

Employing narratives to trigger interest in computational activities with inner-city girls

Sheena Erete, Nichole Pinkard

College of Computing and Media, DePaul University
Chicago, IL USA

Caitlin K. Martin, Jim Sandherr

Digital Youth Network
Chicago, IL USA

Abstract — While women use technology to mediate numerous aspects of their professional and personal lives, few are actively involved in designing and creating the computational devices and software programs they use on a daily basis. The decline in the number of women in computer science and engineering courses is well documented at each level of advancement, and disparities are greater when considering minority women. Decisions about participation are often made early, frequently prior to high school, and have been linked to factors such as prior experience, interest, and sense of fit with community. To address these concerns, we developed a program called Digital Divas, where we invite inner-city middle school girls interested in fashion design to develop computational fluency through scaffolded e-textile projects launched using narrative stories. The Digital Divas program intentionally fosters supportive communities and perceptions of girls and women as strong and successful in fun and engaging STEM learning and careers. In this paper, we discuss the role of narrative stories in Digital Divas, used to initiate situational interest, the first phase of Hidi and Renniger's four-phase model of interest development. Narratives have been identified as a way to engage youth in problem solving tasks, connect to real-world problems, and motivate and contribute to positive STEM-identities. We describe our approach to co-designing narratives with the Digital Divas girls and share preliminary results of their interpretation and reaction to these stories.

Keywords—*narratives; gender; interest; identity; e-textiles*

I. INTRODUCTION

While women are using technology to mediate numerous aspects of their professional and personal lives, few are actively involved in designing and creating the computational devices and software programs they use on a daily basis. In fact, the drop in the number of women in computer science and engineering courses is well-documented [8, 10, 11], and such disparities are even greater when considering minority women [10]. This issue is especially critical given that Science, Technology, Engineering, and Math (STEM) career opportunities have increased in number and variety over the past decade. Research has shown that decisions about participation are related to prior experience, interest, and sense of fit with community [11], and these decisions are often made early, frequently prior to high school [1].

In response to these issues, we created a after-school program called Digital Divas, where we invite inner-city middle school girls interested in fashion design to work

through scaffolded e-textile projects to learn computational thinking and STEM concepts in a blended on and offline environment. A core principle of Digital Divas is that young women, who are in supportive environments where learning goals are embedded in meaningful projects, can demonstrate mastery of STEM at the same level as boys [11] and in doing so, deepen engagement. Despite early successes of Digital Divas [12], we face the challenge encountered by many in the fields of research, design, and education: *How can we initiate interest in STEM literacy and education?*

In this paper, we describe one approach to answering this question through narrative stories as a means of initial engagement. Specifically, we use narrative stories to launch the activities associated with learning the STEM concepts. We share preliminary results from co-design sessions, where we jointly develop these stories with inner-city middle school girls from communities that have traditionally been underserved. In the following sections we describe related research on interest development and use of narratives, our approach to narrative co-design within the Digital Divas program, preliminary results, and future work.

II. RELATED WORK

A. Four Phases of Interest Development

Hidi and Renninger [6] define interest as both the state of heightened affect for a subject and the predisposition to re-engage the subject again, which is based upon one's knowledge, value, and feelings about a subject. According to their model, there are 4-phases of interest development. When youth participate in a new program focused on unfamiliar content, they can experience what Hidi and Renninger refer to as *triggered situational interest*, the first phase. The trigger or "spark" of interest can be a result of one or multiple factors, oftentimes environmental such as location, people, or activity structure. When the program is over, the student may disengage but might also find a next opportunity. The triggered situational interested is critical as an opening to move on to subsequent phases that are more independent of environmental factors. The challenge for many program designers and educators in both formal and informal learning environments is understanding how to initiate situational interest (i.e., Phase 1), which can be especially difficult for underrepresented populations who have been traditionally underserved in terms of prior experience and exposure to communities and knowledge in STEM-related subjects [17]. Understanding potential effective triggers for girls, minorities, and youth from lower

socioeconomic backgrounds is critical to engaging such populations in STEM learning. Based on literature described in the next section, we examine narratives as an opportunity to initiate *triggered situational interest*.

B. Narratives

Much literature has focused on the use of narratives as a method to engage in problem solving tasks and to improve design outcomes [3, 9]. In this study, we use Grimaldi and colleagues' definition of entertainment narratives: "an emotion-evoking and value-laden representation of one or more characters in a series of chronological events that are connected by causality or agency, and which progress through conflicts toward a climax" [4]. Narratives can provide context that relates to real-world problems as opposed to teaching abstract concepts that can otherwise be difficult to understand [5]. Context from narratives increases motivation and positively contributes to girls' science identity [2, 5]. Furthermore, using narratives that girls can relate to increases active engagement and retention of interest in STEM fields [13]. In addition to the potential for narratives to impact young girls, the use of narratives in technology design have been linked to increased creative thinking and motivation to solve problems [14]. Most importantly, narratives provide focus for design by clearly communicating the task and increasing empathy for the audience, specifically when young girls are able to identify with and connect with the stories [15]. In fact, use of literature (fiction and non-fiction) has been recommended as a best practice when creating and designing STEM activities for young girls [2].

