ABSTRACT

This qualitative action research case study seeks to expose the barriers that keep African American middle school girls at a Chicago International Charter School from pursuing learning pathways based in technology. This project, The Digital Divas program, was designed to take advantage of growing STEM career opportunities and introduce this group of girls to new ways of thinking about media and technology in a blended face-to-face and online informal learning space. Activities in this curriculum incorporate personal interests in non-digital art forms, such as fashion design, with areas of technology, media literacy and digital media. Surveys, project based participation, observation, guided online and in class discussion reflection, digital and non-digital artifacts were used to learn more about students' exposure to technology and their attitudes toward developing new skills in areas of New Media. Centering on reflective practices, peer dialogue and peer collaboration, this project aims to identify, engage, and explore issues critical to the effective implementation of a New Media Literacy curriculum.

Flip the Switch: Generating African American Girls' Interest in STEM

INTRODUCTION

Eight years ago, when I began working with Digital Youth Network, I had no idea I would become the face of possibilities for black women with a future in science and technology. Until then, my life's passion had been in the performing arts. Anything related to science, technology or math sounded like a trip to a torture chamber. As a performing artist, new worlds within technology were far into my blind spot. I was an analog girl so afraid of breaking something that I would be paralyzed in fear at every computer sound, click or crash. I barely knew how to turn on a laptop, and when I walked into my first classroom to teach digital media, I realized early that I needed to find ways to connect what I loved about performing arts to the ways in which technology could support my passions. It took months of constant tinkering to find the connection; once I accomplished this I was hooked.

I've discovered over the past ten years that many middle school girls feel exactly the way I felt when put in front of a new piece of technology. Like damsels in distress they feel tied to railroad tracks, and that the technology train is about to run them over. In my experience many girls would rather someone else do the work for them instead of learning to be comfortable making mistakes. For many students I interact with, computational devices are pervasive. They do not yet realize learning to navigate the digital landscape is imperative for educational and career opportunities. This curriculum attempts to expose middle school girls to science and technology by offering alternative

entry points through art and media literacy into a set of activities designed to encourage girls to identify, analyze and tinker with a sub-section of this digitally saturated culture.

SIGNIFICANCE

As the digital landscape expands, new forms of media are developing daily. This ever-evolving environment creates a need for the development of different tools for the teaching and learning of New Media Literacies. These tools require an active approach to media that engages learners in a participatory culture where their contributions are valued in their developing community. In order to prepare learners for the future, educators will need to employ activities that challenge students to perceive information from a wide variety of media sources, understand the sources of information, analyze the effects of the influence of messages within media on their psychology, and help them develop the technical skills needed to create new forms of media. The research for this project-based curriculum seeks to expose the barriers that keep African American middle school girls from exploring technology at the same rate as African American middle school boys and white middle school females, as well as introduce African American girls to alternative experiences within avenues of new media literacy.

RESEARCH QUESTION

The National Association for Media Literacy Education defines Media Literacy as "the ability to access, analyze, evaluate, and create media" ("Media Literacy Defined"). The central theme of this project-based curriculum is critical image analysis within fashion and media in order to develop a role-based identity within African American girls. This research uses the set of New Media Literacies skills theorized by Henry Jenkins. Jenkins defines new media literacies as:

> "a set of cultural competencies and social skills that young people need in the new media landscape. These skills build on the foundation of traditional literacy, research skills, technical skills, and critical analysis skills taught in the classroom. The twelve skills necessary for building cultural participation and active digital citizenship in today's media terrain are play, performance, simulation, appropriation, multitasking, distributed cognition, collective intelligence, judgment, transmedia navigation, networking, and negotiation " (Jenkins p. 4).

For this curriculum, critical image analysis is defined as the examination and deconstruction of images that influence fashion within media including still images, text and video in order to break down media images (Jenkins p. 4). The central research questions of this study are as follows:

1. What barriers keep African American girls from accessing areas of new media (specifically STEM related – Science, Technology, Engineering, Mathematics)?

I've run programs for girls in technology for the past eight years. Each year I start the first day of instruction by asking the girls what their favorite software apps are. I get a wide range of answers and finally we discuss what computer science is and what a computer scientist looks like. Every time I've had this conversation the imagery is the same, white, male, old. I ask the girls if they think the person they described knows enough about them to create an application that will make their lives better. Usually the girls answer no and from that point we begin a journey of deprogramming and channeling the energy of young black girls from loud and overbearing to leaders in technological fields in their age group.

The second research question examines the ways that a small group of African American middle-school girls at a Chicago International Charter School engage fashion images and media messages from the Internet, within music and television. Helping middle school girls understand the core concepts of new media literacy and new media production provides insight into aspects of how and why they are exposed to different messages in order to become creators of new forms of media:

2. How can a curriculum address these barriers & create alternative imagery for girls to explore technology (New Media)?

As a middle school student I was exposed to variety of extra curricular activities in sports, music and theater. The impact of these experiences guided my intrinsic desires through high school. As a high school student, my scope of technology was limited. Outside of typing, I rarely came in contact with a computer. It was difficult for me to wrap my head around the concept of computers; in my mind computers meant complicated algorithms and vocabulary that sounded like gibberish. I didn't belong in front of a computer or anything tech based, I was an artist and a decent athlete but I didn't do well at math. The self I identified with had nothing in common with any math or science teachers and Caucasian men taught all of my classes involving technology. In retrospect, I believe my attitude towards science, technology and engineering may have been different if I were exposed to an educator that I believed could culturally relate with the ideas and social struggles that I was experiencing.

