	Pre	605	4.45	0.71	.107	0.05
	Post	574	4.52	0.74		
2. Programming is hard. (n)	Pre	599	2.99	0.95	.089†	0.05
	Post	572	2.88	1.10		
3. Girls can have jobs in computing.	Pre	602	4.54	0.75	.670	0.01
	Post	442	4.52	0.77		
4. Boys can have jobs in computing.	Pre	600	4.62	0.64	.995	0.00
	Post	438	4.62	0.65		
5. Computer jobs are boring. (n)	Pre	592	2.06	0.97	.967	0.00
	Post	569	2.06	1.00		
6. I am good at computing.	Pre	602	3.59	0.97	.000**	0.15
	Post	563	3.86	0.88		
7. I like computing.	Pre	599	4.18	0.89	.001**	0.09
	Post	568	4.34	0.81		
8. I know more than my friends about computers.	Pre	604	3.40	1.05	.001**	0.10
	Post	570	3.60	1.02		

Seeded Summer Camps

	Pre/Post	N	Mean	Std. Deviation	t-test	Effect size
1. Computers are fun.	Pre	999	4.50	0.70	.287	0.02
	Post	937	4.46	0.81		
2. Programming is hard. (n)	Pre	988	2.99	0.96	.031*	0.05
	Post	931	2.89	1.10		
3. Girls can have jobs in computing.	Pre	969	4.33	0.86	.283	0.03
	Post	747	4.28	1.01		
4. Boys can have jobs in computing.	Pre	977	4.50	0.73	.310	0.02
	Post	749	4.46	0.82		
5. Computer jobs are boring. (n)	Pre	986	2.08	0.97	.002**	0.07
	Post	921	2.23	1.10		
6. I am good at computing.	Pre	989	3.67	0.91	.000**	0.15
	Post	924	3.93	0.86		
7. I like computing.	Pre	980	4.22	0.83	.016*	0.06
	Post	920	4.31	0.81		
8. I know more than my friends about computers.	Pre	989	3.43	1.07	.000**	0.11
	Post	906	3.66	1.04		

Note. Effect size = .10 to .29 = small; .30 to .49 = medium, .50 to 1.00= large; p-value (independent samples t-test): *p<.05 **p<.01; (n)=negatively worded statements
Scale: 1, strongly disagree to 5, strongly agree

In total, 719 students participated in the summer camps at Georgia Tech and 1293 students participated in the seeded summer camps at USG Institutions. Table 5 indicates that a greater percentage of the students who attended summer camps at Georgia Tech were females (34%) and underrepresented minorities (53%). Among participants who attended seeded summer camps, only 20% were female and 28% were from underrepresented minority groups. This indicates that the summer camps at Georgia Tech may be more effective at attracting women and minorities to their camps than USG institutions.

Table 5. Number of students who participated in Summer Camps and Seeded Summer Camps

Summer Camps at GT (n)

Years	Total	Females	URM
2006-2007	86	26	31
2007-2008	152	42	74
2008-2009	116	45	64
2009-2010	164	84	122
2010-2011	201	46	92
Total	719	243 (34%)	383 (53%)

Seeded Summer Camps (n)

Years	Total	Females	URM
2006-2007	62	11	20
2007-2008	223	34	65
2008-2009	186	39	55
2009-2010	348	84	108
2010-2011	474	94	108
Total	1293	262 (20%)	356 (28%)

Note. URM= underrepresented minorities (Black, Hispanic, Multiracial).

2. **Application:** Are middle & high school teachers and USG faculty applying what they have learned through this program?

a. Middle & High School Teachers perceptions of the training quality

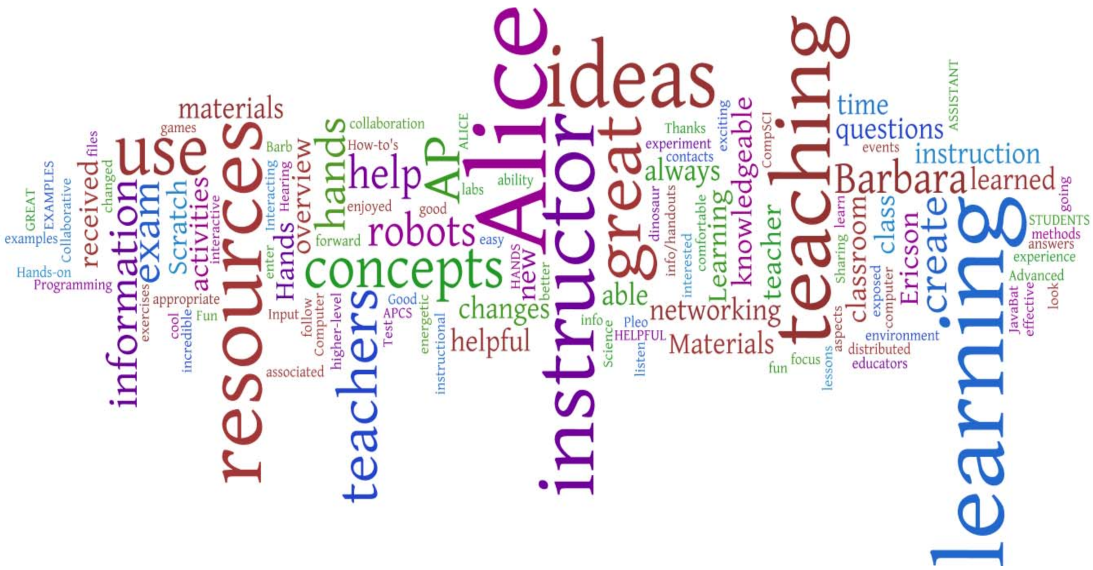


Figure 2. Word cloud of open-ended responses among teachers attending professional development workshops. The word cloud gives greater prominence to words that appear more frequently in the source text.

GAComputes! provided teacher workshops for computer science faculty from K-12 and 4 - year institutions[2]. GAComputes! offered 5-day summer workshops in the four courses which comprise the Georgia Department of Education computing pathway. These courses are: Computing in the Modern World, Beginning Programming, Intermediate Programming and AP CS. In 2008-2009, GAComputes! broadened its teacher workshops to include web development, learning computing concepts with Alice and/or Scratch, Teaching with Robots, and Teaching Java with Multi-Media. These workshops were offered as one day workshops during the academic year. Teacher feedback is gathered at the end of each workshop to gauge participant receptivity to the course. Participant reaction was gleaned from the following statements that assess the workshop agenda items:

1. I learned what I hoped to learn.
2. I can use what I learned in the workshop in the classes I teach.
3. The instruction was effective at helping me learn.
4. The instructional pace was appropriate.
5. The workshop materials helped me learn.
6. The learning activities in this workshop were effective.

[2] As a unit of the University System, most two-year colleges in Georgia have transitioned to four-year institutions.

Table 6 highlights the number of K-12 instructors that have participated in GAComputes! workshops. In total, 34 teacher workshops have been offered and 479 teachers from across the state of Georgia have participated in one or more workshops. 62% of participants were female and 47% were from underrepresented minority groups (URM). On average, participants rated the workshops as a 4.56 on a 5 point likert scale where 1 signifies strongly disagree and 5 signifies strongly agree. Overall, teachers rated all of the agenda items above the critical limit of 4.05 or higher. Participating teachers report that the instruction received at the workshops was effective and appropriate, the workshop materials and activities were helpful and effective, and that they intend to apply what they learned in the workshop to their classrooms

Additionally, a majority of participants reported that the best things about these workshops were the hands-on instruction, the ability to network and share pedagogical techniques with other teachers, and the resources and materials provided by the workshop:

Hands-on Instruction: *"I like seeing the hands-on activities that I can take back to my class."*
Networking: *"Sharing with my fellow computer education teachers. We were able to create good network connections and share great ideas and resources."*
Resources and Materials: *"I gained materials and methods along with time to practice what I will teach in my classroom." "The materials and resources provided by Barb to bring back to the classroom [were the best things about this workshop.]*

Table 6. K-12 teacher workshops

		# of Workshops	N	Female	URM	Feedback[1]
2007-2008	Summer 5-day	5	100	70 (70%)	38 (38%)	4.56
2008-2009	Summer 5-day	4	48	30 (63%)	20 (42%)	4.77
2009-2010	One day teacher workshops	5	57	40 (70%)	23 (40%)	4.27
	Summer 5-days	6	85	51 (60%)	42 (49%)	4.69
2010-2011	One day teacher workshops	10	120	75 (63%)	64 (53%)	4.36
	Summer 5-days	4	69	30 (43%)	38 (55%)	4.72
Overall	**Total**	**34**	**479**	**296 (62%)**	**225 (47%)**	**4.56 (Average)**

[1]Scale: 1, strongly disagree to 5, strongly agree; average computed across 6 feedback items; URM = underrepresented minorities (Hispanic, Black, Multiracial, Native American)

In a comprehensive follow-up survey with 55 teachers who participated in teaching workshops the previous summer, it was evident that **the teacher workshops provide critical computing experience and training which contributes to an increase in the number of teachers teaching programming.** Participating in ICE teacher workshops significantly increased the number of teachers teaching programming by 27%. Only nineteen out of 55 participants surveyed indicated that they were teaching programming before attending the workshop; after the attending ICE workshops, 34 out of 55 participants reported that they are are currently teaching programming. Before attending the workshop, 39% of participants cited "lack of experience/training" as being primary reason for not teaching programming. Thus, GAComputes! fills a critical hole in teachers' preparation to teach programming.

Moreover, **ideas related to animation and hands-on learning activities are most utilized by teachers.** All participants indicate that they are utilizing ideas and materials gleaned from the workshops in their own teaching practices. Over 30% of participants are using ideas related to animation and hands-on learning. Media manipulation and robotics ideas are also being used by over 20% of participants. See Table 7 below.

Table 7. Programming materials used from teacher workshops

WHAT, IF ANY, IDEAS FROM THE WORKSHOP(S) ARE YOU USING WHEN YOU TEACH PROGRAMMING? (N=55)	
I'm not using any ideas from the workshops	0%
Media manipulation	20%
Animation	35%
Robotics	25%
Props	18%
Analogies	18%
Hands-on learning activities	31%
Other idea(s)	9%

Over 45% of teachers are integrating projects/exercises, handouts, and PowerPoint slides that they obtained from the teacher workshops in their computing classrooms. However, fewer than 10% of participants report using sample syllabuses from the book and instructors' manuals or solutions manuals for the book. See Table 8 below.

Table 8. Teaching materials used from teacher workshops

WHAT, IF ANY, MATERIALS FROM THE WORKSHOP(S) ARE YOU USING WHEN YOU TEACH? (N=55)	
I'm not using any of the materials from the workshops	0%
Projects/exercises	58%
Handouts	45%
Movies/videos	20%
PowerPoint slides	47%
Practice database of Advanced Placement test items	16%
Book (introduction to Computing and Programming with Java: A Multimedia Approach)	15%
Sample syllabus from the book	5%
PowerPoint slides for the book	11%
Instructor's Manual for the book	9%
Solutions Manual for the book	9%
Another book	11%

Only 20% of teachers surveyed indicate that they are using materials provided by GAComputes! (e.g. videos, presentations) to recruit students, particularly females and under-represented minorities to their computing courses. Enhancing the effectiveness of recruitment material and highlighting the need to actively recruit females and minorities may be fruitful to augmenting the number of female and minorities in the computing pipeline. Clearly no one recruitment strategy is being used by all teachers. See Table 9.

Table 9. Recruitment strategies used from teacher workshops

WHAT, IF ANY, RECRUITMENT STRATEGIES DID YOU USE TO ATTRACT STUDENTS TO YOUR COURSE(S)? (N=55)	
I did not intentionally recruit	13%
I used materials provided by ICE (e.g. video, presentations)	20%
I used other materials	20%
I wrote letters to students who did well on the PSAT	11%
I asked girl leaders to take the course	9%
I encouraged girl leaders to ask their friends to take the course	13%
I held an open house for the course	15%
Other	20%

Future workshops in cell phone programming are strongly appealing to participants. 78% of participants indicate that they intend to participate in additional teacher workshops in the future. Those who are not interested in attending additional workshops indicate that they are either no longer teaching programming or have received adequate training for the courses that they are presently assigned to teach. Suggestions for improving future summer workshops include providing more programming and software ideas for attracting students to the program and open access to a database of questions and answers for students to use prior to exams.

In general, participants report being pleased with the workshops and are eager to participate in additional training opportunities:

"I think Barb is amazing! There is very little that can be improved upon. If anything, the programming classes should be extended to 2 weeks instead of one."
"I thought the workshops were great. I really liked all the hands-on activities."

b. USG Faculty perceptions of the training quality

From 2007-2010, 287 faculty members from over 120 colleges and universities throughout the United States participated in GAComputes! faculty workshops. See Table 10 for a list of the participating colleges and universities. In total 21 faculty workshops were offered across the lifespan of the program. These workshops focus on media computation and how to run a computing summer camp. Computer science educators attend these workshops to learn new approaches to teaching that may open up the field of computer science to students who may not initially be inclined to think of themselves as computing types. Each workshop lasts between two/three days and offers faculty several different approaches to introducing computing to students; each approach has proven to have previous success in attracting and retaining women and minority students in computer science departments.

Table 10. Participating college/universisites in GAComputes! faculty workshops.

