

Workifying Games: Successfully Engaging African American Gamers with Computer Science

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ABSTRACT

We report on the implementation and evaluation of a three-year program to increase interest in studying computer science (CS) among African American male high school students. Over the course of 3 years, the Glitch Game Tester (Glitch) program employed 25 African American male high school students. These students tested pre-release digital games, full-time in the summer and part-time in the school year, with an hour of each day dedicated to learning introductory CS. Initially, only 20% of our participants expressed interest in pursuing computing as a career. After Glitch, 65% have pursued some form of post-secondary computing studies. These outcomes, and the participants' enthusiasm for engaging in computing, are in sharp contrast to the crisis in African American male education and learning motivation. The research presented in this report discusses lessons learned through implementation of the Glitch program and higher education outcomes after graduation from the program.

Categories and Subject Descriptors:

K.3.2 Computer and Information Science Education.

General Terms

Design, Human Factors

Keywords

Games, Learning, Design, Intent to persist

1. INTRODUCTION

There is a concern in the United States (US) that we are not training enough citizens to fill the need for computer scientists. The pool of individuals who historically have filled these positions, white males, is a shrinking part of our population [9, 12]. African American males have historically underperformed in academic settings, and have high rates of unemployment and underemployed [10]. We propose that increasing the number of African American males who enter higher education to study CS is one strategy to improve the number of trained computer scientists in the US, improve educational outcomes for African

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SIGCSE '13, March 6–9, 2013, Denver, Colorado, USA.

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American males, and increase their participation in computing, a field that holds the promise of high-paying and secure employment [1].

To address these objectives, researchers from a public technical university and a Historically Black College or University (HBCU) developed a targeted program to leverage young African American males interest in digital games into an interest in computing. Our formative work showed that many current computer scientists (mostly white males) were drawn to computing through hacking and modding video games [4]. However, we found that while African American males played games more frequently, they valued sportsmanship in their play practices, and felt that hacking or modding was cheating. [5]. We sought to build on practices with games that seeded interest in computing (i.e. breaking open the game through hacking or modding), while still respecting the play practices of African American males (i.e. a value on sportsmanship). We pursued the idea of game testing as a learning practice because it engages breaking open the games, while still respecting the culture of sportsmanship.

2. DESIGN & IMPLEMENTATION

From 2009 – 2011, twenty-five high school students participated in the Glitch Game Testers program. These participants worked full-time in the summer and part-time in the school year as game testers. They did quality assurance work on pre-release digital games for industry clients. The testers also participated in CS workshops and classes. There were other factors that made Glitch successful with the students, like holding it on a university campus, and offering a competitive point system (e.g. giving points for documenting a bug in a game) with significant rewards.

2.1 Schedule and Pay

During the summer, the testers worked full-time from 10:00 AM – 5:00 PM, Monday – Friday for 8 weeks. Testers were paid an hourly rate of \$8.00. During the school year, testers worked part-time on Saturdays from 9:00 AM – 10:00 PM. While we began our summer days a little later to match adolescent sleep patterns, when we established the schedule for the school year, participants asked to start a little earlier so they could “get more hours in.”

A typical day consisted of testing from 10:00 AM to noon, lunch, a CS workshop after lunch, and then more testing until 5:00 PM. We began the day with testing to make sure we established that this was a work environment rather than an educational environment. The weekly activities varied, but the majority of the time was spent on testing or tasks related to testing.

On Monday mornings there would frequently be quality assurance training and review, which included exploring new concepts or reviewing bug reports. This was another strategy to focus the participants on the work for the week. On Fridays there were pizza lunches with computer scientist speakers, and we held a game tournament late Friday afternoon. These more social aspects of the program helped to facilitate a number of friendships that extended beyond the program – and likely provided social support for their interest in CS. There were other activities, such as tours of colleges or game development companies. We also had visits from our clients, who would conduct training or help with technical issues.