REVIEW OF LITERATURE

CULTURE CAPITAL AND MENTORS

Crowded classrooms, increases in juvenile crime, low graduation rates, and the overall decline of workforce preparedness have been a few of the issues fueling the increase of youth mentoring programs across America (DuBois, Portillo, Rhodes, Silverthorn, & Valentine p. 57; Anton & Temple p. 8). Mentoring programs have been a burgeoning intervention strategy within American schools to combat a lack of adult to youth guidance and provide a caring environment for youth development (Deutsch & Jones p. 1382; DuBois, Portillo, Rhodes, Silverthorn, & Valentine p. 58). Mentorship within middle school programs is loosely modeled on an apprentice relationship where young people develop a skill while closely working with a master of a craft (Metros & Yang). Utilizing mentors that are content experts and professionals within their field may afford experiences on which youth can draw to create their sense of self and promote identity development (Berardi, Colon-Torres, Feuer, Roundfield, & Sanchez p. 147).

An important aspect mentors must consider when attempting to build a safe space for exploration of new areas of learning involves establishing a personal relationship between mentor and mentee (DuBois, Portillo, Rhodes, Silverthorn, & Valentine p. 57). Just as important is the mentor's ability to identify and solve barriers within the adult to youth relationship ("Elements of Effective Practice for Mentoring" p. 17). Racial, cultural and ethnic identity plays a significant role in minority youths positive academic, psychological, and social development (Berardi, Colon-Torres, Feuer, Roundfeld, & Sanchez p. 147). Differences in these cultural nuances may be a major barrier mentors

encounter while working to establish a personal relationship with African American middle school girls.

There are several definitions of race and ethnicity. A common definition of the two includes physical traits connected to a historical legacy of migration and culture ("Race: The Power of Illusion"; Collins p. 210). Justifying generational human slavery based solely on race is a recent development in human history ("Race: The Power of Illusion). Those with ancestral roots from the migratory Trans-Atlantic Slave Trade have experienced a systemic discrimination and/or oppression that contribute to a cultural mistrust for their oppressors. In turn, African American females have created a unique racial and cultural identity that includes as well as rejects oppression ("Race: The Power of Illusion"; Collins p. 513; Beradi, Colon-Torres, Feuer, & Roundfield p. 145; "The Trans-Atlantic Slave Trade Data Base"). In order for American education institutions to properly serve African American females, it is important to include the significance race and culture aid in developing their identity.

Structural racism, cultural mistrust and negative stereotypes contribute to the need for African American girls to have culturally responsive mentors that not only have vested interest in a particular subject but also provide examples of the student's experiences (Tatum p. 44; Gerard, Phelps, & Taylor p. 210). The Digital Divas program utilizes the mentor to mentee relationship by pairing a STEM professional with a group of African American girls in order to expose and foster their skills within science, technology and engineering. Unfortunately, finding examples of black women who are STEM field professionals can leave black middle school girls incapable of self-

identifying with these career paths. White men dominate American STEM careers and education pathways making black girls one of the most marginalized groups.

Only 19% of the 1,762 Ph.D.'s earned from 2010 to 2012 were awarded to women, only 2 percent of were awarded to African Americans, and there are only four black female tenure-track physics professors employed at the top 100 research universities ("HBCUs Key to Producing Black STEM Ph.D.'s, But These Grads Have Less Aid, More Debt"; Blair; Mulvey & Nicholson pgs 3-5; Upton). With such little access to African American female role models in STEM fields black girls approach STEM with lower self-confidence and are influenced by stereotypes such as only men do hard sciences or people of color are not as smart as whites (Upton).

STEM AND THE FUTURE

The National Science Foundation paints a dystopic America in its 2012 report on the urgency of "adequately developing our country's next generation of scientists and engineers" ("The 2011-2012 Biennial Report to Congress" p. 1). The report asserts that the American way of life is "threatened if we don't tap into the end of the labor pool where African Americans, American Indians, Hispanics, women, and persons with disabilities are not fully utilized" ("The 2011-2012 Biennial Report to Congress" p. 1). Across all STEM fields, the proportion of women of color is small, and drops at each level of degree attainment (Towns p. 6-7; De Welde, Laursen & Thiry p. 2; Bose, Drezner, Gary, Gasman, Lundy-Wagner, & Perna p. 5-10). Disparities persist despite women's interest in STEM fields. For example, African-American girls have been shown to start off having higher levels of interest in middle school and early high school years (Hanson p. 101).