- Academy of Allied Health and Science
- Albany State University
- Alderson-Broaddus College
- Alleghany College/ U Minn. Morris
- Appalachian State U
- Armstrong Atlantic State University
- Art Institute of Charleston
- Bennett College
- Bessemer Center for Technology
- Bristol Community College
- Bronx CC of CUNY
- Bucks County Community College
- California State University Easy Bay
- Cape Cod Community College
- Central Ct State University
- City College of New York
- College of South MD
- College of Wooster
- Columbus State University
- CSU Long Beach
- Dalton College
- Dixie State College of Utah
- Drew University
- Framingham State College
- Gainesville State College
- Georgia Gwinnett College
- Georgia Perimeter College
- Georgia Southern University
- Georgia Southwestern State University
- Graceland University
- GT Savannah
- Illinois Institute of Technology
- Jackson State University
- Kennesaw State University
- Kettering University
- Lake Forest College
- Macon State College
- Massachusetts Bay Community College
- Mercer University
- Mesa College
- Montclair State University
- New River Community College
- Norfolk State University
- North Georgia College and State University
- Northeastern University
- Northwest Missouri State University
- Oberlin College
- Ocean County Vocational Technical School
- Okanagan College
- Paulding County Schools
- Randolph-Macon College
- Regis College
- Rochester Institute of Technology
- Rowan University
- Roxbury Community College
- Saint Anselm College
- Salt Lake Community College
- Sayre School
- Sewanee: the University of the South
- Siena College
- Simmons College
- Smith College
- Southern Polytechnic State University
- Springfield College
- Springfield Public School
- St Thomas Aquinas College
- St. Lawrence College
- Strake Jesuit
- Suffolk University
- Temple University
- Texas A & M- Corpus Christi
- The College of New Jersey
- Towson University
- U Mass Dartmouth
- U Mass/ Lowell
- U of M - Dearborn
- U of MN, Morris
- UC Berkeley
- University of Chicago Lab Schools
- University of Denver
- University of Illinois at Chicago
- University of Kentucky
- University of Massachusetts
- University of Massachusetts, Amherst
- University of Michigan
- University of Pennsylvania
- University of Texas at El Paso
- University of West Georgia
- University of Wisconsin, Madison
- Utica College
- Valdosta State University
- Virginia Military Institute
- Virginia Tech University
- Virginia Western Community College
- Washington State University
- Wayne State University
- Wellesley College
- Wentworth Institute
- Wofford College
- Worcester State College

Table 11 indicates that, on average, faculty rated the workshops as a 4.67 on a 5 point likert scale where 1 signifies strongly disagree and 5 signifies strongly agree. Additionally, faculty indicate that the learning objectives for the workshop were met; across all years, the rating for the learning objectives exceeded the critical limit of 3.5 on a 4 point scale. Overall, the faculty workshops aided participants in:

- Generating new ideas for motivating students through the use of contextualized activities
- Identifying at least one HW assignment and related lecture that can be change to become more contextualized
- Identifying a whole course approach that could be adopted at their institutions
- Providing the knowledge needed to adopt contextualized teaching in the classroom
- Convincing them that contextualized computing is a more engaging way of teaching computing to today's students

Table 11. Faculty (College, University) Workshops

Year	# of workshops	# of participants	Workshop Agenda[1]	Learning Objectives[2]
2007	6	68	4.56	3.65
2008	5	70	4.66	3.60
2009	5	61	4.69	3.59
2010	5	88	4.75	3.65
Total	**21**	**287**	**4.67 (Average)**	**3.62 (Average)**

[1]Scale: 1, strongly disagree to 5, strongly agree; average computed across 6 feedback items
[2]Scale: 1, not at all to 4, very much; average computed across 5 learning objective items

Additionally, a majority of faculty participants reported that the best things about these workshops were the learning activities and hands-on assignments, the opportunity to learn from colleagues and peers about best practices in the field, and the general inspiration that they felt to infuse new material into their classes.

- **Learning Activities and Hands-on Assignments:**
  "The hands on demos. The instructors observation on what things have worked (an what hasn't), potential areas of difficulty, things students find frustrating."
- **Opportunity to learn from Colleagues and Peers**:
  "Just great to get firsthand exposure to Mark and the concepts. Meeting the others in the workshops has also been inspiring and helpful. Helps me feel like my research is part of a larger community outside of my own discipline."
- **Inspiration to infuse new material into their classes in order to attract a more diverse body of students into computing:**
  "I have many new ideas to use right away in all of my classes (Math, Physics and computer Science)."
  "Mark's modeling the teaching of the material. Example of ways to make material relevant to students."
  "I am going to talk to my admin about this and figure out how to employ these techniques to get more students intersted in CS!"

> *"I will definitely take steps to make Media Computation to the core of my introduction to programming classes...."*

Among USG institutions, the map depicted in Figure 3 delineates the computer science faculty at colleges and universities across the state of Georgia who have attended summer workshops. The blue dots signify USG institutions offering CS programs and the black dots signify schools sending faculty to summer workshops. Figure 3 indicates that 18 out of 33 institutions that offer CS programs participated in summer faculty workshops. Thus, **GAComputes! successfully drew 55% of the computing departments at college/universities within the state of Georgia for summer faculty workshops.**

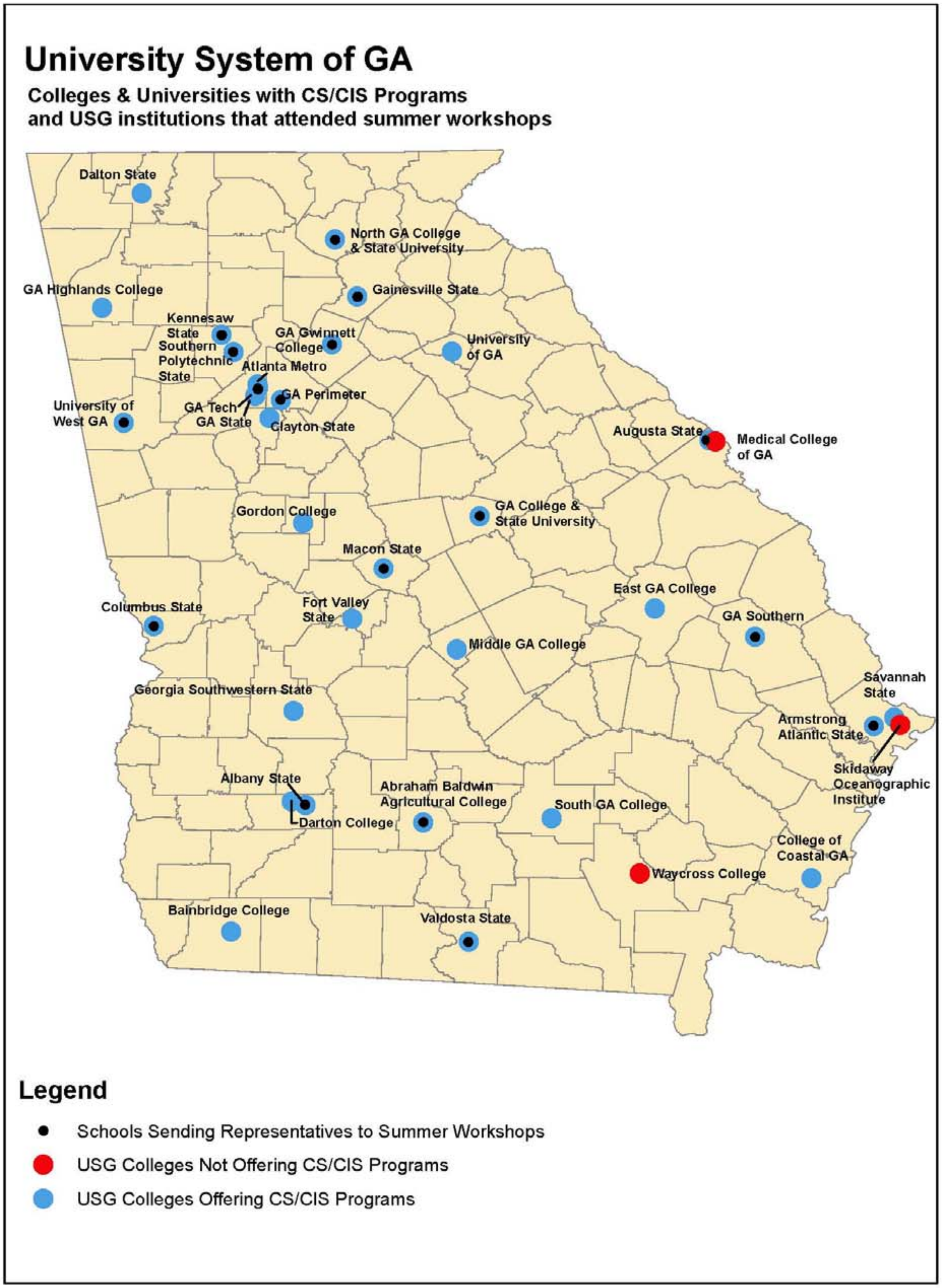


Figure 3. USG institutions attending summer workshops at Georgia Tech

c. Transfer of instruction into practice, *Teacher Interviews*

In the Fall 2010, The Findings Group, LLC conducted interviews with six Advanced Placement Computer Science (APCS) teachers who had previously participated in the ICE workshops. The interviews were designed to answer the following questions:

- What have teachers learned from participating in ICE workshops? How are teachers using what they learned to transform their classes?
- How are students impacted by these changes made by the teachers?
- What recruitment and retention strategies are teachers using in their classrooms?

Teachers' content and pedagogical knowledge

Teachers reported using a wide range of the workshop materials such as lesson plans, projects, PowerPoint, handouts, and websites in their classes to teach Alice, Scratch, Greenfoot, Java, LegoRobots, in particular. One teacher described how she was able to effectively incorporate the content she had learned during the workshop into her course. She said,

> *"I'm definitely using her [workshop facilitator] project samples that she's provided for Scratch. ... I had some PowerPoints I believe I got from her for the Lego stuff that I use. ... She hired someone to do some Computing in the Modern World handouts... she sent a link to the email on these Computing in the Modern World handouts. I use, like, all of those...I use some of the stuff also that teachers have put on the Wiki site that we all did together at the workshops."*

Teachers also talked about how they has been successful in using the various teaching strategies they had learned during the workshops, to effectively teach the afore-mentioned content areas. They reported making use of hands-on activities, visual aids, tutorials, and workshop cds in their classrooms. One teacher described how she had utilized a teaching strategy in her classroom. She said,

> *"One of the things that she [workshop facilitator] does a really good job of is trying to get hands-on or visual activities that the kids can understand with logical concepts as it relates to programming... Something that I use myself [having seen] her visuals... [is] to show arrays of rows and columns and multi-dimensional array[s]... I'll put pieces of gumballs in them and show them how you can put an object inside of these little blocks and borders that have rows and columns and positions, so that they can get a visual concept of how arrays work... I [also] liked [how] she has each of us become an object. Then we were given a method that we had to act upon... [I] show objects and methods... [by using] different sizes of balls - footballs and basketballs, soccer balls and foam balls...[the students] come up with different types of methods of what the ball can do to show all the different methods, but yet those methods can relate from one object to the next."*

Hence, overall, teachers had obtained a lot of content and pedagogical knowledge, which they had successfully implemented in their classrooms, to a large extent. Furthermore, there were a few differences between the teachers who had attended three or more workshops as opposed to the teachers who had attended fewer workshops. The teachers who had attended more workshops reported using more materials and teaching strategies than those teachers who had attended fewer workshops. This may have occurred because the teachers who had attended more workshops simply had a larger collection of materials and teaching strategies at their disposal. Also, teachers with less workshop experience seemed to have obtained more content knowledge (i.e. they got to know about using lesson plans and projects to teach Alice, LegoRobots, Scratch), while teachers with more workshop experience seemed to have obtained more pedagogical knowledge (i.e. they talked more about the benefit of using hands-on activities, visual aids). It is possible that early workshop experiences provide content knowledge to teachers, which they later use as a 'scaffold' to focus more attention on making pedagogical enhancements. More experienced ICE participants also reported having acquired and utilized more knowledge, overall.

Impact on student learning

Consequently, it was important to assess whether the implementation of these new materials and strategies by the teachers had any effect on their students' learning. All the teachers felt that their students were positively impacted in two ways: (a) Increased engagement with computing and (b) Increased awareness of computing careers.

Several teachers reported that the new materials and the new pedagogical approaches had positively affected their students' engagement with computing. They felt that this was reflected in the level of their students' excitement in doing new projects and in knowing more about new content areas. One teacher said,

> *"The students really enjoy using Alice. I'd say probably 70% to 80% of them really got into it. After they met the basic criteria on that we moved onto the next section, the students will regularly ask me, "I'm done with so-and-so. Can I go work in Alice." I'm like, "Sure, go ahead." Then we actually finished up all the standards about two weeks early. The last two weeks of school, I let them go into Alice. They were just doing more stuff, and different stuff, and trying different things, and getting up and going over to each other's computers and watching what they had done. So, the last two weeks last year, they really had a blast."*

Further, all the teachers felt that their students had become more aware of the applicability of CS in a wide variety of fields and how critical their newly acquired CS skills were in different CS vocations and research opportunities. One teacher said,

> "*We've been watching some of the videos... they didn't realize that Computer Science is a part of so much a part of the medical industry, so much a part of like medical research, how it's a part of pretty much any industry. ... They definitely show an interest in learning a little bit more about how Computer Science can relate to their fields. ... We were watching History of Computers... they're like, "So, these people just came up with these ideas on their own? ... They had these great ideas." So, I think they're thinking about that."*

In addition, teachers also felt that their students had become more interested in pursuing a variety of CS fields. One teacher described how her students had become interested in CS and gaming careers, in particular. She said,

> *"They're always into [computer science careers], especially in the gaming and programming to make games. They're very interested in that. A lot of them really do want to pursue that as their career. So, yeah. I definitely see that as helpful…that I can give them outside information."*

Recruitment and retention

Another important goal of the workshops was to equip teachers with strategies to recruit and retain more students (especially, women and minority students) in CS courses. All the teachers reported using a wide range of techniques they had learned during the ICE workshops to recruit and retain students in computing. For example, one teacher used live and captured video demonstrations of student robot projects in various school settings (e.g. parent night and registration) to increase student and parent interest in computing. She also used the fact that one of her students had won a major prize in the Scratch competition as a platform for course recruitment. Finally, she also relied on students themselves to share their experiences from her classes with each other to recruit potential students. Another teacher described how she had taken inspiration from student projects to recruit more students for her CS courses. She creatively used Alice and PicoCricket inspired themes as advertisements for her courses. She also used her in-class, game design competition to generate student word of mouth "buzz" about her courses. Furthermore, she decorated the door of her classroom to attract the attention of people walking by to inquire about what might be going on inside. She would then invite students, administrators and guidance counselors to observe her students working on projects.

Teachers also described how they took extra efforts to recruit women to take their CS courses. All the teachers unanimously agreed that the emails and ancillary materials such as posters, handouts, research data and videos handed out to them by the workshop facilitator had played a pivotal role in helping them recruit girls. One teacher said,

> *"There's a Women in Computing site that she [workshop facilitator] told us about that I have accessed. They sent me a bunch of materials and posters and things. I use that. Plus, she always sends us emails about different groups that are promoting computing, or it might be a woman's organizations that's doing computing... I will use those a lot... So, that has been a good tool, like the posters that I get from the Women in Computing organizations."*

Thus, overall, teachers were consciously implementing multiple strategies to recruit and retain students in computing courses. They were also successfully using recruitment materials to recruit female students in their schools to take CS courses. However, in contrast, there was no evidence that teachers were consciously targeting the goal of increasing recruitment and retention of minority students in their CS courses.

Overall, the impact of the ICE workshops was strong and positive.