The schedule and activities were based around participant input, what would work with their schedule, and what was of value to them. For example, we held resume writing, college application and HTML workshops based upon the participants' request.

2.2 Recruitment and Consent

Participants were recruited to become part of the Glitch program through an email flyer with a one-page application sent to local youth leaders, teachers and community members in predominantly African American communities and schools. The recruitment language was focused on recruiting individuals who loved playing games, not individuals with an interest in technology or computing. Of the approximately 200 applications we received in the first two weeks after these emails were sent each spring, we selected 15 - 18 students to interview for the summer session. Selections were made based upon the date the application was received, meaning that participation was primarily based on a first-in, first-hired basis. The only other qualifying criteria for an interview were age; participants needed to be between 16 and 18 years of age, and currently enrolled in high school.

In all cases, the first 20 applicants that met these criteria were African American males. We generally interviewed more applicants than the 7 – 12 openings. Final selection gave priority to those who, were passionate about playing video games, qualified for free or reduced lunch, and were rising juniors. All data was collected between May 2009 and July 2012 with 25 participants. All participants and their parents were informed of the human subjects protocol. We obtained assent from minor participants and consent from adult participants and adult guardians. Protection of participants was annually reviewed and renewed through our Institutional Review Board (IRB).

2.3 Participants

From the beginning of the Glitch program in June of 2009 to the end of the summer program in July of 2011, we had 33 participants. Only the 25 participants who have graduated from high school are considered in this evaluation. All other participants are still in high school and on track to graduate on time. All participants self-identified as African American males. Two participants also self-identified as Latino. The participants ranged in age from 16 – 18 years of age, with an average age of 17. Of the 25 participants, 19 qualified for free or reduced lunch.

2.4 Location and Transportation

Prototype workshops demonstrated that transportation was an important issue in maintaining participation. We originally intended to hold the program on the HBCU campus; however, it rapidly became apparent that this would not work because of

limited public transportation [3]. Instead, the program was held on the public university campus, where public transportation is more accessible. This set an expectation, similar to any job, that testers were responsible for their own transportation and would not be paid if they did not show up. Testing occurred in a dedicated space in an academic building that primarily houses computing classrooms, chemistry class labs, and robotics project labs.

The location became an important issue for the participants. The responsibility of getting to and from work each day using public transportation was something that made Glitch feasible. In addition, it emerged that participants were quite proud of being independent and responsible for their own transportation. The campus location was also important to participants because they began to see themselves as members of a prestigious university community where classes and research happened [3].

2.5 Game Testing

Game testing is a form of software quality assurance (QA) work. In Glitch, testers would receive early versions of games from our clients, and then look for instances where the code did not perform as expected. There are different types of testing that engaged participants in the software development community of practice. Some were very directed, such as *planned testing* where participants systematically tested specific lists of functionalities that developers requested. On the other end of the spectrum, *play testing* engaged participants in open ended and subjective critique on the balance and playability of the game. The participants also saw the iterative process of software development through *regression testing*, in which a tester checks previously-reported bugs to see if they have been fixed correctly. When participants found an error, they would write up a bug report using online bug tracking software. This report includes a detailed step-by-step description of how to reproduce the bug. Developers then look at these reports and respond to them by fixing the bug or engaging the testers with questions about the bug report.

2.5 Computer Science Learning

We anticipated that testing was one method for encouraging these young men to see video games as computation. In addition, we held computing workshops and classes to increase the opportunities for learning. Our goal was to seed an interest in computing. The workshops helped to make sure that students learned CS. Without the CS workshops, the game "seed" would never sprout.

The introductory CS workshops were built upon existing curriculum that had previously been successfully in teaching non-CS majors basic computing concepts [7]. In their first year in Glitch, participants took part in CS workshops based on the media computation approach (Guzdial, 2003) using *Alice*, a drag and drop programming language (Cooper, Dann, & Pausch, 2000), and Jython.