Women's representation varies by field and by ethnicity or race in post-secondary education. According to the Women in Science, Technology, Engineering and Math (STEM) fact sheet:

> "College women make up over half of all undergraduate degree-earners in life science, but one-fourth of those in physics. In technology, early gender inequities in computer interest, use, and skills are well documented and the proportion of women among those pursuing computer science degrees has *declined* since the mid-1980s. In engineering, trends have flattened, and are highly variable within sub-fields: women earn 35% of chemical engineering degrees, but only 14% in electrical engineering" (De Welde, Laursen & Thiry p. 2).

Women, Blacks and Hispanics are inclined to choose majors in science or engineering at the start of their college experience but less likely to earn a degree in the these majors ("Land of Plenty" p. 1). Women and minorities do not follow learning pathways in science, technology, engineering, and mathematics (STEM) creating gender disparities in fields such as computer science. Some of the reasons minority women are not exploring these fields as a profession can be linked to both internal and external causes. Lack of social connections to STEM jobs, under-education in STEM fields, stereotypical bias, and learned behavior attribute to the barriers of African American women becoming STEM professionals ("Land of Plenty" p. 2-6; Farinde & Lewis p. 421-422; Dillabough p. 377; Acker p. 422). Young black girls have an advantage over Caucasian girls in science but "attitudes, even more than access" act as a barrier when achievement is measured by standardized exams (Hanson p. 101-107). White women score higher due to testing biases that favor "middle-class white students" (Hanson p. 101-17).

ACADEMIA AND AFRICAN AMERICAN GIRLS

Frills, Barbie dolls, ballet, and tea parties; "by age four, societal training in seeing the sexes as opposite has taken hold and children begin to think of girls and girl things as the opposite of boys and boy things" (Burke & Stets p. 5). Establishing differences in gender and gender roles begins as early as the pink and blue wristbands given in hospitals to distinguish girl from boy newborns. Gender assignment of colors, titles, labels, behaviors, and roles has a huge impact on the way identity is framed in homes and in schools. By the time females reach middle school age, the mounting stereotypes of what is identified as feminine affects girls approach to science, technology, engineering, and mathematics (Burke & Stets p. 5).

Differing attitudes toward interest in science begins to surface in middle school youth (De Welde, Laursen & Thiry p. 3). According to an article in the American Educational Research Journal, school and societal attitudes keep girls from engaging with and succeeding in STEM studies due to the portrayal of science as "masculine and girls as incapable of meeting the of meeting its challenges based in a lack of equity-minded curricula, pedagogical strategies, and professional development tools" (Barton, Rivet & Tan, p. 71). Providing middle school girls with entries into STEM based learning can increase their chances of continued exploration in high school and beyond. For African American girls in middle school, fighting through gender stereotypes leads to a second layer of racial bias in areas of blacks and careers in STEM fields (Barton, Rivet & Tan p. 98).

According to an article written in Youth and Society journal "African American girls encounter unique obstacles as it relates to how race, gender and class combine to

shape perceptions of femininity and the educational experience" (Morris p. 490). Unfortunately, schools are adding to the disparities between the way white females, black males and black females are approaching STEM learning pathways. The chances of cultural misunderstandings between educators and African American girls result in negative labels such as loud or uneducable, result in the under-educating and underachievement of this group (Howard p. 181; Dillabough p. 377; Acker p. 442; Morris p. 511).

Many educators are inclined to spend more time socializing this group of girls by discouraging perceived loud domineering behavior in order to encourage lady-like behavior. As it goes in American schools loud behavior must be unlearned in order for a student to be high-achieving, therefore silencing this group in classes (Dillabough p. 378; Acker p. 451; Farinde & Lewis p. 425; Brickhouse & Potter p. 967). Students that are seen as successful in advanced classes exhibit outgoing behaviors such as asking questions, being inquisitive, jumping in and getting started but many African American girls are marginalized and are unlikely to take on the attributes that coincide with high achieving scholars (Brickhouse & Potter p. 967). Largely, the underrepresentation of underserved groups in STEM areas can be traced back to inadequacies in educational environments leading to college ("Land of Plenty" p. 2). It is imperative that instructors are educated in culturally relevant teaching practices that will undermine gender and racial biases within the classroom "in order to improve the learning experiences of African American girls in order to tap into the potential of this groups pursuit of STEM careers and therefore providing them with greater life chances" (Farinde & Lewis p. 422; Ladson-Billings p. 210).

ALTERNATIVE PATHWAYS TOWARDS TECH INTEGRATION

As discussed, many African American girls are suffering in learning environments that reinforce stereotypes of inferiority in fields of science, technology, engineering, and mathematics. One way to mend the crater between African American girls and STEM career pathways is to provide multiple pathways to STEM based fields and an in-formal learning space may be an alternative entry. For my studies, in-formal learning describes the learner undertaking individualized self-paced and self-directed study in an out of school context (Sefton-Green p. 17). Unfortunately, not all after school programs are alike. In order for African American girls to benefit not only socially but academically in an in-formal learning space, a well trained instructor must be put into place (Dillabough p. 376; Acker 442; Morris p. 502). Ideally, a hybrid atmosphere of formally designed learning in an in-formal context would provide an atmosphere where African American girls can thrive in the areas of science and technology.