- Teachers demonstrated enthusiastic utilization of the content, materials, and pedagogical strategies acquired from participating in the ICE workshops and from the post-workshop support provided by the workshop facilitator. Students appeared to be positively impacted by the changes made by the teachers. However, it is important to note that although the teachers were able to provide anecdotal evidence of the positive impact on students, they fell short in providing evidence of student improvement in terms of academic gains.
- Teachers were also implementing multiple intentional strategies to retain and recruit students into computing courses and to target recruitment materials towards female students. However, there was little evidence of successful recruitment or retention of minority students in their CS courses.

d. Transfer of instruction into practice, *Classroom Observations*

In an effort to observe the transfer of instruction received from GAComputes! teacher workshops into practice, The Findings Group, LLC conducted classroom observations. Two teachers from two different high schools in the Atlanta area volunteered to take part in the classroom observations. There were many parallels between the two teachers: Both were currently teaching Computing in the Modern World; both had participated in 4-5 teacher workshops at Georgia Tech; and, both had been teaching Computing in the Modern World for 2-3 years. Despite these similarities in teacher characteristics, there were notable differences between the two high schools. Table 12 summarizes the structural and demographic differences between the schools. For example, School A is considered a high performing high school in the Atlanta area that offers computing courses leading to AP Computer Science. School B, on the other hand, is comprised of a high African-American student population in a low income neighborhood; AP Computer Science, Beginning Programming and Intermediate Programming are not offered at School B. While the students at School A enjoy brand-new computers in a new computer lab, the students at School B contend with outdated computers that "take forever to load."[3]

Table 12. Demographic differences between schools

	% Black Students	% URM Students	% Eligible for Free/ Reduced Meals	AP CS Exam	Technology in Classroom
School A	25%	47%	36%	Offered	Brand-new computers; SmartBoard
School B	98%	100%	59%	Not offered	Outdated computers (4-6 years old); overhead projector

Note. URM= underrepresented minorities (Hispanic, Black, Native American, Multicultural)

Table 13 highlights the differences and similarities in instructional practices between the two teachers. At School A, the students were utilizing their programming skills to create unique games using Google App Inventor. At School B, students were creating PowerPoint presentations of their Alice projects. Thus, the quality of the lesson plans at the two schools were dramatically different: students at School A were learning algorithmic processes that create, describe, and transform information into complex model systems; on the other hand, students at School B were operating a presentation program with minimal programming skills required.

[3] Comment overheard by several students in the classroom at School B

Table 13. Differences in instructional practices between teacher A/ school A and teacher B/School B

	Teacher A/ School A	**Teacher B/ School B**
# of students; # female; # URM	26 students total; 8 African-American; 3 Hispanics; 4 Females	29 students total; 28 African American; 1 Hispanic; 8 Females
Classroom Activity	Android Phone. Google App Inventor to create games ("molemash" or "paint").	PowerPoint presentations of Alice projects.
Classroom Procedure	Teacher modeled activity; reviewed assignment and tutorial; explained to students what they can anticipate in terms of challenges in programming their games.	Teacher provided PowerPoint instruction on how to accomplish task; very little modeling took place.
Student Interest	Kept students on task by giving positive reinforcement to students who were soaring ahead and one-on-one attention to students who needed extra support. Encouraged students to look at each other's work for ideas and inspiration. *"[Name of student's] game looks really cool. Come and take a look at how he used loops in his program."*	Kept students on task by providing negative reinforcement to students who were disengaged in the activity. Little encouragement to students who were working diligently. *"Come on [name of student]; stop fidgeting and get to work." "What's the problem [name of student]?; what crisis are you having today such that you can't do this?"*
Culture for Learning	Set high expectations; showed enthusiasm	Set expectations to accomplish work; showed minimal enthusiasm
Questioning and Discussion Techniques/ Engaging Students in Learning	Posed questions to challenge students' problem solving skills in programming. *"How would you tackle this problem? What is the first step that you would use?"* Discussed short cuts in the program; inspired students to use their creativity/ingenuity to change/alter some features of the program. *"How can you use the editor option that we learned last week to make this even better?"* Also, notified students of the real-world application of their assignment. "*If your game is really good, you can sell it online or give it to your friends and family."*	Very few questions were posed to students; provided individual attention to students who were struggling to load the Alice program; little to no collaboration among students was observed.

Note. URM= underrepresented minorities (Black, Hispanic, Multiracial, Native American)

Likewise, the level of student engagement and the general culture of learning in the two classrooms were vastly different. Teacher A engaged her students with challenging questions and inspired them to extend their programming skills beyond the lesson plan. By showing enthusiasm and setting high expectations, teacher A motivated students to use their problem solving skills to independently complete complex programming issues. Teacher B, by contrast, set low expectations for her students to attain (e.g. "*I just want you to finish the assignment by the end of next week."*) and did not engage her students in discussions that may facilitate their computing skills.

In fact, in follow-up conversations, Teacher A and Teacher B underscored different aspects of the teacher workshops at GAComputes! that contributed to the way that they teach Computing in the Modern World. Teacher A noted that her emphasis on problem solving skills in programming was motivated by her participation in GAComputes! teacher workshops.

"I'm implementing more problem-solving thanks to the workshop because I realized my students in Scratch were not thinking for themselves. They were simply blindly following steps. So, leading up to Scratch, I do more problem-solving in my classroom. Through various activities, games and stuff that I got from Barb, I prepare my students to think critically and to be creative in how they problem solve.

I guess with Computing in the Modern World from last year to this year, it's much more program-based, project-based thanks to Barb's workshop. We do a lot more with projects because, (1) the students like it better and (2) I think it has them learning a little bit more. Like last year, I taught Computing in the Modern World and it was more, "Follow along and do this activity." You know, "Do this programming activity. Program this." But this year like with the robots, I gave them a challenge, and they had to figure out, based on the little bit we did together, how to solve it. So, I've definitely done that more where it's more project-based where they're actually thinking for themselves, and doing it on their own, and using the resources that I've given to them, but not giving them everything."

Teacher B emphasized the abundant computing activities and resources that the teacher workshops provided her.

"I use tons of resources that I received from Barb. I use the videos like "A Day in the Life as a Computer Scientist;" I use Alice, LegoRobots, Scratch. I also use a lot of the classroom activities that Barb emails us about throughout the year. I give students the tutorials and they follow them. They seem to enjoy being creative with the Alice and Scratch programs. I mainly try to get them to see how computing can lead to interesting careers and things."

These quotes suggest that, **in addition to providing valuable resources and materials, the GAComputes! teacher workshops encourage teachers to cultivate in their students higher-order cognitive skills that require the modulation and control of more routine or fundamental skills in programming.** Despite using the resources provided to her, Teacher B may be disadvantaging her students by not developing their creative programming skills and challenging them to utilize problem solving methods in computing. Teacher B remarked that her main goal in Computing in the Modern World is to encourage her students to see their potential as computer scientists by exposing them to "interesting careers" and encouraging them to be "creative with the Alice and Scratch programs." **Although inspiring underrepresented minority students to reach their potential as computer scientists is a goal of GAComputes!, providing such students with the necessary tools and skills is even more vital and should continue to be emphasized in teacher workshops.** The differences in instructional practice between School A and School B may be reinforcing deeply entrenched racial differences in student computing outcomes. For example, in 2009-2010, white students who took the AP Computer Science exam in Georgia were nearly 3 times more likely than Black students to pass with a score of 3 or higher[4] (College Board, 2010). **Addressing discrepancies in instruction between high achieving and low achieving schools in Georgia may help bridge the achievement gap between the races and advance the goals of GAComputes!.**

[4] Refer to Evaluation Question #6, Table 31 for more information

Despite the differences in instructional practice between the two teachers, notable similarities were observed. Both classrooms were adorned with posters and material received from GAComputes! teacher workshops. Such posters and flyers depict careers in computing, courses in computing, and other general computing themes. For example, in School A, a poster depicting women and technology promoted the concept of engaging in creative, people-oriented work through computing ("What's your passion? Do you want to be creative, work with great people, change the world? Make it happen with computing"). At School B, a poster inviting students to "Expand Your Connections" to computing was hung prominently in the classroom. See Figures 5 and 6. These visual aids were suggested to them at GaComputes! teacher workshops and served to enhance the general atmosphere of academic achievement at their respective schools. In addition to these visuals, both teachers noted that they actively use several recruitment strategies that they learned at GAComputes! teacher workshops. Teacher A and Teacher B promote their classes and the field of computing by using posters at school fairs and by airing a video of their students engaged in LegoRobots during the course registration period and at Parent's night.

Figure 5. Sample Poster at School A

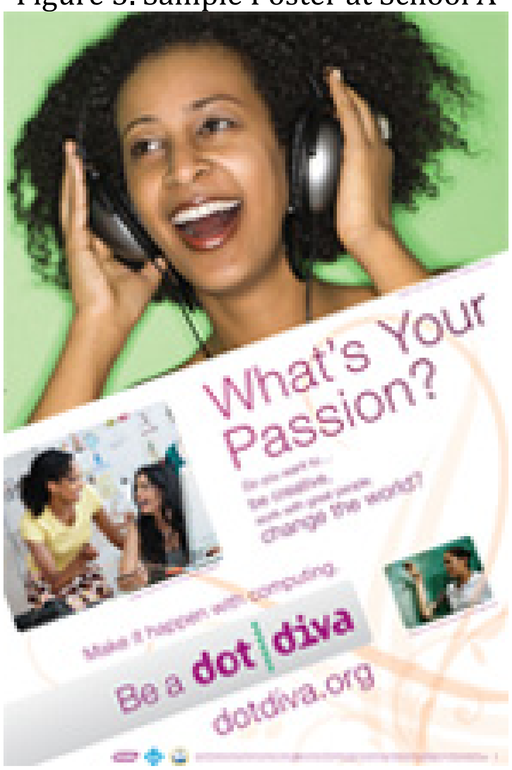
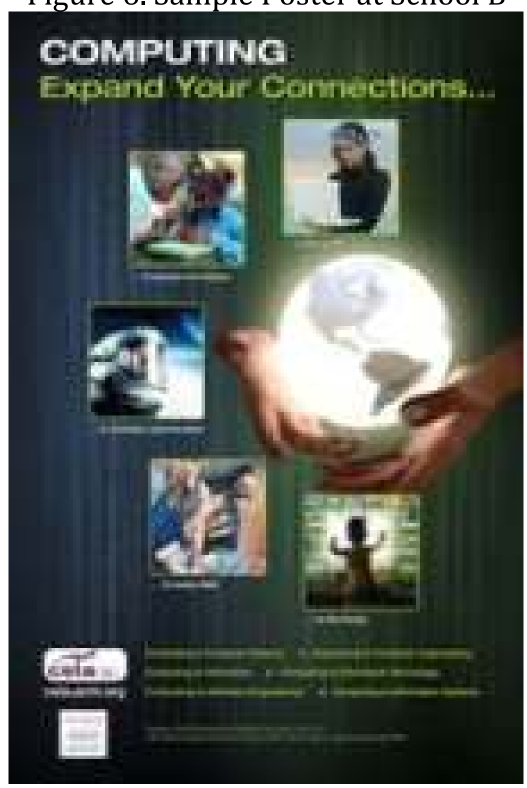


Figure 6. Sample Poster at School B



Even with their recruitment efforts, both teachers suggest that they face several major challenges to recruiting more women and minorities to their classes. Teacher A noted that "30% of the students [in Computing in the Modern World] love this stuff and want to go on in computer science; 40%, however, are just going through the motions because they were placed in this class by their advisor cause it fit their schedules." This sentiment was mimicked by Teacher B who said that "a lot of students were placed in the class, but I think they would rather take a free period." The perception that computer science courses are seen by counselors as a dumping ground for students who need an elective is common in high schools, according to social psychologist, Jane Margolis (2008). Because computer science courses are not seen as holding as much academic currency as other courses (e.g., English), counselors and students fail to understand how the problem solving skills that they learn in a programming class could be helpful across a variety of careers and disciplines. **Stronger relations between computing teachers, school administrators and counselors may be needed in order to clarify the academic currency that computing courses hold.**

Additionally, both teachers noted that they have difficulty engaging female students in computing. Teacher A voices frustration over the gender stereotypes that seem to hang over female students and the seeming impenetrability of these prejudices.

> *"Our girls think that computer science is boring and just for nerdy boys. They look at society and all they see are men doing computers. They think it is not for them. I try really hard to break these stereotypes. I think part of it is just a lack of understanding and knowledge. But, also, it is so hard to break this kind of ignorant thinking."*

Teacher B indicates that the lack of female engagement is mainly due to the false notion that one must be good at math to be good at computer science.

> *"I hear girls saying "I can't do [computer programming] because I am bad at math." This is a big problem. I mainly tell them about Web Design and 3D animation courses, and they seem to like that."*

At both schools, gender stereotypes appear to be an impediment to recruiting female students into computer science. It is apparent that both teachers struggle to find a clear path to dismantle these stereotypes. **Providing teachers with specific strategies or lesson plans to break gender stereotypes may be an important way that GAComputes! can expand the computing pipeline to include more female students.**

Additionally, teachers at both schools express concern over budget cuts and the seeming divestment of resources towards computer science. This concern was most pronounced at School B where recent budget issues led to the cancellation of several computing courses (i.e. Beginning Programming) and the failure to update the computers in the computer lab.

> *"My principal has so much going on with the budget and stuff. She just can't give us new computers now. These computers are terrible. They are so slow that my students sometimes can't do their work efficiently on Alice and Scratch and other programs."*

Teacher B praised GaComputes! for advocating on behalf of computer science teachers and forming relations with school administrators to promote computer science; however, additional support from principals is still needed

> *"We need more buy-in from administrators. Georgia Tech can be our advocates. It helps to have somebody outside of my school who is speaking for me. Barb should continue her work with administrators. She was helpful a few years ago. But, I think she stopped because she didn't see immediate results. I would say that Barb needs to continue this. Keep getting at them. Keep advocating on our behalf."*

Although Teacher A is also troubled by dubious economic resources, she praised her principal for conveying interest in Computer Science and noted that the information that GAComputes! provided was instrumental in facilitating positive relations between her and school administrators.

> *"My principal is really interested in information about women in Computer Science. Barb's information has been a big help. Actually [my principal] just sent stuff to the administrator as well, and the administrator brought it all to me, and talked to me about it, and sat down, which is great because my administrator hasn't really showed much interest in Computer Science previously. So, for him to get that information and actually come talk to me about it was important. It was progress."*

3. **Attitudes:** Do students participating in camps express positive attitudes toward computing, contextualized computing, and careers in computing?

Increasing the number of individual students engaged in computing education is the core objective of the GAComputes! program. All activities are designed to maximize the number of students from underrepresented groups entering and persisting through the pipeline. Table 14 highlights the number of students participating in the following programs:

a. After School and Weekend Student Workshops

A major thrust of theGAComputes! approach is to start filling the pipeline from the pre-high school levels. Previous research has found that students start losing interest in science, math and technology in middle school (American Associatio of University Women Education Foundation, 2000. GAComputes!, thus, provided informal education opportunities for elementary, middle and high school students. Weekend/ after school computing workshops were facilitated in partnership with YMCA, YWCA, Boys and Girls clubs, Cool Girls (an award-winning early intervention after school program dedicated to the empowerment of low-income girls), and Girl Scouts of Atlanta. These workshops introduce real programming in Alice, Scratch, and Robotics. Female and underrepresented undergraduate and graduate students are involved as teachers and mentors in these sessions. From 2006 to 2011, 1,932 students (1679 females, 933 underrepresented minorities, URMs) have participated in the 4-hour workshops. See Figure 4.

b. Summer Camps

GAComputes! offered 4-5 day summer computing camps to elementary, middle and high school students. GAComputes! provided funding and training to other colleges and universities in Georgia to host their own summer computing camps for K-12 students. Overall, 2,012 students (505 females; 739 URMs) participated in computing summer camps. It is important to note that while 87% of the students who participated in the 4 hour weekend and after school programs were female, only 25% of the students who participated in the summer camps were female. This may indicate that **partnering with organizations that are focused on enhancing the life and educational outcomes of females (e.g., Girl Scouts) may be an important avenue for recruiting this target population into computing.** See Figure 5.