Initially we had no plan for different CS workshops for the participants' second year in the program – we thought they would just do more in-depth projects with *Alice* and Jython. However, the participants' requested an opportunity to learn a more realistic programming language (they felt Jython was not a real language). In response, we offered them a chance to take an Advanced Placement Computer Science (APCS) course to prepare them for

the Advanced Placement exam. All of the participants voluntarily chose to take this class rather than taking the first workshop again.

Finally, both first- and second-year students built computers that were used in our testing (it was cheaper to build them than to buy them) and used as prizes in the *Glitch Competition* (see section 2.6). The participants seemed to appreciate authentic work, such as building computers we really needed, and working towards taking a test that would mean something for their future in computing. We continued to design elements of what they were doing with game testing into the development of our curriculum including the development of a Java class using *Greenfoot* [8] to create their own games in 2011.

Another way we contextualized the CS learning was through our teachers. Most CS workshops and classes were taught or assisted by African American CS majors from the partnering institutions. These young people (most of whom were male) were paid to help manage and teach in the Glitch program, and they were motivated to make a difference in the education of young African American males. The contribution these young people provided the program was immeasurable. Of particular note is how they became role models for success in CS and college, and they were able to inform the older, White and African American researchers about the interest of the high school participants. For example, the young men who taught the first APCS course used an elaborate description of basketball positions, teams, and individual players to introduce object oriented programming.

2.6 Competition

Formative work indicated that competition was important to young African American males when gaming and in their everyday lives [5]. Because of this, we designed competitive elements into the Glitch program. During workshops and classes, mentors and teachers used competition and rewards to motivate the participants. The types of rewards and prizes varied. Sometimes participants were awarded candy as a prize, or rewarded intangibles, such as being voted as having the "best" presentation, or with points in the overall *Glitch Competition*.

The *Glitch Competition* was an ongoing tally of the points posted on a white board in the room. Keeping track of points became an important part of each day for the participants. When updates were made on the board, everyone stopped what they were doing, turned to look at the manager writing the new scores down, and started bragging, making excuses or trash talking (using insulting or boastful speech) with each other based upon the outcome. The points were added up each week to determine a winner. In the summer, the weekly winner received a video game or a gift certificate. At the end of the summer and the school year, the winner won one of the computers the group had built.

2.7 Notes on Implementation

The point system, weekly Friday speakers, CS workshops and QA training were iterated upon over the 3-year implementation. This ongoing effort was based upon participants' opinions and insured they had a voice in designing the learning environment. Perhaps due to this flexible implementation, participants frequently asked for additional help, training and mentorship.

2.8 Funding

The project was primarily funded through a National Science Foundation grant which covered the most of the cost of undergraduate staff, about half of the technology and materials, and all of the hourly wages of the participants for the first two summers. Wages for the third summer were paid with funds from foundations Arthur Blank Foundation and Yahoo! Games.

So while we were testing pre-release games companies were not willing to pay us directly for our services. There seem to be three main issues that contributed to this. First, we did not have trained and dedicated sales staff member. Second, the payment structure proved to be difficult to coordinate with an academic institution and for profit companies. Third, we did not attain consistent quality in our game testing services. To address these issues we are now working with a for profit company that has a sales staff for technology serves, a business model for more traditional client structures, and better trained managers for quality assurance. The academic institutions were good at the CS educational components, and will continue those aspects of the program.

3. DATA COLLECTION AND METHODS

Quantitative and qualitative methods were used to evaluate Glitch. This report will focus on quantitative measures including two online tools developed and administered with the assistance of The Findings Group, LCC,¹ and follow-up communications with participants one year after their high school graduation. The surveys were administered in 2010 when 22 of the 25 graduates of Glitch participated.

3.5 Confidence & Interest in Computing

We used a survey instrument to measure participants' *interest in and confidence with computing* [15] based upon two validated instruments that measure self-efficacy, outcome expectancy, and computer attitudes. The first validated surveys used was the Microcomputer Beliefs Inventory (MBI), which assessed the participants' self-efficacy and outcome expectancy beliefs toward computers [6]. Item analysis, scale reliability assessment, and factor analysis of scale integrity were previously conducted and both scales performed with "good" reliability (Cronbach's Alpha $r = 0.80, 0.85$, respectively) [6].