Instructors in after school programs are likely to be effective if they employ formal training and professional development of all instructors and mentors that helps clearly define and design goals and curriculum that emphasizes active forms of learning, and utilizes activities that give youth opportunities to develop and practice new skills (Durlak, Pachan, & Weissberg p. 295). It is also important to employ pedagogical practices to create learning environments that encourage a connection between cultural identities and pushes high academic achievement (Howard p. 182).

Many times, afterschool programs designed to teach technological skills overlook the importance of participatory culture and in turn isolate a diverse collection of would-be members. Henry Jenkins defines participatory culture as one with low barriers to

artistic expression and civic engagement, strong support for creating and sharing creation, some type of informal mentorship, value of contribution, and social connection (Jenkins p. 6). When working with African American middle school girls engaging them in participatory culture is very important. As it goes for most middle school girls of any race, it is important what people of a shared space think of them.

The Digital Divas program not only stresses the importance of scientific and technological rigor but also places emphasis on building a supportive community around girls at a pace of individual choosing while placing value on participation. Digital Divas is anchored in maker activities, which naturally align with the definition of a participatory culture as defined by Jenkins. Participants are provided opportunities to contribute and express themselves in an environment where they develop a strong social connection with other like-minded girls while being mentored through artistic STEM activities (Jenkins p. 6). Girls in the program develop an understanding of the Digital Divas culture through collaborative troubleshooting activities and by utilizing an online social learning network where they contribute creations and provide valued commentary to other participants.

BLACK GIRLS CODE & TECHBRIDGE

Throughout my research I discovered the abundance of literature written about STEM learning as it relates to African American boys and minorities but very little is contributed about African American girls. At the same time, there are not many programs targeted specifically at African American middle school girls in order to increase their awareness and self-efficacy towards STEM learning and career pathways. Nor is there much research conducted on the importance of educating African American middle school girls in in-formal learning spaces in an after school setting and the ways in

which self-efficacy is molded and sustained. There are, however, contributions on the significant correlations between "mastery experiences, vicarious experiences, social persuasions, physiological arousal, and self-efficacy and the beliefs of middle school students" (Britner, & Pajares p. 485).

Black Girls Code and Techbridge are two programs with the aim to equalize the disparities of minority women in STEM career fields. Techbridge is sponsored by Chabot Space and Science Center in Oakland, California. It introduces about 250 girls annually to a variety of applications of technology that include digital storytelling, building robots, programming, animation, and career exploration. The afterschool technology programs are hosted at elementary, middle, and public high schools in Oakland and surrounding communities and at the California School for the Blind in Fremont. Techbridge designs their curriculum for both girls and boys in out-of-school time settings, including afterschool programs, summer programs, and youth groups. (Techbridgegirls.org).

Black Girls Code is a non-formal program (non-formal meaning not held in schools but at a separate location) that provides young and pre-teen girls of color opportunities to learn technology and computer programming (Sefton-Green p. 17). Black Girls Code has reached 2,000 students through chapters in half a dozen cities, including New York, Memphis, Detroit, San Francisco, Atlanta and Johannesburg, South Africa ("Encouraging More Minority Girls to Code"). Black Girls Code exposes elementary through high school age girls of color to STEM fields through computer science and technology by providing curriculum in computer programming, web page development and game design (BlackGirlsCode.com).

Both programs address a wide age range of girls, which provides a longer-term trajectory of support for girls that join the programs. This way, girls are provided with mentors that can direct them from middle school, through high school and into college programs grounded in STEM career pathways. In addition, career exploration is a high priority for both programs. This is an extremely important aspect of nurturing tomorrow's leaders in science and technology. While both programs target exposing girls to career paths in STEM fields, Techbridge adds an artistic element in the area of animation and storytelling. Black Girls Code also uses game design for girls to explore area of storytelling through game development. Both programs utilize technological tools to create forms of new media but, it seems, both are using these technologies in isolation rather than approaching the benefits of cross curricula ecology.

Each program utilizes media as a way to engage and enrich the lives of their participant community. Techbridge and Black Girls Code, as well as other STEM enrichment programs would benefit from thinking about the interrelationship among different communication technologies and how their students can thrive in the cultural communities that grow up around them (Jenkins p.7). Digital Divas seeks to capitalize on this ecology by combining analog dexterities such as sewing, crafting and tinkering with digital, technological and scientific skills through the employment of E-Textile activities.

E-Textiles are "the first female-dominated computing community" (Buchholz, Peppler, Shively, & Wohlwend p. 1). Exposing African American girls to this section of hands-on maker movement provides them access to a wide variety of activities that are traditionally considered to be for girls, such as crafts, and fuses them with activities that

are usually considered for boys, such as robotics and computing (Buchholz, Peppler, Shively, & Wohlwend p. 1). This exposure not only assists in diversifying the maker movement but it also taps into movement's potential to transform education and address notable gender and racial disparities, particularly in STEM fields (Buchholz, Peppler, Shively, & Wohlwend p. 1).