Figure 4. Girl Scouts Scratch workshop; students engaged in creating their own interactive stories and animation using Scratch

Figure 5. Summer Camp Pleo (dinosaur) Robot; students listening to an explanation of how sensors, programming and motors work together to create artificial life.

Table 14. Number of students participating in computing workshops and camps

		Pipeline	Years	Total	Females	URM
4 hour Student Workshops	Weekend/After school Workshops	K-12 Students	2006-2007	37	n/a	10
			2007-2008	40	21	17
			2008-2009	107	51	31
			2009-2010	125	124	125
			2010-2011	290	162	218
	Girl Scouts Computing Workshops	K-12 Girls	2006-2007	17	17	12
			2007-2008	294	294	101
			2008-2009	416	407	170
			2009-2010	360	359	170
			2010-2011	246	244	79
Summer Camps	Summer Camps at Georgia Tech	K-12 Students	2006-2007	86	26	31
			2007-2008	152	42	74
			2008-2009	116	45	64
			2009-2010	164	84	122
			2010-2011	201	46	92
	Seeded Summer Camps	K-12 Students	2006-2007	62	11	20
			2007-2008	223	34	65
			2008-2009	186	39	55
			2009-2010	348	84	108
			2010-2011	474	94	108
			Total	**3944**	**2184 (55%)**	**1672 (42%)**

Note. URM= underrepresented minorities (Black, Hispanic, Multiracial, Native American).

At each workshop and summer camp session, questionnaires were administered before (pre) and after (post) the event to measure changes in attitudes toward computing. These items assessing positive attitudes toward computing were:

1. Computers are fun
2. Programming is hard
3. Girls can do computing
4. Boys can do computing
5. Computer jobs are boring.
6. I am good at computing.
7. I like computing
8. I know more than my friends about computers.

Results from these surveys indicate that students who participated in GAComputes! workshops experienced statistically significant (p<.05) growth in their positive attitude towards computing. Specifically, students made significant gains from pre to post in their reported self-efficacy in computing ("I am good at computing" and "I know more than my friends about computing"), their perception of computing as fun and likeable, and their view that computing is less difficult than they initially conceived. Surprisingly, students' perceptions that girls can do computing significantly <u>decreased</u>. Thus, despite reporting that they feel more competent at computing and that they perceive computing as more enjoyable and less difficult than initially expected, students' negative gender stereotypes appear to *increase* from pre to post. See Table 15.

Table 15. Attitudinal change across all years (pre/post)

	Pre/Post	N	Mean	Std. Deviation	p-value	Effect size
1. Computers are fun.	Pre	2910	4.49	.70	.004**	0.04
	Post	2682	4.54	.74		
2. Programming is hard.	Pre	2888	2.99	1.00	.000**	0.07
	Post	2671	2.83	1.15		
3. Girls can have jobs in computing.	Pre	2373	4.45	.83	.046**	0.03
	Post	1907	4.40	.96		
4. Boys can have jobs in computing.	Pre	2303	4.40	.91	.717	0.01
	Post	1805	4.41	.91		
5. Computer jobs are boring.	Pre	2877	2.26	1.09	.812	0.00
	Post	2652	2.27	1.16		
6. I am good at computing.	Pre	2809	3.57	1.02	.000**	0.16
	Post	2553	3.89	.92		
7. I like computing.	Pre	2795	4.17	.90	.000**	0.09
	Post	2549	4.32	.84		
8. I know more than my friends about computers.	Pre	2817	3.36	1.10	.000**	0.11
	Post	2547	3.59	1.09		

Effect size = .10 to .29 = small; .30 to .49 = medium, .50 to 1.00= large; p-value (independent samples t-test): *p<.05 **p<.01
Scale: 1, strongly disagree to 5, strongly agree

Table 16 indicates that female students experienced significantly more growth in positive attitudes toward computing than male students. Both females and males report significant improvements in computing self-efficacy ("I am good at computing"), liking computing, and viewing computing as less difficult than initially conceived. However, once again, we see that female students' negative gender stereotypes increased following workshop participation.

Table 16. Attitudinal change by gender across all years (pre/post)

Statistics: Mean						
	Female			**Male**		
	Pre (n=1659)	**Post (n=1524)**	**p-value**	**Pre (n=1009)**	**Post (n=948)**	**p-value**
1. Computers are fun.	4.50	4.58	.004**	4.50	4.50	.967
2. Programming is hard.	3.01	2.78	.000**	2.95	2.90	.338
3. Girls can have jobs in computing.	4.62	4.51	.006**	4.29	4.22	.175
4. Boys can have jobs in computing.	4.23	4.29	.189	4.59	4.53	.081
5. Computer jobs are boring.	2.39	2.34	.259	2.07	2.20	.004**
6. I am good at computing.	3.51	3.86	.000**	3.67	3.93	.000**
7. I like computing.	4.132	4.297	.000**	4.246	4.373	.001**
8. I know more than my friends about computers.	3.28	3.54	.000**	3.47	3.67	.000**

p-value (independent samples t-test): *p<.05 **p<.01
Scale: 1, strongly disagree to 5, strongly agree

Table 17 indicates that White and Asian student as well as underrepresented minority (URM) students experienced statistically significant growth in positive attitudes toward computing. It appears, however, that White/Asian students are expressing significantly more negative gender stereotypes after participating in the workshops. Combined with Table 16, this may suggest that White females are absorbing message that girls may have tenuous career prospects in computing. To explore this issue further, The Findings Group conducted an observation of a Girl Scout workshop in the Fall of 2010. The results of that observation indicate that the female instructors were subtly communicating self-deprecating statements that may be internalized by female participants. For example, during a momentary technical glitch, one of the female instructors (an undergraduate student in Media Computation at Georgia Tech) remarked, "Gosh, this is so hard to fix. I can't seem to do it. Maybe we should call [name of male] to help us." These statements, though subtle, may be contributing to the significant decrement we see in students' perceptions that "Girls can have jobs in computing." Training workshop instructors, particularly female instructors, to utilize language that is empowering may be an important avenue to addressing this statistic. Additionally, exposing students to careers where females hold a prominent role may be another route to curbing this trend.

Table 17. Attitudinal change by race/ethnicity across all years (pre/post)

Statistics: Mean						
	White/Asian			**URM**		
	Pre (n=1429)	**Post (n=1318)**	**p-value**	**Pre (n=1244)**	**Post (n=1177)**	**p-value**
1. Computers are fun.	4.48	4.57	.001**	4.51	4.52	.715
2. Programming is hard.	2.98	2.80	.000**	2.97	2.84	.002**
3. Girls can have jobs in computing.	4.46	4.38	.033*	4.47	4.41	.125
4. Boys can have jobs in computing.	4.44	4.45	.813	4.35	4.34	.897
5. Computer jobs are boring.	2.31	2.28	.479	2.21	2.25	.379
6. I am good at computing.	3.55	3.89	.000**	3.59	3.88	.000**
7. I like computing.	4.17	4.35	.000**	4.18	4.31	.001**
8. I know more than my friends about computers.	3.39	3.67	.000**	3.33	3.51	.000**

p-value (independent samples t-test): *p<.05 **p<.01 Scale: 1, strongly disagree to 5, strongly agree
Note. URM= underrepresented minorities (Black, Hispanic, Multiracial, Native American).

c. Content Knowledge Assessment

In an effort to assess the growth in content knowledge that students learn over the course of the computing camps, content knowledge assessment items were included on the student questionnaires for summer computing camps at Georgia Tech in 2011. Content knowledge assessment items were pilot tested on Scratch and Alice programming material. **Overall, students gained significantly more content knowledge in computing as a result of participating in the computing camps.** At baseline, students answered 32% of the Scratch questions correctly, compared to 49% after the computing camps. Likewise, following the computing camps, students scored 51% correct on the Alice content knowledge questions compared to 35% at baseline. The effect of the camps on content knowledge among students was medium to large. See table 18 for more information regarding effect size.

Table 18. Overall Mean Analysis per item, Scratch CKA

		N	**Percent Correct**		**p-value**	**effect size**
Overall Mean-*Scratch*	Pre	106	32%		.000**	0.34
	Post	106	49%			
Overall Mean-*Alice*	Pre	16	35%		.001**	0.75
	Post	16	51%			

*p<.05 **p<.01 †approaching significance at p<.10 Cohen's Effect size = .10 to .29 ~ small; .30 to .49 ~ medium, .50 to 1.00 ~ large

Tables 19 and 20 show the specific content knowledge items and distribution of responses for the questions related to Scratch (Table 19) and Alice (Table 20). In general, students are significantly more likely to correctly identify and apply several programming concepts following their participation in summer computing camps at Georgia Tech:

- **Loops**: repeated execution of specific code
- **Conditional Executions**: if-then statements
- **Variable modification**: manipulation and modification of data blocks
- **Handling Events**: responses to environmental cues
- **Sending a message**: activating a block of code
- **Tracing**: interpreting a block of code and identifying the outcome

Table 19. Overall Analysis per item, Scratch Content Knowledge Assessment

Item # and answer	Pre/Post	n	Percent Correct	p-value	effect size	a	b	c	d	e	f	Blank
1. Motion (b)	Pre	109	**74%**	.000**	0.27	**11%**	**74%**	**2%**	**0%**	**0%**	**13%**	0%
	Post	106	**92%**			**5%**	**92%**	**1%**	**0%**	**0%**	**1%**	1%
2. Loop-repeated execution (d)	Pre	109	**34%**	.002**	0.21	**4%**	**7%**	**6%**	**34%**	**3%**	**44%**	3%
	Post	106	**55%**			**5%**	**13%**	**7%**	**55%**	**8%**	**10%**	3%
3. Handling an event (b)	Pre	109	**17%**	.107	0.11	**14%**	**17%**	**4%**	**4%**	**8%**	**50%**	5%
	Post	106	**25%**			**28%**	**25%**	**19%**	**5%**	**7%**	**15%**	1%
4. Modifying a variable (e)	Pre	109	**25%**	.000**	0.24	**8%**	**17%**	**5%**	**5%**	**25%**	**39%**	3%
	Post	106	**48%**			**9%**	**22%**	**8%**	**1%**	**48%**	**9%**	2%
5. Sending a message (c)	Pre	109	**24%**	.055†	0.13	**9%**	**8%**	**24%**	**7%**	**2%**	**45%**	5%
	Post	106	**36%**			**11%**	**10%**	**36%**	**8%**	**6%**	**26%**	2%
6. Conditional execution (a)	Pre	109	**11%**	.001**	0.23	**11%**	**18%**	**3%**	**1%**	**9%**	**52%**	6%
	Post	106	**29%**			**29%**	**25%**	**9%**	**4%**	**9%**	**19%**	4%
7. Repeat a simple animation (a)	Pre	109	**44%**	.000**	0.28	**44%**	**1%**	**1%**	**4%**	**8%**	**37%**	6%
	Post	106	**72%**			**72%**	**0%**	**3%**	**4%**	**9%**	**9%**	3%
8. Draw a square using the pen (b)	Pre	109	**35%**	.000**	0.24	**13%**	**35%**	**4%**	**4%**	**6%**	**34%**	6%
	Post	106	**58%**			**9%**	**58%**	**7%**	**2%**	**7%**	**15%**	2%
9. "I had better get out of here" (b)	Pre	109	**38%**	.025*	0.15	**8%**	**38%**	**0%**	**10%**	**4%**	**31%**	9%
	Post	106	**53%**			**10%**	**53%**	**0%**	**15%**	**5%**	**13%**	4%
10. Triangle (d)	Pre	109	**17%**	.147	0.10	**13%**	**16%**	**6%**	**17%**	**35%**		14%
	Post	106	**25%**			**11%**	**19%**	**11%**	**25%**	**21%**		13%

*p<.05 **p<.01 †approaching significance at p<.10 Cohen's Effect size = .10 to .29 ~ small; .30 to .49 ~ medium, .50 to 1.00 ~ large; answers are highlighted in grey

Note. The content knowledge assessment items were administered to participants in the summer camps at Georgia Tech only. See Appendix A for information regarding the content knowledge assessment questions for Scratch.

Table 20. Overall Analysis by School, Alice Content Knowledge Assessment

Item # and (answer)		n	Percent Correct	p-value	effect size	a	b	c	d	e	f	Blank
1. How many objects are in this object tree? 9 (c)	Pre	18	16%			**11%**	**53%**	**16%**	**5%**	**11%**	**5%**	0%
	Post	16	13%	1.000	0.000	**19%**	**56%**	**13%**	**0%**	**0%**	**13%**	0%
2. Executing a method (a)	Pre	18	11%			**11%**	**0%**	**53%**	**5%**	**0%**	**32%**	0%
	Post	16	38%	0.020*	0.559	**38%**	**0%**	**50%**	**6%**	**0%**	**6%**	0%
3. Changing a field (b)	Pre	18	11%			**11%**	**11%**	**5%**	**21%**	**16%**	**37%**	0%
	Post	16	6%	0.333	0.250	**25%**	**6%**	**13%**	**19%**	**6%**	**31%**	0%
4. How many objects can you make from a class in Alice? As many as you want (e)	Pre	18	26%			**0%**	**0%**	**0%**	**11%**	**26%**	**63%**	0%
	Post	16	63%	0.020*	0.559	**0%**	**0%**	**6%**	**0%**	**63%**	**31%**	0%
5. Creating an object (e)	Pre	18	58%			**0%**	**0%**	**5%**	**16%**	**58%**	**21%**	0%
	Post	16	94%	0.004**	0.661	**0%**	**0%**	**0%**	**0%**	**94%**	**6%**	0%
6. bunny2(d)	Pre	18	74%			**0%**	**0%**	**0%**	**74%**	**11%**	**16%**	0%
	Post	16	88%	0.333	0.250	**0%**	**0%**	**0%**	**88%**	**6%**	**6%**	0%
7. The bunny will say "hello" and the cow will talk one time (b)	Pre	18	47%			**0%**	**47%**	**0%**	**32%**	**0%**	**21%**	0%
	Post	16	75%	0.041*	0.500	**0%**	**75%**	**0%**	**19%**	**0%**	**6%**	0%
8. The horse will move toward bunny2 (d)	Pre	18	53%			**0%**	**0%**	**5%**	**53%**	**16%**	**26%**	0%
	Post	16	69%	0.104	0.408	**0%**	**13%**	**6%**	**69%**	**6%**	**6%**	0%
9. Bunny2 will turn 5 times and cow will talk 10 times (d)	Pre	18	26%			**16%**	**32%**	**0%**	**26%**	**0%**	**26%**	0%
	Post	16	25%	0.580	0.144	**38%**	**13%**	**13%**	**25%**	**0%**	**13%**	0%
10. Cow will talk 9 times (d)	Pre	18	32%			**0%**	**16%**	**11%**	**32%**	**5%**	**37%**	0%
	Post	16	38%	1.000	0.000	**13%**	**13%**	**13%**	**38%**	**6%**	**19%**	0%

*p<.05 **p<.01 †approaching significance at p<.10 Cohen's Effect size = .10 to .29 ~ small; .30 to .49 ~ medium, .50 to 1.00 ~ large; answers are highlighted in grey

Note. Table 20 reflects the data obtained from the Summer Camp at Georgia Tech on June 27-July 1, 2011, ICE II: Alice and Lego Robots with high school students. See Appendix B for information regarding the content knowledge assessment for Alice.

