BUILDING TECHNOLOGY FLUENCY: FOSTERING AGENTS OF CHANGE

Wanda Eugene, Shaundra Bryant Daily
School of Computing
Clemson University

Richard Burns
Department of Computer Science
West Chester University

Tiffany Barnes
Department of Computer Science,
North Carolina State University

Abstract

As technology is increasingly incorporated into our everyday lives, technological fluency, the ability to create and express with technology, becomes increasingly important. Further, engaging students to create technologies that can impact their own communities helps them become civically engaged, 21st-century citizens. Two case studies are presented, one in Birmingham, Alabama and another in the Republic of Haiti, where technology fluency development was integrated with community engagement. We present student projects developed in the MIT-developed Scratch programming language, including their envisioned solutions to healthcare and electricity. We also make recommendations for how other practitioners might cultivate these types of environments.

Introduction

Our society is rapidly transforming through the appropriation and re-appropriation of technology. This constant innovation can empower individuals and communities to be agents of change. For example, various communities in countries such as Egypt, Tunisia, and Libya are harnessing the power of mobile technology and leveraging social media to maintain a voice in the midst of political oppression. Social media have been cited as the driving force of the uprising or revolution of 2011, better known as the Arab Spring [1, 2, 3] where many used blogs, Twitter, and Facebook to defuse disinformation, facilitate social activism, and effect change. Similarly, a more casual example is the use of mobile technology by fishermen, which has decreased price dispersion, eliminated waste, and enabled new modes of cooperation through the sharing of information regarding promising fishing grounds and rescue at sea [4, 5].

Mobile, multimedia, mapping, communication, and other technologies have a tremendous potential for social empowerment; however, many of these are far from being in mainstream use [6]. Opportunities must be created for a wider number of people to become creatively productive with technology [7]. In this paper we present case studies of two interventions, one in Birmingham, Alabama and another in the Republic of Haiti, where learning technology fluency was integrated with community engagement. In both locations, students designed and prototyped solutions to community problems such as adequate healthcare, accessible water, and personal finances by using computational technology.

Background

In our research, we differentiate between technical familiarity and technological fluency. *Technical familiarity* is proficiency in using computing for everyday tasks and it can be

demonstrated in a multitude of ways including using electronic communications, designing electronic media, and taking advantage of digital resources [8]. *Technological fluency*, however, involves the ability to create and express efficacious solutions through technology [7] and is acquired by integrating knowledge with the ability to engage in collaboration, problem solving, and discourse [9]. Learners achieve self-perpetuating fluency when they are provided with a set of fundamental tools with which to understand technology from both a practical and social perspective. The process of building technological fluency is very similar to the classroom application of the scientific method—posing a problem, doing research, planning, developing a prototype, testing, redesigning, and sharing solutions. In this process learners are equipped with tools for systematically addressing a problem, such that it becomes transparent to their own thinking and learning trajectories [10].

Many today recognize that technological fluency and access to new technology allow individuals to position themselves better in life [9]. As a result, such people strive to become technologically fluent in order to participate in the digital world and benefit from it [11] However, from a societal view, it is vital, that individuals utilize these skills not only for themselves but also for the benefit of their communities. Social change—significant alteration over time in cultural symbols, rules of behavior, and value systems—cannot occur unless individuals employ their skills *collectively* to enhance their communities.

Social constructionism integrates personal and community development by focusing on initiatives that engage people in the creation of personally meaningful activities that improve their social settings. The goal, in short, is to generate an empowerment cycle wherein the activities of individuals contribute to strengthened communities that, in turn, become more conducive to the wellbeing of individuals [12]. The interventions described below employ the social constructionist framework to address the need to develop technological fluency while actively engaging students as agents of change for their own communities. Although implemented in ways appropriate for each context, the strategy employed began with a discussion of community issues as well as solutions to existing problems. Next, workshop participants used Scratch, a programming environment developed by the MIT Media Lab Lifelong Kindergarten group [13], to express their ideas. These projects were often in the form of advertisements, stories, and games. Further details about this process are presented below.

Case Study 1: Birmingham, Alabama

The context of this summer camp was the release of XO laptops at a pilot school in Birmingham, Alabama. In the summer of 2008, we worked with twelve rising third-, fourth-, and fifth-grade students (50% female and 92% African American) from around the school district, as well as six teachers (83% female and 83% African American) from the school. Only two of the students and one of the teachers had previous programming experience. During each half-day of the four-week workshop we collaborated with students in creating health campaigns to educate their communities via advertisements and games on the XO laptops.