E-Textiles merges sewing and electronics practices, combining two sets of gendered practices and expectations associated with craft and electronic materials (Buchholz, Peppler, Shively, & Wohlwend p. 3). The Digital Divas curriculum draws and builds principle of participatory culture through the production of hands-on artifacts that are shared and valued among the members of this group. Jenkins states "schools currently are still training autonomous problem solvers, while as students enter the workplace they are increasingly being asked to work on teams, drawing on different sets of expertise and collaborating to solve problems" (Jenkins p. 33). Digital Divas is an afterschool program designed to expand the engagement of African American girls in STEM fields by providing access to culturally reflective curriculum and mentors. Through collaborative and individualized designing, troubleshooting and development of E-Textile and E-Fashion artifacts middle school girls have a pathway to a participatory culture that identifies, empathizes and celebrates the cultural style and behaviors of African American youth.

CURRICULUM

While both Techbridge and Black Girls Code programs seek to diversify the talent pool, Jenkins suggests that we forget the gap and discover the possibilities to build

culture and participation (Jenkins p. 15). The Digital Divas program not only can serve as a bridge between African American girls and fields of STEM careers, it also builds on the notion of production-based learning. The production and distribution of wearable technology for girls by African American girls is the basis of this curriculum. Digital Divas takes place in an in-formal learning space within an after school program.

Classroom and Learning Space

Digital Divas relies heavily on the cultural aspects of a maker community. During sessions, girls develop habits such as working together to turn the space into one that supports maker activities. Desks are physically moved to create one large table where each girl can see the others work. Sharing resources and working together to help sister Divas is encouraged through the physical set up on the learning space. Unlike in formal learning spaces, such as core classes taken during the school day, discussion and conversation is encouraged through the assemblage of desks.

Journals, Writing Prompts and Share Outs

Through my work as an educator in predominately African American schools, I've noticed that black girls show affection through verbal negativity. Schools that are dominated by white and non-African American instructors commonly misread this behavior and perceive it as combative, overly aggressive and inadequately feminine (Morris, pgs. 503-510). For most instructors this can be alarming and much time can be spent trying to reverse this behavior. The significance of exposing African American girls to the maker movement and the broader do-it-yourself (DIY) culture gives them an idea of how to be unified by a common commitment. Girls learn innovation, creative and

community engagement through the exploration, intrinsic interest, and sharing out of creative ideas (Buchholz, Peppler, Shively, & Wohlwend, p. 1).

In addition to developing an understanding of the culture derived from the maker community, the curriculum addresses this behavior through a set of norms and agreements that are stated at the beginning of each session. Using journal entry prompts at the beginning of each class focuses the girls' attention towards the purpose of the day's goals. The pre-created journal prompts give girls language to use throughout the session.

Academic Skills and Beyond

Preparing 21st century learners for the college and career landscape has expanded beyond academic preparedness. To ensure all students have a balanced understanding of the global market requires the accumulation of non-cognitive or soft skills such as the ability to function interpersonally, moral decision making, coachability, collaboration, initiative, persistence, self-discipline, time management, and a work ethic (Gaines & Mohammed p. 1). The Digital Divas curriculum incorporates ways to develop and build the aforementioned skills through the E-Fashion and E-Textile activities.

Girls must feel encouraged throughout the entirety of the E-Fashion and E-Textile production process. This is especially true due to the in-formal nature and self-paced atmosphere the Digital Divas curriculum. One of the first activities in the entire Digital Divas curriculum is design to ensure that African American middle school girls understand the importance of developing self-efficacy. The activity revolves around tinkering with battery and light in order to figure out how an electrical circuit works. Girls are required to work collaboratively to problem solve the issue of a non-working circuit.

Artifacts and Activities

Science, technology and fashion are combined to create a set of E-Fashion activities. This curriculum seeks to help African American girls understand the interrelationship among different communication technologies and the cultural communities that grow up around them through supportive activities (Jenkins p. 7). In order to support girls in developing the skills needed to create well-designed pieces of wearable technology, girls must learn some basic fashion design elements such as color theory, line & shape, texture, space, sewing, and stitching.

When developing a program that expounds on the basic understanding of technology, the computer is best utilized in conjunction with non-digital technology instead of in a vacuum. Paper and pen are heavily relied upon as a part of the design process. Sketching and drawing play a major role in not only the fashion designing aspect of the curriculum but also in helping girls understand the basics of circuitry and electricity.

In addition girls are learning crafting practices that value creative and aesthetically pleasing construction while also learning electronic practices that value effective and efficient problem solving (Buchholz, Peppler, Shively, & Wohlwend p. 5). African American females are exposed to STEM fields by providing them with opportunities that bring traditionally feminine aspects of sewing and fabric selection with traditionally masculine aspects of electronics like circuitry and fusing. Girls can begin to develop a confidence in science and technology through the practice of tinkering and troubleshooting (Abel-Palmieri).