4. **Cool Computing:** How many women and minority students participate in the Cool Computing community and weekend? How active is the community and to what degree does it create positive attitudes toward pursuing computer-related disciplines?

The goal behind the Cool Computing community and weekend activities was to introduce computing to middle and high school students. Initially, GAComputes! had planned on creating online communities where women and underrepresented minorities can showcase their work (e.g. Alice creations) and be part of an interactive network of peers and scholars who hold an interest in computing. Six months into the project, it was decided to disband the cool computing communities but keep the four Cool Computing Days at Georgia Tech. These Cool Computing Days are one-day computing events at Georgia Tech for high school and middle school students. These events aimed to expose students to computing education, industry and research. Each event included a student panel, a corporate panel, research speakers, campus tour and lunch on the Georgia Tech campus. See Figures 6 through 9. In total, 632 students from 38 high schools and middle schools in Georgia have participated in a Cool Computing Day. See Table 21. 26% of the participants at the Cool Computing events were females and 43% were underrepresented minorities.

Table 21. Overall Analysis by School, Alice Content Knowledge Assessment

	Participating Student Data		**Females**		**URM**	
Event Date	# of schools	n	n	%	n	%
Feb. 2010	5	55	24	44%	36	65%
March 2010	17	240	54	23%	91	38%
December 2010	7	160	39	24%	66	41%
February 2011	9	177	45	25%	77	44%
Overall Total	**38**	**632**	**162**	**26%**	**270**	**43%**

URM= underrepresented minorities (Black +Hispanic +Native American +Multicultural)

Table 22 shows the overall responses across four Cool Computing activities: Student Panel, Corporate Panel, Professor Panel, and Campus Tour.

Table 22. Participant feedback on the Cool Computing Day activities

		n	**Mean**		**Not at all (1)**	**2**	**3**	**Very Much (4)**
Dec. 2010	Informative	22	2.92		11%	19%	39%	32%
	Useful	22	2.70		14%	27%	33%	26%
	Engaging	22	2.67		20%	21%	34%	26%
Feb. 2011	Informative	15	3.47		0%	10%	33%	57%
	Useful	15	3.23		1%	23%	27%	49%
	Engaging	15	3.25		1%	20%	31%	48%

Note. Student feedback was not obtained for the February 2010 and March 2010 Cool Computing Day Events

Figure 6. High school students listening to a student panel at Cool Computing Day, February 2010

Figure 7. Presentation at Cool Computing Day, December 2010

Figure 8. Hands-on activities at Cool Computing Day, February 2010

Figure 9. Hands-on activities at Cool Computing Day, February 2011

In general, any item below an average of 3.5 requires attention, and any item below an average of 3.0 requires action. Table 22 shows that participants, on average, find the activities to be moderately informative, useful and engaging. Table 23 suggests that participants rated the campus tour and the corporate panel as being the most informative, useful and engaging activities in December 2010 and February 2011, respectively. The student and professor panel received the lowest ratings.

Table 23. Overall mean per activity and rank

	Dec. 2010			Feb. 2011		
	n	**Overall Mean (average of informative, useful and engaging)**	**Rank**	**n**	**Overall Mean (average of informative, useful and engaging)**	**Rank**
Student Panel	23	2.67	3	20	2.90	3 (lowest)
Corporate Panel	22	2.76	2	22	3.26	1 (highest)
Professor Panel	22	2.44	4 (lowest)	17	3.11	2
Campus Tour	23	3.18	1 (highest)	2*	4.00	--

Scale: 1, not at all, to 4, very much *low n; -- not included due to low n

The participants also evaluated the degree to which they perceive the Cool Computing event as enhancing their knowledge and interest in computing. The findings are listed in Tables 24 and 25. Overall, participants rated the Cool Computing event as a 3.13 in December 2010 and a 3.95 in February 2011 (on a 5.00 scale, where 1 is strongly disagree and 5 is strongly agree). Over three- fourths of participants who responded to the survey indicated that they had fun and liked the event, learned about computing jobs, and have an increased interest in learning more about computing. More attention is needed in helping students understand how the information they learned from Cool Computing applies to their own lives (see "I will use what I learned at Cool Computing"). Importantly, positive attitudes towards the Cool Computing events improved from December 2010 to February 2011. Formative feedback provided to the principal investigators following the December 2010 Cool Computing event contributed to this observed improvement in attitudes. Notably, more hands-on activities were incorporated into the Cool Computing Day agenda in 2011 in response to students' suggestions that they would improve the program by infusing the day with more interactive activities. **The data provides demonstrable evidence that GAComputes! was responsive to student feedback and modified its event accordingly to ensure that students receive the best computing experience possible.**

Table 24. Participants' feedback on the effectiveness of Cool Computing, December 2010

	n	Mean			Strongly Disagree (1)	Disagree (2)	In between (3)	Agree (4)	Strongly Agree (5)
I liked Cool Computing.	31	3.35			6%	16%	23%	45%	10%
I had fun at this event.	31	3.58			3%	13%	26%	39%	19%
Cool Computing made me want to know more about computing.	31	3.23			10%	10%	35%	39%	6%
This event made me interested in computing.	31	2.84			13%	26%	35%	16%	10%
I learned about computing at this event.	31	3.19			19%	3%	26%	42%	10%
I now know more about computing as a job because of this event.	31	2.97			16%	23%	19%	32%	10%
I will remember what I learned at Cool Computing.	31	2.90			19%	16%	26%	32%	6%
I will use what I learned at Cool Computing.	31	2.68			19%	19%	42%	13%	6%
I learned how computing can be used in different ways at this event.	31	3.48			10%	13%	13%	48%	16%
I know more about jobs in computing because of this event.	31	3.23			13%	16%	19%	39%	13%
I would recommend Cool Computing to my friends.	31	2.97			16%	19%	29%	23%	13%
Overall	**31**	**3.13**			**13%**	**16%**	**27%**	**33%**	**11%**

Table 25. Participants' feedback on the effectiveness of Cool Computing, February 2011

	n	Mean			Strongly Disagree (1)	Disagree (2)	In between (3)	Agree (4)	Strongly Agree (5)
I liked Cool Computing.	24	4.08			0%	4%	13%	54%	29%
I had fun at this event.	24	4.21			0%	0%	8%	63%	29%
Cool Computing made me want to know more about computing.	24	4.00			0%	4%	13%	63%	21%
This event made me interested in computing.	24	3.88			0%	4%	25%	50%	21%
I learned about computing at this event.	24	3.75			4%	8%	8%	67%	13%
I now know more about computing as a job because of this event.	24	3.83			0%	8%	21%	50%	21%
I will remember what I learned at Cool Computing.	24	4.00			0%	4%	4%	79%	13%
I will use what I learned at Cool Computing.	24	3.75			0%	4%	33%	46%	17%
I learned how computing can be used in different ways at this event.	24	4.04			0%	0%	17%	63%	21%
I know more about jobs in computing because of this event.	24	4.04			0%	0%	17%	63%	21%
I would recommend Cool Computing to my friends.	23	3.91			4%	0%	22%	48%	26%
Overall	**24**	**3.95**			**1%**	**3%**	**16%**	**59%**	**21%**

In open-ended responses, participants reported enjoying the hands-on activities (e.g. Augmented reality; dinosaur) and the opportunity to gain exposure to how computing is utilized in different career fields and industries. Relatedly, participants also noted that the corporate panel was effective in expanding their outlook on computing.

"The best part was seeing the cool things computing can be used for."
"I liked how the speakers showed me the many different products that involve programming."
"The corporate panel was very informative and engaging. I want to have a CS job in corporate."

The following comment from a participating female high school student struck us as unique and noteworthy. The participant highlights a specific event, namely the dean of admission's presentation, as a motivating factor in her decision to pursue a career in computing. This statement provides insight into the potential effect that one computing experience might have. More importantly, this statement was made by a female participant from an underrepresented minority group. **This provides initial qualitative evidence that Cool Computing Days may serve to provide underrepresented students with an important life experience which piques their interest in a computing career and eventual pursuit of a computing degree.**

> *"I enjoyed the dean of admissions at the college of computing at Georgia Techs' presentations at the corporate panel and the closing discussion. He talked about seeing a map where the world lit up every time the internet is used throughout the world. He said that he realized the distinct boundaries and borders of poverty-stricken places like Africa and parts of Asia and places where high living is found. Africa was pitch black while places like Japan and America were blazing. This anecdote has stayed with me for many weeks now and has encouraged me to have a computer programming based job."* (Cool Computing, February, 2011)

Demographic data displayed in Table 22 suggests that a greater number of males participate in Cool Computing events than females. As the quote above demonstrates, Cool Computing days may be a promising "hook" to attracting females into computing. Ensuring that proper recruiting strategies are in place that draws a greater number of females may help augment the gender diversity of such events in the future.

5. **Influence & Impact:** How has the program influenced and impacted individual institutions and the larger computing community?

The influence and impact that GAComputes! had are illustrated by the interactions and effects that go beyond the level of individual institutions such that they involve a larger computing community. GAComputes! has developed programs and activities that have impacted members and organizations within the alliance as well as beyond the alliance. Such activities and events have enlarged the geographic influence of the program. In particular, GAComputes! has strengthened individual members, strengthened connections between members, and spread effects to nonmembers within and beyond the region via three channels: a. Faculty Workshops, b. Professional presentations and papers, and c. Serving as a catalyst for new NSF programs.

a. Faculty Workshops

From 2007-2010, over 120 colleges and universities throughout the United States participated in GAComputes! faculty workshops. See Table 10 for an exhaustive list of the participating college and universities. These workshops focus on media computation and how to run a computing summer camp. Computer science educators attend these workshops to learn new approaches to teaching that may open up the field of computer science to students who may not initially be inclined to think of themselves as computer scientists. Each workshop lasts between two/three days and offers faculty several different approaches to introducing computing to students; each approach has proven to have previous success in attracting and retaining women and minority students. Likewise, in July 2010, Mark Guzdial (PI) presented a two-day workshop entitled "Innovative Approaches to First Courses in Computing" at the University of Massachusetts, Amherst which garnered interest from instituitons as far away as Kuwait and South Africa. Overall, this suggests that **GAComputes! has had a strong presence in the computing community, both regionally and nationally, and been instrumental in bringing together faculty from computer science departments in colleges and universities across the United States with the aim of providing them with tools to draw women and minority students into computing.** Figure 10 highlights the number of states that have sent computer science faculty to GAComputes! faculty workshops; in total, colleges/universities from 21 states have been represented at GAComputes! faculty workshops.

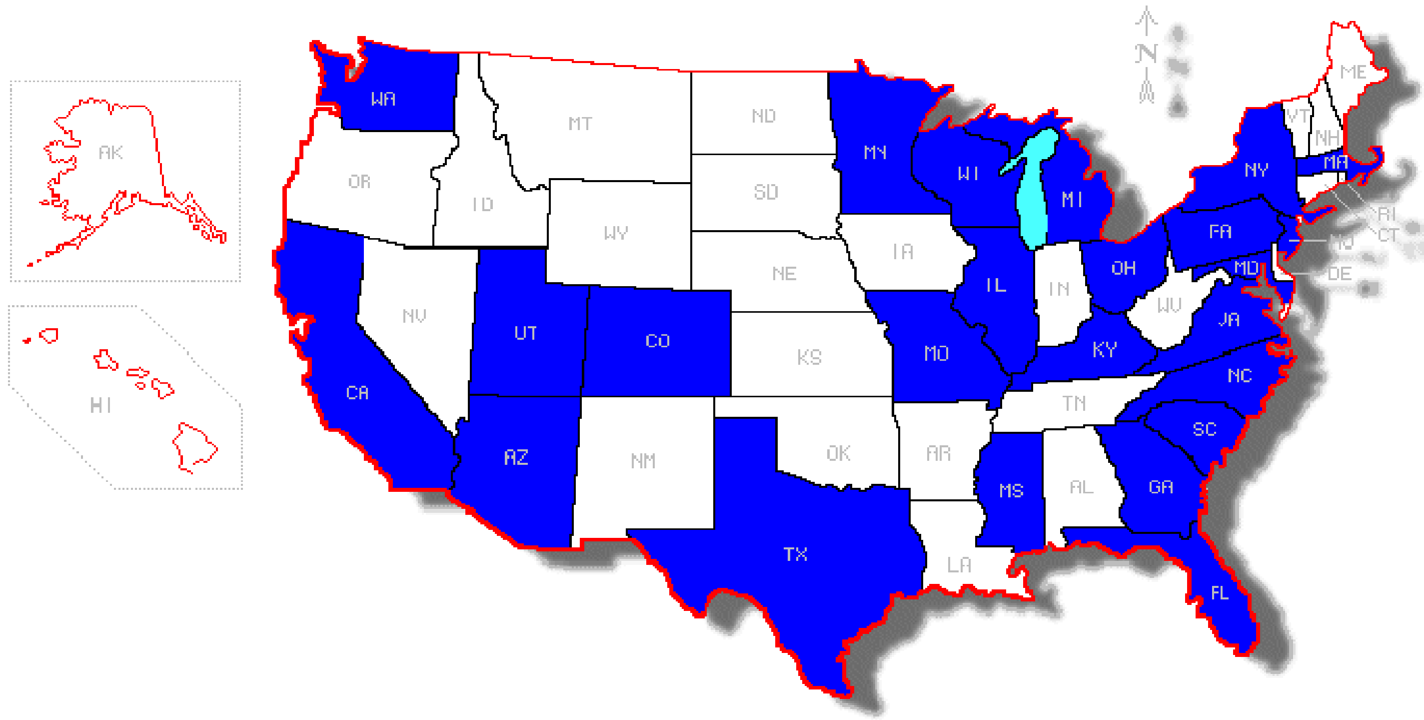


Figure 10. Blue states sending computing faculty to GAComputes! faculty workshops

b. Professional Presentations and Papers

The results of GAComputes' efforts have influenced academic communities via the following peer-reviewed papers, evaluation reports and national presentations.

Peer-Reviewed Papers

- Bruckman, Amy, Maureen Biggers, Barbara Ericson, Tom McKlin, Jill Dimond, Betsy DiSalvo, Michael Hewner, Lijun Ni, and Sarita Yardi. "Georgia Computes!": Improving the Computing Education Pipeline. To appear in the Proceedings of SIGCSE '09. Chattanooga, TN.
- Hewner, Michael, and Mark Guzdial. 2008. Attitudes about computing in postsecondary graduates. In Proceeding of the fourth international workshop on Computing education research, 71-78. Sydney, Australia: ACM.
- Hewner, Michael, and Maria Knobelsdorf. 2008. Understanding Computing Stereotypes with Self-Categorization Theory. Proceedings of Koli Calling International Conference on Computer Science Education. In Koli National Park, Finland, November.
- Ni, Lijun. 2009. What Makes CS Teachers Change? Factors Influencing CS Teachers' Adoption of Curriculum Innovations. To appear in the Proceedings of SIGCSE '09. Chattanooga, TN, March, 2009.
- Yardi, Sarita, Pamela Krolikowski, Taneshia Marshall, and Amy Bruckman. 2008. An HCI Approach to Computing in the Real World. ACM Journal on Educational Resources in Computing 8, no. 3, 9: 1-20.