The motivation for this workshop was threefold. (1) Biotechnology and medical research are a large part of Birmingham's economy. Known for its medical education program and facilities, the University of Alabama at Birmingham, the largest employer in the state, is a prime resource for introducing students to healthcare issues and for providing them with opportunities to learn from healthcare professionals. (2) African American health issues are very prominent in the South and other parts of the United States. Fifty percent of all new cases of HIV are black women. Diabetes, high blood pressure, obesity, and suicide also disproportionately challenge the black community. With 73% of its population being

African Americans, Birmingham is an excellent location to educate students on these issues. (3) The workshop was used as a professional development activity for Birmingham City Schools teachers and staff. These educators helped shape the workshop's direction.

During the first week of the camp, students spent time becoming more acclimated with the Activities (programs) on the XO laptops. Later, during the second week of the camp we worked with University of Alabama at Birmingham health educators to introduce students to possible topics of interest. They spent approximately one hour lecturing about substance abuse, diabetes, and emotional health. The goal of these sessions was to help students start to brainstorm ideas. On Thursday of that week students did individual and group brainstorming under the theme of "Something I would like to teach my community about healthcare." The groups that formed as a result of this activity included Diabetes Healers, Emotions Squad, Healthy Hearts, M. K. Fitness Together, Drug Stoppers, Teeth People, Got Health, and Brainiacs.

Students decided in the following week what sort of projects they would be making in Scratch. The dozen students were very enthusiastic about getting to come up with their own ideas and the six teachers were impressed by the quality of the students' ideas and their excitement. One teacher noted that the students would get out of their parents' cars in the morning with their laptops open. Another stated, "They really did not want to stop working." By the end of the workshop students had created such projects as a newscast, three mazes, a television commercial, and a song.

The Diabetes Healers created a newscast detailing the precautions those living with diabetes should take. Each student took his or her turn describing the facts they had learned about diabetes, most of which they had discovered by conducting research themselves after a brief introduction by the University of Alabama at Birmingham health educators.

Since students were not required to focus on a specific topic, the Brainiacs created a futuristic story in which a man walking along a road is struck by a vehicle. Fortunately a robot is there to rescue the man and he is taken to a local hospital, where the robot shrinks itself and enters the man's brain to make the necessary repairs. Then a game starts where the player helps the robot navigate different mazes that represent the different parts of the brain that the robot needs to repair. The Brainiac team's goal was that people would understand the brain better through interaction with the game.

The team called Drug Stoppers decided to educate the community about issues associated with drug use and abuse. It first created a discussion about the dangers of drug use as well as the possibility of death. The team ended with a song encouraging people in its neighborhoods to avoid drugs at all cost. Finally, the Emotions Squad created a maze to teach about different emotions. One of the students took pictures of himself expressing different emotions and when a player saw a picture the game would indicate what emotion was being expressed. These projects are depicted in Figure 1 below.

At the end of the camp, the students demonstrated their understanding of the healthcare subject matter by presenting their campaigns in a public forum. Their presentations included descriptions of their topic as well as the reasoning behind what they had created. Furthermore, analysis of their Scratch projects revealed an understanding of introductory computing concepts including conditionals, function calls, sensing, and event handling. All students found the work exciting and they were challenged to collaborate with each other. Every student expressed a desire to teach others what he or she had learned during the camp.