The second validated instrument we used was the Computer Attitude Questionnaire (CAQ), which was designed to measure attitudes and disposition towards computers and was shown to have "very good" internal consistency [2]. This version of the CAQ used three of the eight possible subscales: Computer Importance, Computer Enjoyment, and Creative Tendencies (Cronbach's Alpha $r = 0.80, 0.80, 0.87$, respectively).

Both surveys used a 5-point scale where 1=Strongly Disagree, 3 = Not Sure, and 5 = Strongly Agree. In the first year, 2009, we administered this survey as a pre ($N = 12$) and post ($N = 12$) measure at the beginning and end of the 8-week summer program. For some questions, participants' post surveys reported lower self-efficacy. We suspected that students were overconfident about their computing abilities pre-Glitch, and after participating in the 8-week program discovered the breadth and depth of computing knowledge that was available, and gave more conservative

¹ The Findings Group, LCC. is the independent firm hired to evaluate the Glitch project with funding from NSF.

estimates of their confidence and knowledge. In response to this, we modified the survey in 2010 and delivered it as a retrospective survey to participants (N = 21), which allowed us to ask the participants to evaluate how they changed in their attitudes, self-efficacy and outcome expectancy. The reported findings are from these retrospective surveys from 2010.

3.2 Intent to Persist Scale

Toker and Ackerman [13] developed a validated measure on *Intent to Persist* to assess vocational interest in STEM fields. We used a modified version of this survey that included focused questions on computing. Participants were asked to rate the truth of statements regarding intention to persist with education, STEM interest, and interest in computing on a 6 point scale, with 1 being Very Untrue of Me and 6 being Very True of Me (N = 22). Wyer's [14] short-term, mid-level, and long-term commitments were used to frame the 12 items in this survey. Six additional computing questions were added and these followed the same framework, but which were specific to intent to persist in computer science. In 2009, the survey was given as a pre and post measure. In 2010 and 2011, we gave the survey only at the end of the 8-week summer program and added retrospective questions to gauge more exact reflections on changes in participants' intent to persist in education, technology and computing. The reported findings are from the retrospective surveys.

3.3 Post High School Graduation Follow-up

The lead author maintained a relationship with most of the participants through occasional emails and participation on social network sites. Through these correspondences and direct email appeals, we have data on the post high school activities of 23 of the 25 participants who have graduated from high school. In this paper we report actual persistence: whether the participants have attended a higher education or training program, the type of education program they are involved in and the subject they study, within one year of leaving the Glitch program.

4. RESULTS

In this section we will report on the results from surveys on confidence with computing and interest in computing, scores on *intent to persist* with computing, and details on the post-secondary education outcomes. Throughout these findings, we can see demonstrations of Glitch's success in motivating this group of young African American males to study computer science.

4.1 Confidence with Computing Results

The retrospective surveys measuring confidence in computing from the summer of 2010, showed statistically significant gains and small to medium effect sizes. Participants' responses to indicated that they gained computing confidence. Particularly participants demonstrated increased confidence in computing on two questions; "I know how to use the computer" (p=0.005) and on the negatively worded "I get a sinking feeling when I think of trying to use a computer" (p=0.046) (Table 1).

4.2 Interest in Computing Results

Glitch participants self-reported interest in computing and other factors involving technology before and after the summer 2010 (Table 2). We see statistically significant gains in their interest in computer programming (p=0.008), in their interest in information technology (p=0.013), and in their interest in computer engineering (p=0.013). Comparatively, we did not find significant gains in other items of interest such as music programming, web

programming and game design. Further, Vargha and Delaney's *A* is used to measure effect size, and we see small to medium effect sizes for computer programming, information technology, computer engineering, graphic design, web programming, and game design. Table 2 indicates that the program has increased student interest in our primary target, computer programming.