Evaluation Reports

- Trevisan, B., McKlin, T., & Guzdial, M. (2011). Factors Influencing CS Participation: Introductory Computer Science Students Describe What Led Them to Computing. (GAComputes!! Technical Report). Atlanta: The Findings Group, LLC.
- Engelman, S., McKlin, T., & Guzdial, M. (2011). Conditions that encourage participation in computer science (GAComputes!! Technical Report). Atlanta: The Findings Group, LLC.
- Engelman, S., McKlin, T., & Ericson, B, Guzdial, M. (2011). Georgia Computes! Advanced Placement Analysis (2010).(GAComputes!! Technical Report). Atlanta: The Findings Group, LLC.
- Engelman, S., McKlin, T., & Ericson, B., & Guzdial, M. (2011). Georgia Computes! Roll-Up Analysis: Student Workshops August 2009 to August 2010. (GAComputes!! Technical Report). Atlanta: The Findings Group, LLC.

Other Papers

- Dimond, J., Yardi, S., and Guzdial, M. (2009). "Mediating Programming through Chat for the OLPC" In Proceedings of the 27th international Conference Extended Abstracts on Human Factors in Computing Systems (CHI'09). Boston, MA, Apr 4-9, 2009.
- Dimond, Jill and Mark Guzdial. 2008. More Than Paradoxes to Offer: Exploring Motivations to Attract Women to Computing. Georgia Institute of Technology Technical Report.
- DiSalvo, Betsy and Amy Bruckman. 2008. Exploring Video Game's Relationship to CS Interest. Submitted to Proceedings of the 40th SIGCSE technical symposium on Computer science education.

- Ericson, Barbara and Tom McKlin. 2008. Girl Scouts Compute! Submitted to Proceedings of the 40th SIGCSE technical symposium on Computer science education.
- Ni, Lijun and Tom McKlin. 2008. How CS Teachers Change? The Story from Teachers. Submitted to Proceedings of the 40th SIGCSE technical symposium on Computer science education.
- Yardi, S., and Bruckman, A. (2009). "Teens as Designers of Social Networks." In Extended Abstracts of ACM Conference on Human Factors in Computing Systems ACM SIGCHI workshop: Socially Mediating Technologies. Boston, MA, Apr, 2009.

Presentations

Guzdial, M. (2006). "Teaching Computing for Everyone." Consortium for Computing Sciences in Colleges: Central Plains Conference, Northwest Missouri State University, Maryville, Missouri.

Guzdial, M. (2007.) "Computing Education for All." Visual and Computational Teaching and Learning. College of Charleston, Nov. 16-17.

Guzdial, M. (2008.) "Computing Education for All." Meeting of Computing and Information Science Departments, Georgia Technical Colleges, Griffin, GA. Feb 1.

Guzdial, M. (2008.) University of Michigan, EECS Division. CSE@50 Plenary Talk. "Meeting the Needs of Computing Across Campus." April 2008

Guzdial, M (2009.) "Computing Education for All." Plenary Talk at Australasian Computing Education conference, 20 April 2009.

Guzdial, M. (2009.) "Meeting Everyone's Needs for Computing." Invited keynote speech at Informatics Education Europe, Frieburg, Germany, 5 November, 2009.

Guzdial, M. (2010). "Technology for Teaching the Rest of Us." Invited keynote speech to the Inaugural Educational Applications of Artificial Intelligence (EAAI), 2011. 13 July.

Guzdial, M. (2010.) "Computing education for all." Invited keynote speech at 11th Annual Conference of Higher Education Academy Subject Centre for Information and Computer Science, Durham University, UK. August.

Guzdial, M. (2010.) "Meeting Everyone's Needs for Computing." Invited keynote speech at CCSCW:MW (Consortium for Computing Science in Colleges: Midwest), 24 September.

Guzdial, M. (2010.) "Meeting the Computing Needs for Everyone." Invited keynote speech at University Fundamental Computing Courses Forum, Jinan, China. 5 November.

Guzdial, M. (2011.) "Meeting the Computing Needs for Everyone." Invited keynote speech at "Pearson University Forum. Leaders in action: the new educational trends". Mexico City, Mexico. 21 May.

Guzdial, M. (2011.) "Technology for Teaching the Rest of Us." Invited keynote speech ACM Innovation and Technology in CS Education (ITICSE), Darmstadt, Germany. 27 July.

Guzdial, M. (2012.) "Helping Everyone Create with Computing." Invited keynote speech at International Conference on Creating, Connecting and Collaborating through Computing at University of Southern California. 19 January.

c. Catalyst for new NSF programs

GAComputes! served as the catalyst for at least two projects supported by NSF: 1. Developing Regional Communities of Computing Educators (DCCE), and 2. Glitch- Games Testing. DCCE, funded by NSF CPATH, is aimed at connecting computer science teachers at different levels in order to develop a community focused on common goals and activities to revitalize undergraduate and high school computing education in Georgia. Every year, 10-20 high school and undergraduate computing faculty convene monthly for workshops aimed at pedagogical and content knowledge enhancement. Figure 11 illustrates how the program was instrumental in both expanding and strengthening the connection among participants. Glitch-Games Testing is a BPC Demonstration Project that seeks to leverage low-income African American teenage boys' love of video games to encourage their participation in computing education and introduce them to the idea of pursuing computing careers. This is accomplished by offering youth a contextualized computing curriculum focused on games and games testing. This demonstration project was developed in affiliation with GAComputes!; Morehouse College, a pre-eminent historically black college, offers facilities on campus and provides expertise in developing and maintaining strong relationships with area high school and social science research on African-American males.

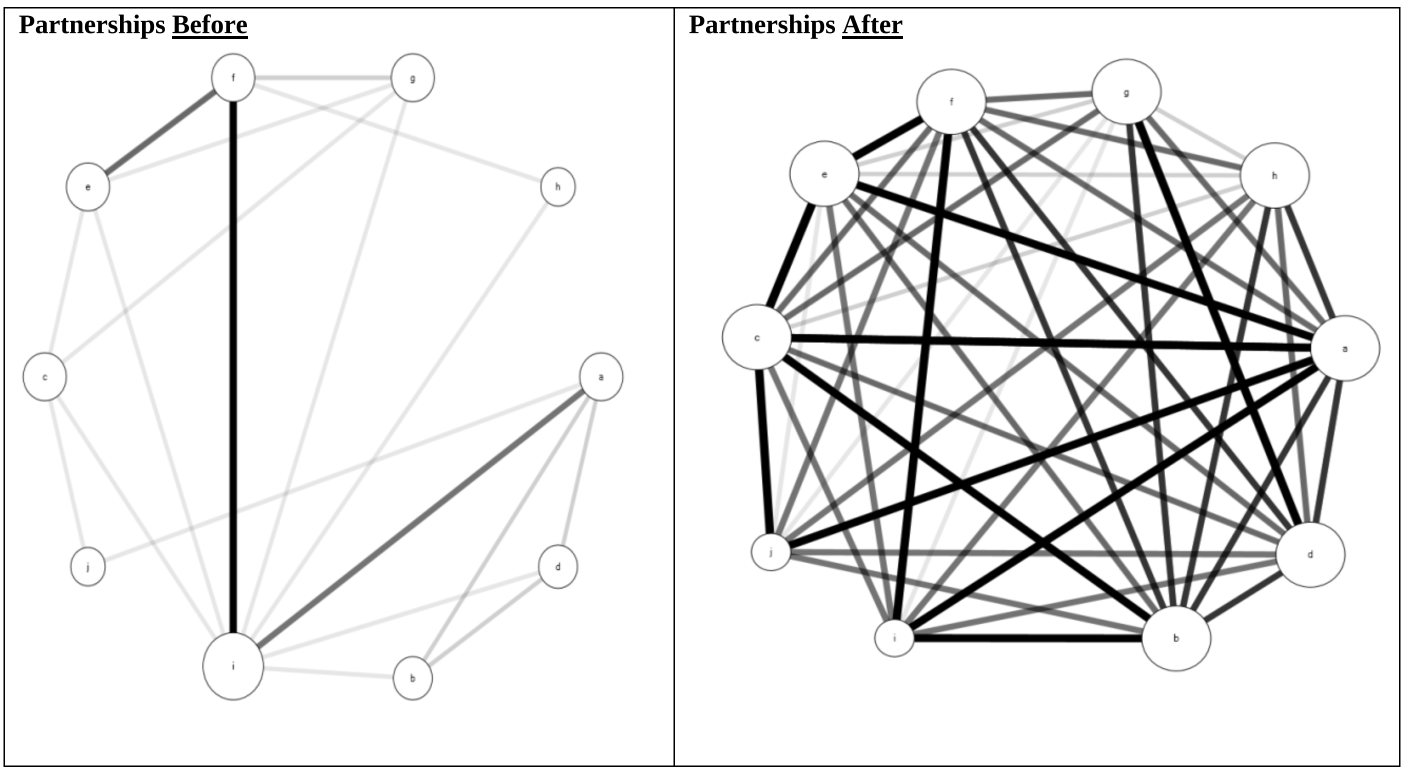
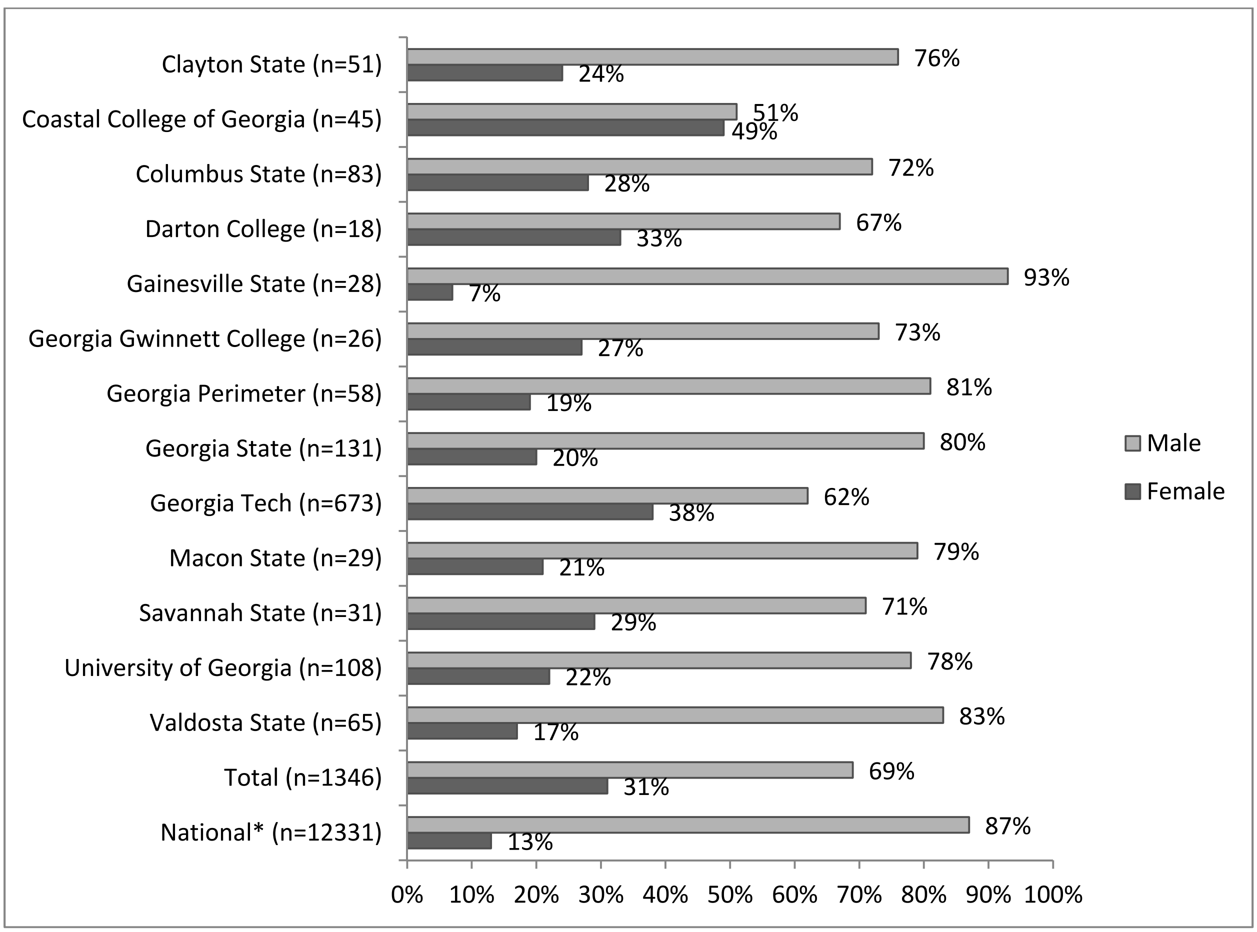


Figure 11. Before and after sociograms comparing the strength of a network of ten participants at the beginning and end of a program.

6. **Enrollment & Retention:** How many women and minorities are enrolled in computer-related disciplines in USG institutions? Has the program generated an increase in the number of high schools offering AP Computer Science and is there a larger diversity of students pursuing and passing the AP Computer Science test?

a. USG Institutions

In 2009-2010, all USG institutions offering computer science were asked to complete a survey to gauge the percentage of women and underrepresented minorities who are enrolled in introduction to computer science courses. These courses are considered to be the first course that undergraduate students take towards a major in computer science. The results of that survey indicate that 31% of all introductory to computer science students are female. Georgia Tech, Darton College, and Coastal College of Georgia have a slightly higher percentage of female students enrolled in intro to computing courses. See Figure 12. A national sample of computer science majors indicates that 13% of the population of CS majors are female and 87% are male. Although the statistics gleaned from the USG surveys reveal higher ratio of females compared to the national sample, it is important to note that retention rates of students were not obtained. Follow-up studies are necessary to assess the retention rates among female computer science majors at USG institutions.



* National data was obtained from the 2008-2009 Computing Research Association Taulbee Survey of CS Majors: http://www.cra.org/uploads/documents/resources/taulbee/CRA_Taulbee_2009-2010_Results.pdf

Figure 12. USG Intro to Computing Gender Ratios

Table 26 summarizes the percentage of underrepresented minorities enrolled in intro to computing courses at each USG institutions. Overall, 25% of the students enrolled in intro to computing courses across all USG institutions are underrepresented minorities (Black, 16% + Hispanic, 4% + Native American, 0.3% + Multiracial, 5%). See Figure 13. A national sample indicates that 7% of CS Majors are underrepresented minorities. The highest percentage of intro to computing students who self-describe as Black are at Georgia Perimeter college (40%) and Savannah State University (97%). Again, it is important to follow-up with students to assess the retention rates of CS majors among minority students.