PARTICIPANTS

Twenty African American girls across three Chicago International Charter schools were registered for the Digital Youth Network Digital Divas program. The middle school girls (ages 11-14) were recruited through in-person school visits, flyers posted around the school, letters sent home to families, and in class demonstrations. The Divas program was run at each school in an afterschool context. Girls participated in face-to-face programming one day a week for 45-75 minute blocks for 22 weeks. Girls were expected to also participate in online activities outside of the scheduled program times in order to provide 24-hour access to the lead instructor and online activities.

METHODS

A collection of both qualitative and quantitative data was collected in an attempt to provide a multi-dimensional picture of learning around areas of STEM-related new media, specifically wearable technology. The primary techniques, data collection strategies used to understand the barriers keeping African American middle school girls from accessing areas of STEM new media were youth surveys of technology access, interests, and experiences; and interviews with teachers and youth participants. The primary strategies used to understand how a curriculum addressed these barriers & created alternative imagery for girls to explore STEM new media were observations of in-class discussions and student tinkering, retrospective interviews with youth and educators involved with the Divas program, and collection of program artifacts, including journal entries, videos created by instructors and photographs from online blogs that documented the Digital Divas progression.

RESULTS

What evidence of barriers was collected?

Many of the participating girls did not enter the Digital Divas program with computation expertise. On the survey given before the program began, most girls reported access to a home computer (89%), access to home printers (83%), digital cameras (78%), digital video cameras (61%), game consoles (78%), smart phones (89%), tablets (78%), and wireless internet (89%). Few girls reported consistent experiences with computational projects such as programming or digital media production (1%) and creating a game or animation (3%). Most girls reported that their parents had no influence on their interest in technology or computational devices (85%). A small percentage of girls considered their parents as experts in science or technology (1%) and few girls reported an interest in technology outside of entertainment purposes such as playing games, chatting, checking social networks (5%). Girls had no interest in a pursuit in advanced computer classes (0%); the girls had no exposure to circuitry, programming electrical devices or robotics (0%).

Once surveys were taken, it was obvious this group of African American girls in primarily African American schools were not being exposed to new media in ways that connect to STEM-based learning. The girls used technology for the purposes of socializing and entertainment but not in ways that rooted them in a culture of participation through production.

What evidence of youth learning was collected?

Digital Divas is designed to expose girls to pathways of interest that combine artistic interests with science and technology. Students worked through stages of design

and computational thinking including paper prototyping and implementing working circuits into design (see figures 1 & 2). One way I looked at youth outcomes was observation of an in class experience and participation in computational projects, measured by the number of different activities explored and the number of submitted pieces of work.

Figure 1. Sample student activity work, E-Fashion E-Cuff: paper prototype.

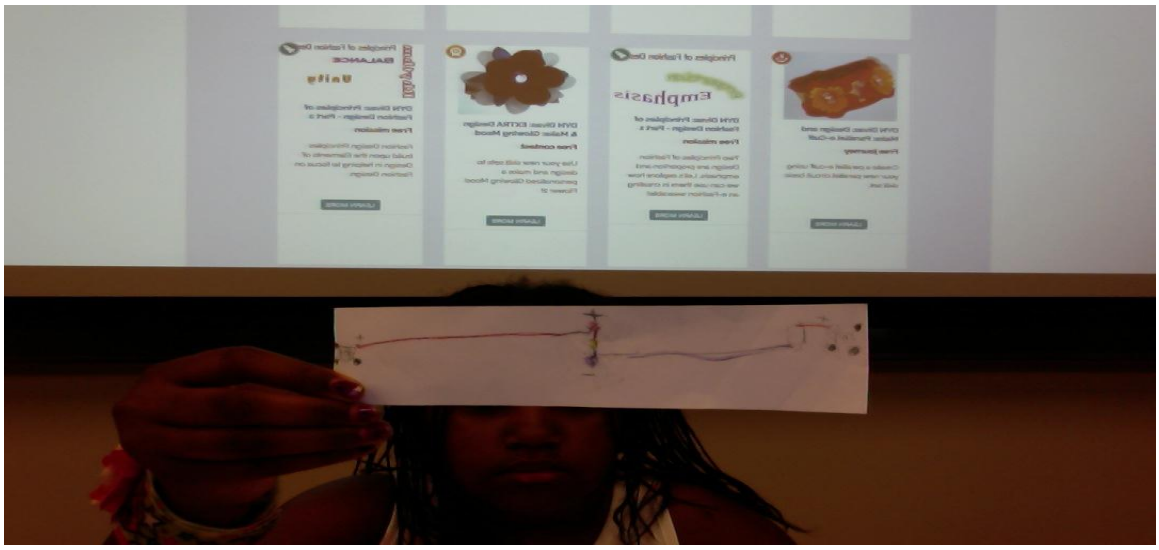


Figure 2. Sample student activity work, E-Fashion E-Cuff: sewn design with circuits, and final artifact exhibiting working lights.

I was able to assess how girls were developing an understanding of fashion and science by reading through journal entries. Students were required to answer questions that inquired about the problems they encountered, what they were enjoying and their decision-making throughout the production process (figure 3). Almost all girls were able to articulate the working parts of circuits employing learned vocabulary. In their reflective entries regarding perseverance during times of troubleshooting and problem-solving, most girls answered that they were confident with their ability to complete the process of wearable technology construction (figure 4).