Table 1: Participants' Confidence in Computing (n=21)

Statement	Time	Mean [†]	A	Wilcoxon
1. I know how to use the computer.	Before	4.43	0.690 ^c	0.005**
	After	4.81		
2. I am not very good at using a computer.	Before	2.19	0.532 ^a	0.610
	After	2.29		
3. Even when I try hard, I do not use the computer as well as others do.	Before	1.90	0.502 ^a	1.000
	After	1.95		
4. I think I generally use the computer poorly.	Before	1.86	0.517 ^a	0.157
	After	1.67		
5. I understand what a computer can do well enough to use it correctly.	Before	4.10	0.590 ^b	0.102
	After	4.29		
6. I get a sinking feeling when I think of trying to use a computer.	Before	1.71	0.544 ^a	0.046*
	After	1.57		

Note. Vargha & Delaney's *A* is a non-parametric measure of effect size. An *A* value of 0.50 indicates no difference between group means; an *A* of 0.56 equates to a small effect size (d=0.20), an *A* of 0.64 equates to a medium effect size (d=0.50), and an *A* of 0.71 is equivalent to a large effect size (d = 0.80). Effect size ranges are denoted with the letters a-d to indicate the range within which the effect size statistic falls.

^a none to a small effect; ^b small to medium effect; ^c medium to large effect; ^d large effect [†]Scale ranges from 1 (Strongly Disagree) to 5 (Strongly Agree) with "I'm not sure" as the midpoint.

*Statistically significant (p<0.05)

**Statistically significant (p<0.01)

4.3 Intent to Persist Results

The *Intent to Persist* scale indicates that participants intended to pursue CS in their future careers. Table 3 indicates that participants' plans to attend and graduate from college began and remained high. While, there was no significant increase in these numbers, their stability gives us more trust in the measure. The participants' plans to pursue computing while in college did change positively and significantly from pre to post. These findings indicate that the Glitch program had an impact on the participants' intent to study computing in both college and graduate school (Mcklin et al., 2010).

Table 2: Participants' Interest in Computing (n=21)

		Mean	A	Wilcoxon
I was interested in computer programming.	Before	4.48	0.600 ^b	0.008**
I am interested in computer programming.	After	5.05		
I was interested in information technology.	Before	4.40	0.592 ^b	0.013*
I am interested in information technology.	After	4.79		
I was interested in computer engineering.	Before	4.36	0.582 ^b	0.013*
I am interested in computer engineering.	After	4.81		
I was interested in graphic design.	Before	4.15	0.576 ^b	0.347
I am interested in graphic design.	After	4.45		
I was interested in music programming.	Before	4.23	0.476	0.861
I am interested in music programming.	After	4.05		
I was interested in web programming.	Before	4.29	0.595 ^b	0.062
I am interested in web programming.	After	4.70		
I was interested in game design.	Before	4.62	0.564 ^b	0.054
I am interested in game design.	After	5.00		

See notes from Table 1

Table 3: Glitch Participants' Intention to Persist in CS (n=22)

Statement	Time	Mean [†]	A	Wilcoxon
1. I plan to apply to college.	Before	5.86	0.478	0.317
	After	5.82		
2. I plan on graduating from college.	Before	5.86	0.457	0.157
	After	5.77		
3. I plan on graduating from college with a computing-related degree.	Before	4.05	0.648 ^c	0.026*
	After	4.55		
4. I would like to go to graduate school after college.	Before	4.41	0.571 ^b	0.096
	After	4.68		
5. I would like to go to graduate school after college for a computing-related degree.	Before	3.59	0.653 ^c	0.028*
	After	4.14		

See notes from Table 1

Participants were also asked about their career aspirations (see Table 4). Again, there are significant changes from pre to post in their “plans to work in a technology-related field” (p=0.02), “plans to find a job as a computer scientist or computer programmer” (p=0.01), “plans to earn a living as a computer scientist or programmer” (p=0.004), and “plans to devote my career to an area related to computer science” (p=0.026). As with their intentions to continue their education in computing, the participants expressed a growing interest in pursuing computing as a career.