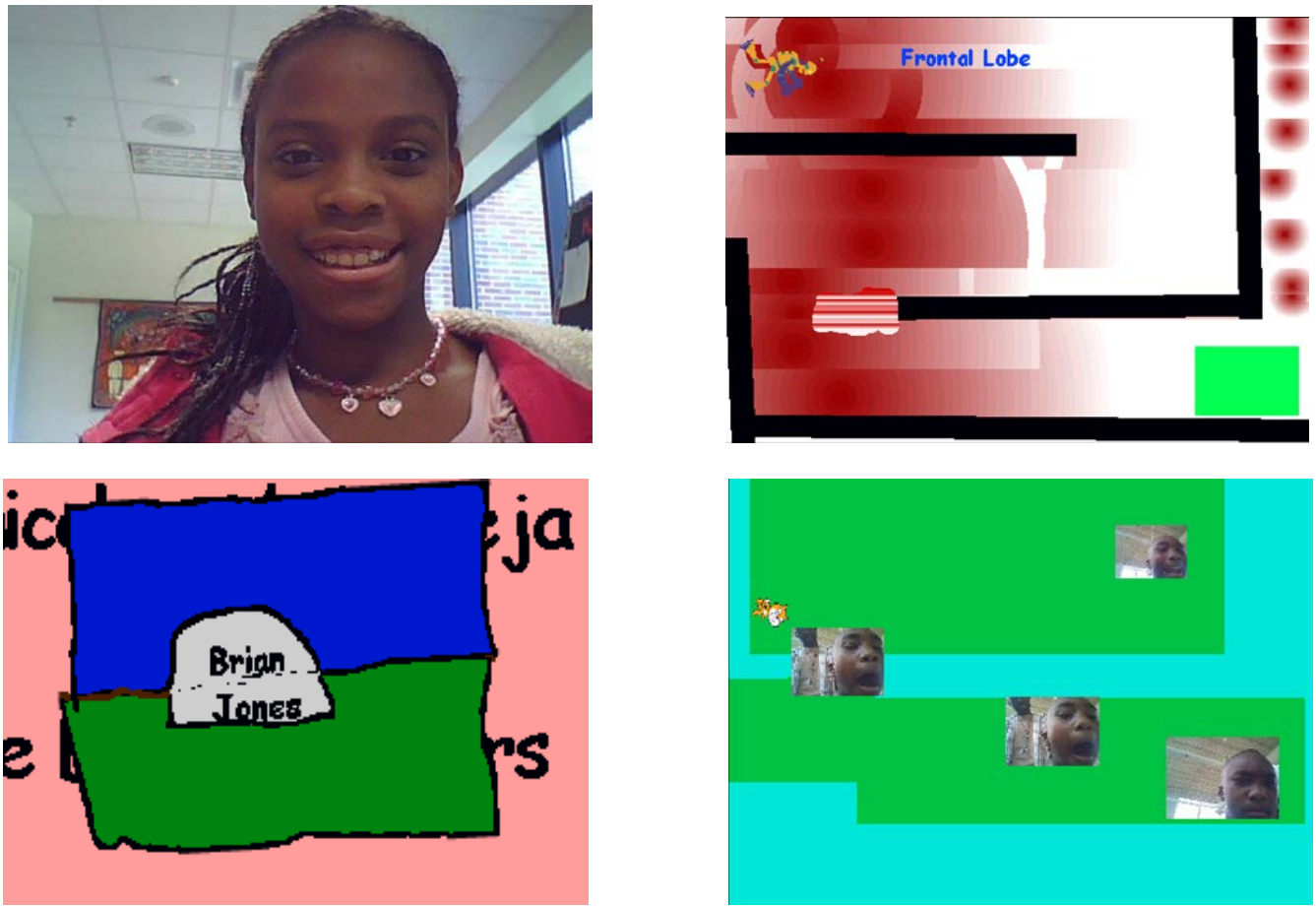

Figure 1. Clockwise: Diabetic Healers, encouraging people to watch what they eat in a news report; Brainiacs, using a robot in a maze to help people learn the different parts of the brain; Emotions Squad, demonstrating different facial expressions to support game players in learning about emotion; Drug Stoppers, encouraging people to stay away from drugs that could possibly end their lives.

Case Study 2: The Republic of Haiti

In the spring of 2012, students and faculty from the STARS Alliance visited the Republic of Haiti and worked with twenty-four young female mentors (ages 18-32) at three different rural schools on the outskirts of the city of Cap-Haïtien. At each school we spent about ten hours working with the mentors over a two-day period. Prior to our arrival these mentors taught computer classes after school on XO laptops to children in grades three through five (ages 8-15) for about six hours per week. The mentors had previously taught the children to create animations, but the learning had little connection to their schoolwork or daily lives. Although we tweaked our approach at each school, we present here the final approach utilized since it encompasses all of the practices developed from lessons learned at the first two schools.