Figure 3. Sample journal entry work: reflection student thinking during production process.

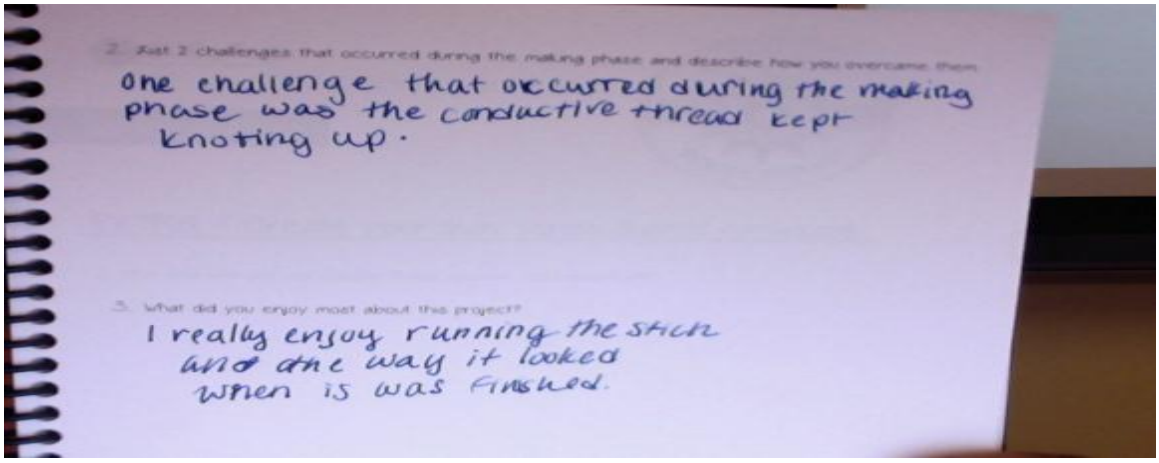
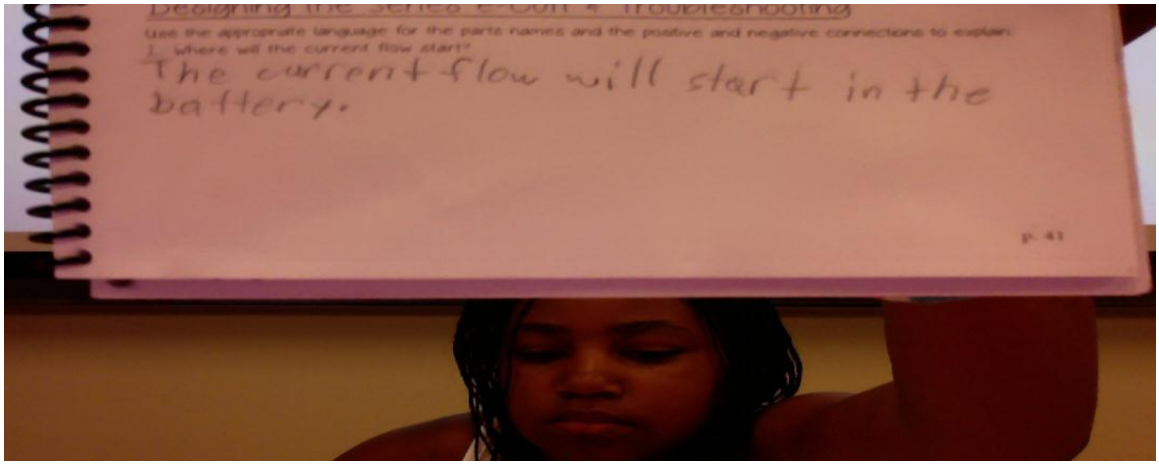


Figure 4. Sample journal entry: reflection student understanding of current flow and batteries.



How was the curriculum used to dismantle barriers that keep African American girls from accessing areas of new media?

The first activities in this curriculum are based on concepts of color theory such as complimentary and tertiary colors. I observed that by allowing girls to use communication tools such as pencils, pens, markers, crayons, and paint before moving toward technology, girls wrote in their journals that they were able to make a smoother transition into more complex ideas and projects (figures 5 & 6).

As discussed by Buchholz, Peppler, Shively, & Wohlwend, I observed that low barrier activities encouraged girls to use the hands-on approach to problem-solving and allowed them time to get comfortable with the intricate pieces within E-Fashion and E-Textile (Buchholz, Peppler, Shively, & Wohlwend p. 3-4). Physically touching and using fabrication, electronic and design tools while tinkering and troubleshooting was stated in many journals as a major part of helping girls discover how electrical circuits work. Most girls stated that using alligator clips to make LED connections was their favorite part of problem-based learning. Almost all girls stated that they liked to play with parts until a solution presented itself (figure 7).

Figure 5. Sample student activity: employment of fashion design principles and low barrier technology, creating a color wheel.

Figure 6: Sample student work: applied fashion design theory to make design decisions based on complimentary colors within the color wheel.