Table 4: Participants' Interest in Pursuing a Computing Career (n=22)

Statement	Time	Mean [†]	A	Wilcoxon
1. I am planning on working in a technology-related field.	Before	4.86	0.589 ^b	0.02*
	After	5.18		
2. I can see myself working as a computer scientist or programmer in the future.	Before	4.23	0.582 ^b	0.07
	After	4.68		
3. I am planning to find a job as a computer scientist or computer programmer.	Before	3.77	0.624 ^b	0.01*
	After	4.36		
4. I am planning on earning a living as a computer scientist or programmer.	Before	3.55	0.640 ^c	0.004**
	After	4.27		
5. I am planning to devote my career to an area related to computer science.	Before	3.77	0.582 ^b	0.026*
	After	4.27		

See notes from Table 1

4.4 Post High School Graduation Outcomes.

As of May 2012, twenty-five participants had graduated, and the remaining participants were still enrolled in high schools. Of the twenty-three graduates that responded, twenty-one have pursued post-secondary education and as of one year after their graduation all but one were still enrolled in school.

The five students pursuing non-CS related education generally came from families with a stronger history of educational attainment. These students are attending in-state public schools and majoring in education, marine biology, business and film.

The sixteen students who are pursuing additional computing education are taking several different paths to pursue careers as computer scientist, game developers, web developers and software engineers. Only four of these students had indicated that computing was a possible major before the Glitch program started. As of one year after graduation, 11 were continuing on in four-year schools majoring in computer science. Most of these students are attending in-state public schools, but one is attending a private HBCU and one transferred to a military academy after his first year. Three students started in 2-year institutes studying computer information technology, but one dropped out at the end of the year and enlisted in the military with hopes of pursuing

technology training as a soldier. Finally, Two students were pursuing arts degrees with digital media as their focus, one in a 4-year college and one in a 2-year institute.

5. DISCUSSION & CONCLUSION

The design of the Glitch program was based in extensive formative work that informed the initial concepts, but Glitch was also continually refined. We approached Glitch as a prototype and worked daily with the young African American participants in shaping this environment to their values. These ongoing iterations to the program helped us polish the implementation. Through these iterations the program began to focus on three things that may be key for creating CS learning environments for young African American males. First, we found that real work and authentic contributions to valued artifacts were significant motivators for enthusiasm in all aspects of the program. Second, we found that competition was often used as a tactic for making it socially acceptable to make a concerted effort to learn. Third, we found that integration of the program on a college campus, with undergraduates teaching, gave the participants a sense of belonging in a higher education environment.

The qualitative data presented suggest that the focus areas were on target and most participants increased their confidence with computing, interest in computing, intend to persist in computing and are seeking CS educational options post graduation. However, there are still real barriers to success outside of the Glitch environment that these young men may not be equipped to handle. After entering college, some of the participants have not made good grades as easily as they thought they would with their prior CS experience. One participant did not attend school at first because of finances, then went to a technical school, then dropped out to enter the military. Another participant completed his first year but dropped out in his second year. While the findings are compelling that, over time, these young men have the intent to persist in computing, long-term effects may be tempered with the reality of the barriers that young lower-income African American males face.

While we began the Glitch program leveraging the fun of video games to learn CS, through the iterative process with our participants, we discovered that a real world work environment about a product (video games) that young African American men care about was more motivating than making something “fun.” For future work we hope to take a different approach than the gamification advocates [11]. We seek to focus on the work of game making, rather than the gaming of work.

6. ACKNOWLEDGMENT

The Glitch Game Testers was made possible by the National Science Foundation through support of grant # 0837733. Additional funding was provided by the Arthur Blank Family Foundation and Yahoo!.

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