Table 26. USG Intro Computing Race/Ethnicity %

	n	**Asian**	**Black**	**Hispanic**	**Native American**	**White**	**Multiracial**
Clayton State	51	10%	39%	4%	0%	41%	6%
Coastal College of Georgia	45	2%	29%	9%	0%	53%	7%
Columbus State	83	2%	39%	8%	0%	49%	1%
Darton College	18	6%	28%	0%	0%	56%	11%
Gainesville State	28	4%	4%	14%	0%	79%	0%
Georgia Gwinnett College	26	4%	4%	0%	8%	62%	4%
Georgia Perimeter	58	12%	40%	9%	0%	33%	5%
Georgia State	131	21%	26%	6%	2%	37%	7%
Georgia Tech	673	20%	4%	4%	0%	66%	5%
Macon State	29	0%	21%	0%	0%	76%	3%
Savannah State	31	0%	97%	0%	0%	0%	3%
University of Georgia	108	16%	9%	0%	0%	71%	4%
Valdosta State	65	8%	29%	5%	0%	54%	5%
Total	**1346**	**15%**	**16%**	**4%**	**0%**	**58%**	**5%**
Average	**104**	**8%**	**28%**	**5%**	**1%**	**52%**	**5%**
Min	**18**	**0%**	**4%**	**0%**	**0%**	**0%**	**0%**
Max	**673**	**21%**	**97%**	**14%**	**8%**	**79%**	**11%**
Median	**51**	**6%**	**28%**	**4%**	**0%**	**54%**	**5%**
National Statistics[1]	**9606**	**15%**	**4%**	**1%**	**1%**	**66%**	**1%**

[1]Data was obtained from the 2008-2009 Computing Research Association Taulbee Survey of CS Majors: http://www.cra.org/uploads/documents/resources/taulbee/CRA_Taulbee_2009-2010_Results.pdf

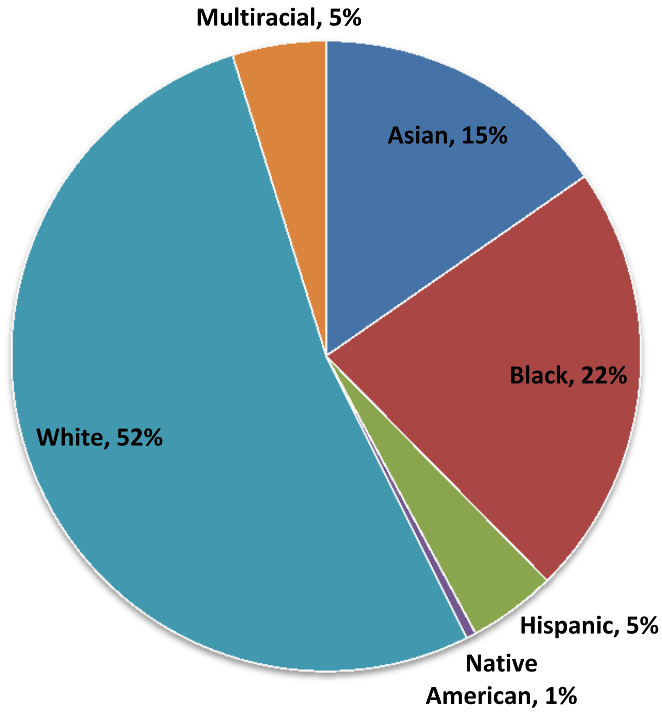


Figure 13. Race/Ethnicity percentages of intro to computing students across all surveyed USG Institutions

To further assess the impact that GAComputes! had on enrollment rates among women and minorities, The Findings Group, LLC examined the high schools from which the intro to computing students hailed . Introductory computer science students are most likely freshmen who attended high school during the 2005-2006, 2006-2007, 2007-2008, and 2008-2009 school years. GAComputes!, in partnership with the Institute for Computing Education (ICE), has been training teachers since 2004. Therefore, any influence from the program would be from teachers who attended between 2004 and 2009 which is a population of 258 teachers from 53 public school districts in Georgia. Overall, these 258 teachers represent 152 public schools in Georgia. This group of teachers represents almost 36% (152 out of 422) of all schools in Georgia offering high school grade levels.

Overall, the introductory CS students surveyed come from 252 public schools in Georgia, and 107 of those schools have sent teachers for ICE training. While GaComputes! has trained teachers at fewer than half of the schools sending students to introductory CS programs in Georgia, GaComputes! schools are responsible for 60% of all Georgia students attending introductory computing courses. That is, of the 1,434 students taking the survey, 932 (64.99%) report that they attended a public high school in Georgia, and 531 (56.97%) of Georgia students attended a school that has sent a teacher to ICE training between 2004 and 2009.

Compared to high schools who have not sent teachers to ICE Workshops, high schools who have sent teachers to ICE workshops produce more female introductory CS students. Conversely, non-ICE schools produce significantly more male introductory CS students than ICE schools.

Table 27. Number and percentage of male and female students currently in an introductory computing class from ICE and Non-ICE high schools

	Non-ICE Schools		ICE Schools	
	n	%	n	%
Female	69	26.54%	67	29.91%
Male*	193	73.66%	224	76.98%
Total	**262**		**291**	

* statistically significant (p<0.05)
Note. After omitting Georgia Tech students[5], results suggest that ICE schools produce significantly more male introductory CS students than Non-ICE schools. Albeit not statistically significant, ICE schools produce more female introductory CS students than non-ICE schools.

Likewise, significantly more White introductory CS students come from non-ICE schools than ICE schools. In comparison, ICE schools send more under-represented minorities to intro CS. Table 28 indicates that ICE schools send a higher percentage of Black, Hispanic, and Multiracial students although no single group is statistically significant.

Table 28. Number and percentage of students by race/ethnicity currently in an introductory computing class from ICE and Non-ICE high schools

	Non-ICE Schools		ICE Schools	
	n	%	n	%
Asian	22	8.46%	29	9.97%
Black	69	26.34%	80	27.49%
Hispanic	7	2.69%	19	6.53%
Native American	2	0.77%	2	0.69%
White*	152	58.02%	144	49.48%
Multiracial	9	3.46%	16	5.50%
No Response	1	0.38%	1	0.34%
Total	**262**		**291**	

* statistically significant (p<0.05)
Note. Georgia tech students were omitted from the analysis; see table 27 for an explanation.

Combined, Table 27 and Table 28 provide some evidence to support the assertion that **women and underrepresented minority students are more likely to persist in computing science courses at the undergraduate level if they come from high schools where their computing teachers received professional development training at ICE workshops.** Future studies are necessary to explore the extent to which women and minorities from ICE schools are retained as computer science majors.

[5] Georgia Tech students were omitted from the analysis because Georgia Tech is unique from other institutions in Georgia in that introductory computer science are required of all students. To gain a better understanding of the students who have self-selected into computer science courses in Georgia, it was necessary to omit Georgia Tech participants from the analysis.

b. AP Computer Science

As part of the goal of increasing the pipeline of female and minority students pursuing computing, GAComputes! sought to increase the number of high school offering CS AP in the state of Georgia by 50%; likewise, it strived to double the share of CS AP seats going to women and minorities. The AP CS exam is important because it has been found to have an impact on students choosing to major in computer science and other STEM disciplines. For example, students who take the AP exam in CS are 10 times more likely to major in an area related to CS (College Board, 2007).

Table 29 indicates that **GAComputes! successfully increased the number of schools offering AP CS by 61% (from baseline, 2004), thus exceeding its goal.** In 2004, approximately 44 schools offered AP CS A. In 2007-2008, 81 schools offered AP CS A. In 2008-2009, 73 schools have the AP designation, and in 2009-2010, 71 schools have the AP designation (College Board, n.d.). There appears to be a downward trend in the number of schools offering AP CS since 2007-2008. Speculatively, fiscal problems within the state may have led to teacher reassignment and/or cancellation of rigorous computer science courses in many schools, thus accounting for the drop in the number of schools offering AP CS A in 2008, 2009, and 2010. See Figure 14 for a map of schools offering AP CS. Another year of data will determine if this downward trend continues in 2010-2011.

Table 29. Georgia schools offering AP CS A

	Baseline (2004)	**Target (50% increase**	**2007-2008**	**2008-2009**	**2009-2010**
Schools offering AP CS A	44	66	81 (84% increase)	73 (66% increase)	71 (61% increase)

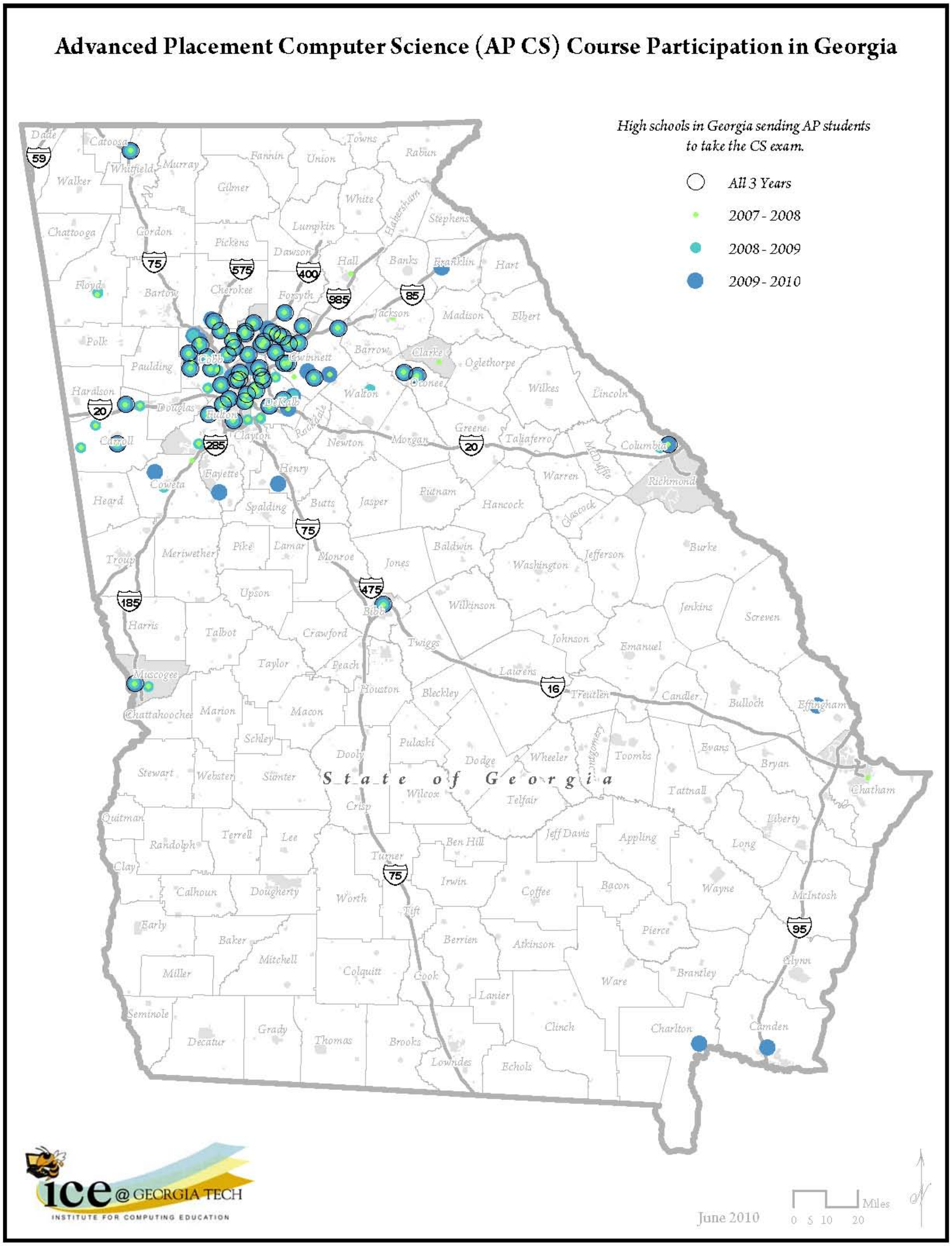


Figure 14. Georgia high schools offering AP CS

Likewise, GAComputes! exceeded the target for Hispanic test takers by 12 and has not met the targets set for female and Black students. The number of female test takers increased by eight from 2008-2009 to 2009-2010 for an overall increase of 48 (69%) over the baseline. Further, the number of Black students taking the AP CS A exam fell slightly from 69 to 68. The population of Black students taking the AP CS A fluctuates considerably from one year to the next experiencing gains and losses of between 50% to 100% over the course of a year. See Table 30.

Table 30. Status of program outcomes regarding women and under-represented minorities

	Baseline (2004)	Year One (2007)	Year Two (2008)	Year Three (2009)	Current Year (2010)	Target	Difference
Female	70	76	108	110	118	140	-22
Black	66	40	84	69	68	132	-64
Hispanic	9	13	22	27	30	18	+12 (met)

While the number of female test takers has increased over time, their scores on the AP CS exams suggest that they are underperforming as compared to their male counterparts: approximately 48% of females pass the AP CS A exam with a score of 3 or higher compared to 58% of males. A similar pattern is found with Hispanic test takers: their numbers are steadily increasing over time yet they continue to underperform on the AP CS exam as compared to White test takers. In general, female, Black, and Hispanic test takers are scoring a 3 or higher on the AP CS exam at comparatively lower rates than male and White test takers. See Table 31.

Table 31. Percentage of test takers by gender and race/ethnicity scoring a 3 or higher on the AP CS A exam

		Baseline (2004)	Year One (2007)	Year Two (2008)	Year Three (2009)	Current Year (2010)
Gender	**Female**	30.0%	30.9%	32.4%	46.4%	48.3%
	Male	52.0%	54.2%	48.6%	53.5%	57.7%
Race/ Ethnicity	**Black**	7.6%	22.5%	10.7%	10.1%	23.5%
	Hispanic	44.4%	37.5%	38.9%	45.8%	32.1%
	White	58.7%	51.4%	53.6%	61.4%	62.8%

Compared to a national average, the percentage of test takers who scored a 3 or higher on the AP CS exam in Georgia is comparatively lower than the national average. Although the % of AP test takers passing the exam grew by 8% from 2004 to 2010 in the state of Georgia, the national average is still higher at each year since 2004. See Table 32.

Table 32 . Combined percentage of test takers scoring a 3 or higher on the AP CS A exam: National vs. Georgia

Year	National 3 or Higher (reference lines at 30% and 50%)	Georgia 3 or Higher (reference lines at 30% and 50%)
2004	57.2%	48.1%
2005	55.6%	46.9%
2006	58.3%	38.9%
2007	56.3%	50.5%
2008	56.9%	45.6%
2009	61.8%	52.1%
2010	64.7%	56.1%

Moreover, the percentage of underrepresented minorities who scored a 3 or higher on the AP CS exam is lower in Georgia as compared to the national average. See Figure 15. Thus, despite increasing the number of underrepresented minorities who take AP Computer Science, the percentage of students passing the AP CS exam remains below the national figure. As described in Evaluation Question 2 d. (Transfer of instruction into practice, *Classroom Observations),* addressing discrepancies in instruction between high achieving and low achieving schools in Georgia may help bridge the achievement gap between the races. For example, it was observed in a predominantly African-American Computing in the Modern World classroom that the teacher failed to emphasize programming concepts and did not challenge her students to utilize problem solving methods. In fact, students were observed creating PowerPoint presentations as part of their core requirement for the class. This lack of emphasis on higher-order thinking skills in computing may contribute to the lack of preparedness among underrepresented minority students to effectively tackle advanced computing courses (e.g. AP Computer Science).