At the beginning of the session we began by finding a common ground with the mentors in order to build rapport. After introductions we discussed their goals, interests, and learning objectives. At all three schools language learning was discovered to be a common ground. The mentors wanted to learn English and the STARS team members wanted to learn Kreyol. As a result, we utilized the Byki app to do a brief language-learning exercise. We next paired the mentors for a "community chat," a thoughtful round-table conversation in which

they shared in detail how they perceived their community, its challenges, and possible solutions to those challenges. We then explained how the scientific process works – and that the first step in that process is to fully understand the problem to be solved. We then charged the groups to come up with thorough written storylines, sketches, and oral presentations of their dialogue to help build a thorough understanding of the issues in their community. Participants told compelling stories about community problems including access to energy, schooling, water, food, and healthcare.

Using the tutorials made available in the Scratch environment, we then devoted about two hours to taking students through the layout and structure of Scratch, using its basic features to create a program. At the end of the first session mentors were assigned homework to encourage self-exploration of Scratch and the XO laptop. They were also asked to think about how the computer classes could be integrated to serve community needs. Session two began with mentors getting help on any questions or inquires they stumbled upon while doing their homework, then demonstrating their projects to the group as a whole. For the second half of session two, mentors assisted their students in doing introductory Scratch. As one of the STARS team members conducted the same introductory Scratch session with everyone in the room, the mentors floated around answering questions and helping kids troubleshoot. After the mentors and students created projects, a culminating event was held as an opportunity for participants to present their project ideas to the community.

Many of the projects were structured as scenarios to exemplify challenges faced within the community because of the lack of energy, schooling, water, food, and healthcare. Figure 2 shows one story of life without electricity and the impact of that situation on education and quality of life. In this story the originators described completing daily chores and tasks while fumbling around in the dark by limited candlelight. As they narrated their Scratch animations in their native tongue, they also vividly situated their stories in images and dialogue. For example, one group talked about food disparities and then created images that included bags of rice and coconut trees, both representing staple food items in the island nation. These stories represent the first step in a scientific process of understanding a problem to solve, and the community presentations are the first step in engaging people in a discussion about how these problems might be solved.

Discussion and Conclusion

In this paper we have discussed the potential and importance of technological fluency as a vehicle for community empowerment. Through technology individuals can prototype and communicate solutions to complex problems in their communities. We presented two cases involving the application of social constructionism in which students embraced the idea of developing technological fluency for the betterment of their community in a way that could ultimately impact their own lives. In our cases, students utilized the XO laptop and explored basic computational concepts for the creation of their ideas. Based on our interactions with Scratch, we found that the majority of the "blocks" used by the students were either conditionals or motion, suggesting that sequencing and case-based sequencing were vital for conveying the students' final products.

In both case contexts participant excitement was contagious: teachers observed a change in their students' demeanor as well as a change in the classroom's environment. An important motivating factor for the students was their freedom to construct a movie, program, or advertisement, etc. on a community-based topic of their choosing. They embraced collaboration with their peers. Equally important, they embraced the presentation of their final product to others for the enhancement of their communities.

Figure 2. Clockwise: "Community chat", mentors and students explain community issues; Mentors assisting students in sketching out their projects; Students converting stories into online animations; Students presenting their work to peers and community members.

Through these experiences we have learned the importance of the following:

- Creating a safe space for a discussion of community challenges so that participants feel comfortable discussing personal experiences.
- Encouraging personal storytelling, connection, and imagination as important parts of problem solving.
- Allowing ideas to originate from participants organically rather than being handed down.
- Providing adequate support to scaffold participants' use of technology in order to express ideas. The amount of support varies based on the previous experience of the participants and should be assessed prior to the workshop.
- Helping participants become experts on their own situation in order to facilitate ownership and a desire to persist.

In summary, enabling students to imagine approaches to improving their communities will plant the seeds for them to view themselves as "agents of social change". By incorporating the

development of technological fluency into the approach, instructors can promote the skills necessary for capitalizing on the potential of new technologies. Our current findings are based on field notes and an analysis of Scratch programs written. In future work, we will administer surveys and interview participants to refine our understanding of program impact.

Bibliography

1 S. Cottle, "Media and the Arab Uprisings of 2011: Research Notes," *Journalism*, vol. 12, no. 5, 2011.

2 A. M. Attia, N. Aziz, B. Friedman, and M. F. Elhusseiny, "Commentary: The Impact of Social Networking Tools on Political Change in Egypt's 'Revolution 2.0,'" *Electronic Commerce Research and Applications*, vol. 10, no. 4, 2011.