Figure 7. Sample student activity: problem solving through tinkering with technology.

Figure 8. Sample activity: turn and talk.

What evidence of developed alternate imagery of African American girls and STEM was collected?

Part of the Digital Divas program focus is to dismantle the stereotypical connections of ethnic, cultural and racial identity African American girls make to learning and career pathways in science, technology and engineering. Digital Divas

curriculum achieved this by providing African American middle school girl's access to an African American female mentor (Berardi, Colon-Torres, Feuer, Roundfeld, & Sanchez p. 151). 75% of participants indicated they were exposed to new opportunities and topics of personal interest in STEM areas through the Digital Divas instructor in post-program survey. Data collected from the survey reflected 75% of the girls felt they could relate to the Digital Divas instructor, 80% of the girls stated that learning about the interrelationship between art (non digital based activities), science (electrical circuits) and technology (circuit boards) in sessions made them want to learn more about each area of study, 85% of the girls reported they did well in the class and the same amount of girls felt the subject was interesting.

At the beginning of programming only 1% of girls reported consistent experiences with computational projects such as programming or digital media production and creating a game or animation (3%). By the end of the program, 75% of girls reported they were experts in troubleshooting problems with computational devices and 80% reported they were experts at new media production. Fifty percent of the Digital Divas stated they wanted to be designers of technical devices, 30% stated they wanted to be a doctor or go into a profession that helped people, while 20% stated they didn't know what they wanted to be when they grew up.

DISCUSSION

While not all girls expressed a desire to become a computer scientist or engineer after creating E-Textile and E-Fashion products, girls did develop a tenacity to persevere through complex scientific ideas and developed troubleshooting skills when working with technological devices as described in many of their journal entries. In addition to journal

entries as a major tool within the curriculum, girls were introduced to the concept of "turn and talk" in order to share out ideas (figure 8). Turn and talk is conducted after a new idea, theory or practice is brought to the community. Turn and talks were also used during critique process. Girls were introduced to the concept of "warm and cool" in order to provide critical feedback. Warm feedback is positive aspects of creations while cool feedback is advice on ways to improve an artifact. During these sessions, I was able to hear students employing vocabulary and language based in the curriculum

Giving African American girls resources to employ their natural leadership skills such as professional vocabulary and tools while working through problems and using their natural inclination to discuss and converse generates an atmosphere where perceived loud and aggressive behavior is channeled toward rigorous academic pathways. For black middle school girls, having a community where their contributions are valued is very important to developing identity (Jenkins, p. 6). Based on my observations of African American middle school females, it is equally important to commune with like-minded individuals where competition is encouraged in areas of troubleshooting and tinkering. Using activities with low technology integration, as it relates to Jenkins' definition of participatory culture, aided in dismantling some of the behaviors and ideas that this set of African American girls had about computer science, technology and new media (Jenkins p. 6).

It is also important to discuss the images African American girls see in STEM careers. Having African American women in STEM professions speak and hold workshops is an integral part of dismantling the stereotypes black girls have when considering careers in these areas. Discovering a variety of ways to present STEM-based

learning can help students of African descent dismantle programming of what is and isn't possible in career pathways. Computer scientists, programmers, web developers, E-Textile, and E-Fashion professionals being physically present and incorporated within curriculum sessions helped the girls attain an image that places them within an attainable future.

SUMMARY /CONCLUSION

As I sit in classrooms with talkative middle school girls who look like me, I understand the importance of my role as an instructor and mentor of new media literacies. I, too, sat in my science, math and technology classes distracted from tasks at hand because I was turned off and turned away from a tangible example of STEM careers. I didn't see where I fit in and worse I was afraid that I wasn't smart or good enough to succeed in what seemed to me to be such complicated areas of study. The importance of African American girls seeing someone that looks like them doing things they think they can't cannot be stressed enough. What my image does is help them develop a relationship with science, technology and engineering in a manner that is culturally trusting and relatable.

High academic expectation and good coaching through problem solving has been key in implementing this curriculum. Unfortunately, Nikki Manaj isn't rapping about multi-meters and the conductive power of a 3V battery; if she was, most girls in my community would be calling themselves scientists instead of Barbie. The image of a black woman building a computer, developing the cure of an infectious disease or solving the issues within the infrastructure of a collapsing dam isn't celebrated widely within popular black culture. Figuring out why African American girls don't dive deeply into STEM career pathways isn't either. American teachers must find a way to rethink their approach to STEM pathways if we really want black women to be part of the fruitful STEM future.

Diva is a term used for a woman with exceptional abilities and talents; it is also used to describe a woman who knows what she wants and behaves in a less than desirable way when she doesn't get it (Merriam-Webster; UrbanDictionary). By combining the concepts of STEM with the imagery of a Diva we may be able to take what is considered by many as careers for white men and make them relevant for black girls. There has to be an appeal for young African American girls to pursue these learning pathways with passion, desire and vigor. Digital Divas curriculum is a way to expose African American middle school girls to a supportive community where STEM-based activities are used to channel perceived bad girl behavior into scientific, technological, engineering, and artistic masterpieces.

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