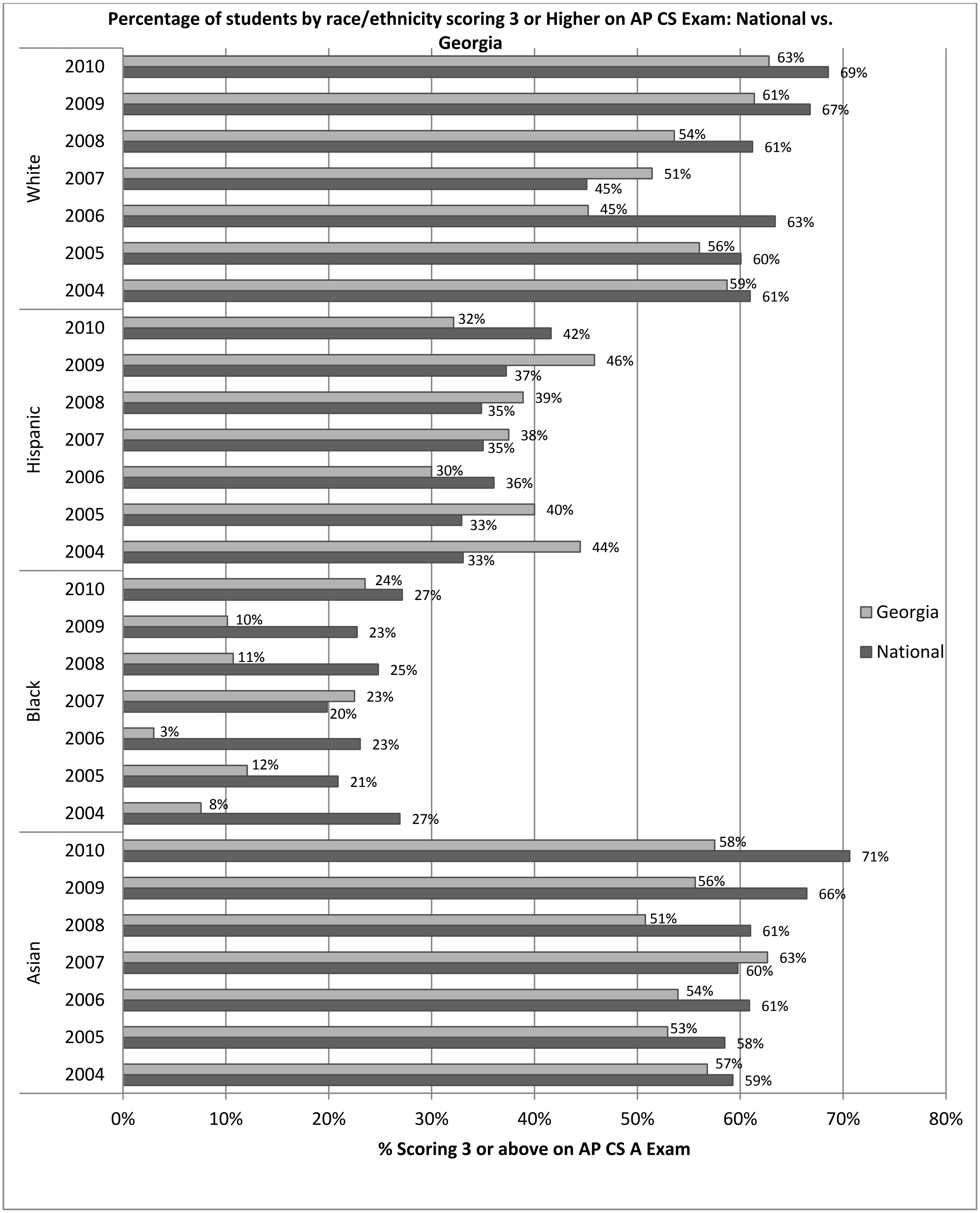
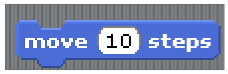


Figure 15. Percentage of students by race/ethnicity scoring a 3 or higher on the AP CS A Exam: National vs. Georgia

Appendix A. Content Knowledge Assessment- Scratch

Correct Answers are underlined

1) In what category is the 

block?
   a. Control
   b. Motion
   c. Sensing
   d. Variables
   e. Looks
   f. I don't know
2) What is the following an example of?

   a. Conditional execution
   b. Handling an event
   c. Sending a message
   d. Loop – repeated execution
   e. Modifying a variable
   f. I don't know
3) What is the following an example of?

   a. Conditional execution
   b. Handling an event
   c. Sending a message
   d. Loop – repeated execution
   e. Modifying a variable
   f. I don't know
4) What is the following an example of?

   a. Conditional execution
   b. Handling an event
   c. Sending a message
   d. Loop – repeated execution
   e. Modifying a variable
   f. I don't know

5) What is the following an example of?

a. Conditional execution
b. Handling an event
c. <u>Sending a message</u>
d. Loop – repeated execution
e. Modifying a variable
f. I don't know

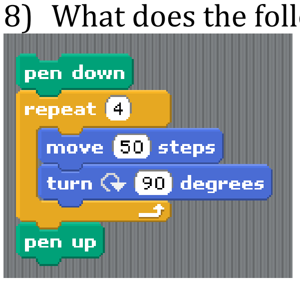
6) What is the following an example of?

a. <u>Conditional execution</u>
b. Handling an event
c. Sending a message
d. Loop – repeated execution
e. Modifying a variable
f. I don't know

7) What does the following code do?

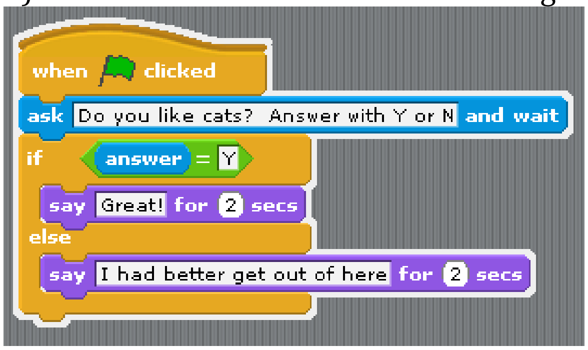
a. <u>Repeat a simple animation</u>
b. Draw a square using the pen
c. Make a ball fall
d. Increment the score
e. Stamp the current costume at the current mouse location
f. I don't know

8) What does the following code do?



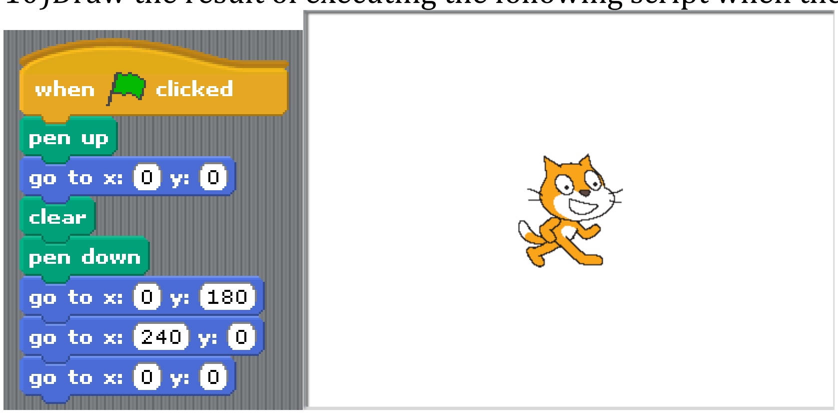
a. Repeat a simple animation
b. <u>Draw a square using the pen</u>
c. Make a ball fall
d. Increment the score
e. Stamp the current costume at the current mouse location
f. I don't know

9) What will be said when the following executes and the user answers with No?



a. Great!
b. <u>I had better get out of here</u>
c. I don't know
d. It won't say anything
e. You will get an error message
f. I don’t know

10)Draw the result of executing the following script when the cat is in the center of the stage.



a. Square
b. Circle
c. Rectangle
d. <u>Triangle</u>
e. I don’t know

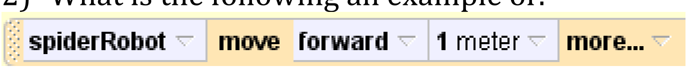
Appendix B. Content Knowledge Assessment Items- Alice

Correct Answers are underlined

1) How many objects are in this object tree?

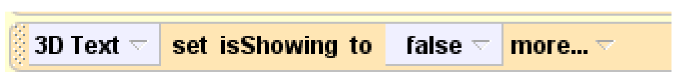
   a. 5
   b. 8
   c. 9
   d. 0
   e. 4
   f. I don't know

2) What is the following an example of?



   a. Executing a method
   b. Changing a field
   c. Executing a function
   d. Changing a variable
   e. Creating an object
   f. I don't know

3) What is the following an example of?



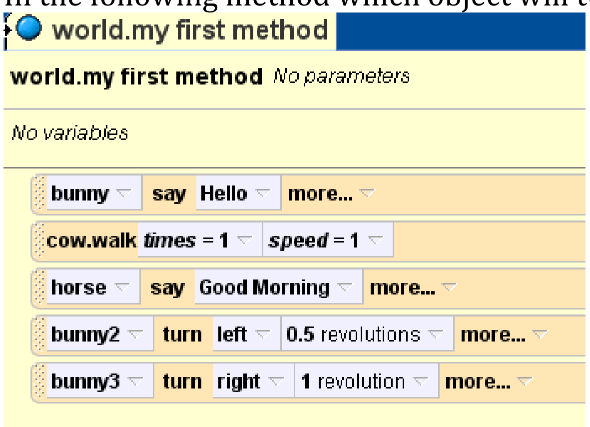
   a. Executing a method
   b. Changing a field
   c. Executing a function
   d. Changing a variable
   e. Creating an object
   f. I don't know

4) How many objects can you make from a class in Alice?
   a. None
   b. 1
   c. 20
   d. 100
   e. As many as you want
   f. I don't know

5) What is the following an example of?

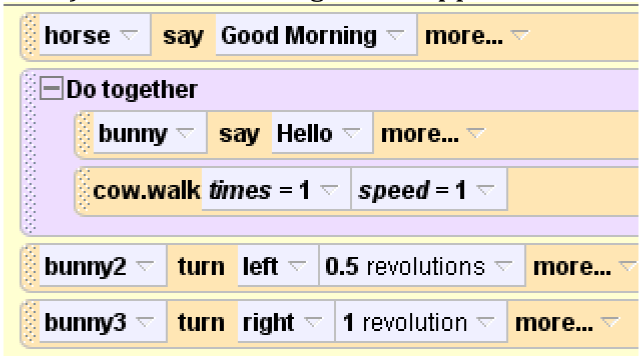
a. Executing a method
b. Setting a property
c. Executing a function
d. Changing a variable
e. Creating an object
f. I don't know

6) In the following method which object will turn around 180 degrees?



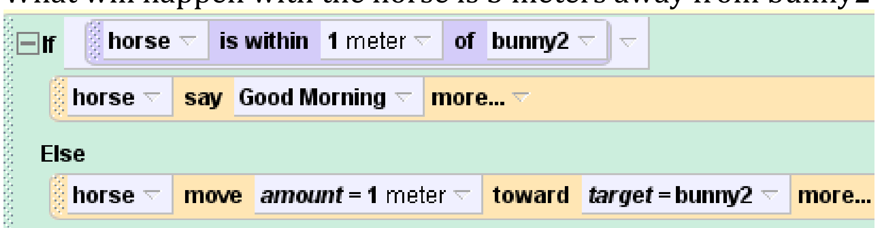
a. bunny
b. cow
c. horse
d. bunny2
e. bunny3
f. I don't know

7) Which two things will happen at the same time?



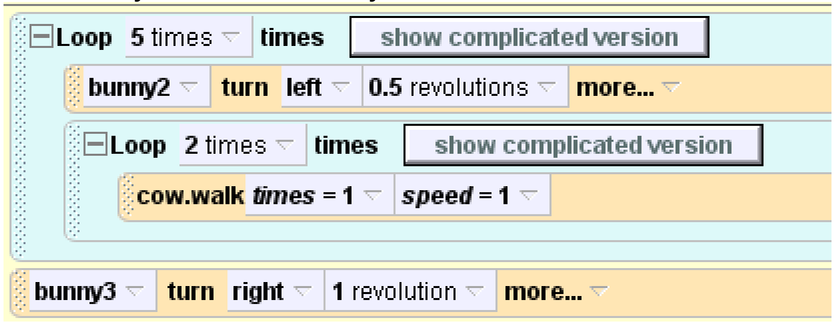
a. The horse will say "Good Morning" and the bunny will say "Hello".
b. The bunny will say "Hello" and the cow will walk one time
c. The Cow will walk 1 time and bunny2 will turn half way around
d. The bunny2 will turn half way around and bunny3 will turn all the way around
e. The horse will say "Good Morning" and bunny3 will turn all the way around
f. I don't know

8) What will happen with the horse is 3 meters away from bunny2 when the following executes?



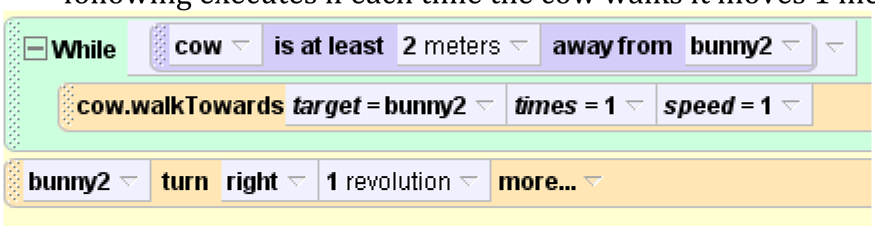
a. The horse will say "Good Morning".
b. The horse will move away from bunny2
c. The horse will move forward in the direction it is facing
d. The horse will move toward bunny2
e. The horse won't do anything
f. I don't know

9) How many times will bunny2 turn and cow walk when the following code executes?



a. Bunny2 will turn one time and cow will walk one time
b. Bunny2 will turn 5 times and cow will walk 2 times
c. Bunny2 will turn 10 times and cow will walk 2 times
d. Bunny2 will turn 5 times and cow will walk 10 times
e. Bunny2 will turn6 times and cow will walk 10 times
f. I don't know

10) If the cow starts out 11 meters away from bunny2 how many times will the cow walk when the following executes if each time the cow walks it moves 1 meter?



a. Cow will walk 1 time
b. Cow will walk 10 times
c. Cow will walk 11 times
d. Cow will walk 9 times
e. Cow will walk 8 times
f. I don't know