3 J. Ghannam, "Freedom Beyond 140 Characters," *The Herald-Sun*, March 12, 2011.

4 R. Jensen, "The Digital Provide: Information (Technology), Market Performance, and Welfare in the South Indian Fisheries Sector," *Quarterly Journal of Economics*, vol. 122, no. 3, 2007.

5 T. T. Sreekumar, "Mobile Phones and the Cultural Ecology of Fishing in Kerala," *Information Society*, vol. 27, no. 3, 2011.

6 L. Burd, "Technological Initiatives for Social Empowerment: Design Experiments in Technology-Supported Youth Participation and Local Civic Engagement," Doctoral dissertation, Massachusetts Institute of Technology, 2007.

7 M. Resnick, and N. Rusk, "The Computer Clubhouse: Technological Fluency in the Inner City," in *High Technology and Low-Income Communities: Prospects for the Positive Use of Advanced Information Technology*, edited by D. Schon, B. Sanyal, and W. Mitchell, MIT Press, Cambridge, MA, 1998.

8 E. Christensen, U. Anakwe, and E. Kessler, "Receptivity to Distance Learning: The Effect of Technology, Reputation, Constraints, and Learning Preferences," *Journal of Research on Computing in Education*, vol. 33, no. 3, 2001.

9 B. Barron, C. Martin, and E. Roberts, "A Design Experiment to Build Technological Fluency and Bridge Divides," *Proceedings of the Fifth International Conference of the Learning Sciences*, Seattle, WA, October 2002.

10 M. Bers, "The Tangible K Robotics Program: Applied Computational Thinking for Young Children," *Early Childhood Research & Practice*, vol. 12, no. 2, http://ecrp.uiuc.edu/v12n2/bers.html, 2010.

11 D. Cavallo, "Models of Growth—Towards Fundamental Change in Learning Environments," *BT Technology Journal*, vol. 22, no. 4, 2004.

12 A. Shaw, "Social Constructionism and the Inner City," in Y. B. Kafai and M. Resnick (eds.), *Constructionism in Practice: Designing, Thinking, and Learning in a Digital World*, Routledge, Mahwah, New Jersey, 1996.

13 M. Resnick, J. Maloney, A. Monroy-Hernández, N. Rusk, E. Eastmond, K. Brennan, and Y. Kafai, "Scratch: Programming for All," *Communications of the ACM*, vol. 52, no. 11, 2009.

Biographical Information

Dr. Wanda Eugene is a postdoctoral researcher in the School of Computing at Clemson University. She completed her doctorate at Auburn University. She earned a bachelor's in Electrical Engineering and a master's in Industrial Engineering from Florida Agricultural and Mechanical University - Florida State University College of Engineering, and a master's in Interdisciplinary Studies specializing in Instructional Technology and African American Studies from George Mason University. Her research interests include how cultural, social, and personal surroundings affect the appropriation of computational artifacts and ideas and how they can influence the design of new technologies. Her research spans human centered design.

Dr. Shaundra Daily is an Assistant Professor in the School of Computing at Clemson University. Her doctorate from MIT involved designing and implementing technology-infused collaborative learning environments. Her B.S. and M.S. in Electrical Engineering are from Florida Agricultural and Mechanical University - Florida State University College of Engineering and her S.M. is from MIT. Her research interests include Affective Computing and computing education. She is a Co-PI on the NSF Institute for African American Mentoring in the Computing Sciences.

Dr. Richard Burns is Assistant Professor of Computer Science at West Chester University. He received his doctorate from the University of Delaware in the areas of Artificial Intelligence, Natural Language Processing, Machine Learning, and Cognitive Science. His other interests include computer science outreach, especially for underprivileged communities. He has published and presented at numerous computing science education and service-learning conferences.

Dr. Tiffany Barnes is Associate Professor of Computer Science at N.C. State University. She received an NSF CAREER Award to build data-driven intelligence for STEM learning environments. She is Co-PI on the NSF-funded STARS Alliance grants to broaden participation. Dr. Barnes's Game2Learn lab builds serious games for education, exercise, and environmental awareness; conducts educational data mining research; promotes undergraduate research; and is working to bring a new CS Principles course to high schools. Dr. Barnes serves on the ACM SIGCSE Board, and is a leader in the Broadening Participation in Computing, Foundations of Digital Games and Educational Data Mining communities.