III. OUR APPROACH

A. Digital Divas Program

Our goal was to structure learning experiences through the integration of narrative, innovative programming tools, and computational textiles within a blended face-to-face and online environment focused on building community. The Digital Divas program consists of project-based curriculum in four computational strands: programming, design, circuitry, and fabrication. These topics purposefully correspond with rigorous and important STEM content learning, and they offer a rare opportunity to make STEM-learning tangible through the creation of computational artifacts that force the application of science, programming, and engineering.

The creation of artifacts are completed during face-to-face time organized as weekly 2-hour after school sessions with female mentors that guide the girls through the learning activities. As part of the Divas program, girls have access to a private online social learning network that provides additional resources, guides, and instructions, allowing them to work more independently. The network further builds community by allowing participants to post work, create profiles, and view and comment on the work of others.

We envisioned narratives as a way to connect the real world community to a fictional community through

common challenges and problem-sets, asking Digital Divas participants to engage with characters and situations through a storyline shared in multiple formats (written, audio, visual) as they work through computational projects. Additionally, narratives were developed to provide context for the project work, with each chapter (or installment) launching an activity. A professional children's author wrote a draft of a narrative to enhance the first curricular unit on e-Fashion, where the girls design wearable accessories that incorporate working circuitry. The story centered on a group of students in a middle school context.

B. Co-Designing and Implementing Narratives

We felt that it was imperative that the narratives resonated with our unique target population. Thus, we engaged middle school girls as co-designers in a pilot of the Digital Divas program. We recruited sixth and seventh grade girls from two urban charter schools serving underserved populations (over 89% of students classified as low-income) to participate in after school programs through flyers and in-school advertising as well as mentor visits in person to showcase design artifacts. The program, led by two female African American digital media mentors, met once a week for 18 weeks at each school. Seventeen girls signed up to participate: 6 at one school and 11 at the other. Overall, 71% were sixth graders, and 29% were seventh graders; 71% self-identified as African American and 29% as Latina. Twenty-four percent were from bilingual English-Spanish households. Survey responses at the beginning of the program indicated that only 14% of girls described themselves as engineers, while 50% described themselves as readers and 57% as designers.

Each week, the girls came together to collectively read, listen to, or watch the latest narrative installment before moving on to the design and creation activities in e-Textiles. The mentors then engaged the class in discussion about the unfolding narrative, prompting comments, questions, and suggestions. Sometimes these prompts were suggested by the research team depending on an area of interest, such questions related to character identity and physical appearance to learn more about participant preferences (i.e., did students want characters that were undefined in terms of race and ethnicity or characters who were more like them?). In addition to in-person action, students also used the online platform to communicate thoughts and opinions about the story in response to prompts. We created online profiles for the main characters in the narrative, and students interacted with the characters [played by adult mentors in the online system] via private messaging.

Results reported in this paper represent data collected during the first seven weeks of the program. One member of the research team attended approximately two Digital Divas sessions each month at each location and recorded observations through field notes (12 documents representing 24 hours of observation) and occasionally audio-recorded conversations with the girls (5 recorded conversations totalling approximately 150 minutes of audio). Two members of the research team conducted weekly digital

ethnographies [7] to document the online interactions. In this initial analysis, we used an inductive process [16] to summarize the extensive qualitative field notes and connect data to the theoretical ideas of narratives and interest development, which led us to iterate on the narratives themselves.

IV. FINDINGS

Results of our qualitative analysis suggest that the narrative co-design process provided girls with feelings of agency and initiated discussions about issues related to identity. The results also replicate findings that compelling, relatable narratives may trigger situational interest in computational literacy [6].

A. Narrative and Identity

One of our main objectives is to understand the role of narrative in developing positive STEM-related identities and self-efficacy. Thus, we intentionally gave little detail about physical attributes of the characters in the written narratives. Participants made statements about how they envisioned the characters, oftentimes by making comparisons to themselves. For example, one participant describes the main character as “*relatable*” and that she envisions the character as “*A teenage me, I see her as myself.*” A frequent suggestion demonstrating the girls’ sense of agency in co-designing the stories was to include more of themselves in the storylines. One girl says, “*I don’t know if you make the stories or not, but you should add some of us into the story, like us in this room.*”

In addition to self-references, there were numerous comments relating characters to people they knew. When describing how they imagined the teacher character, one student begins by describing personality traits that were not included in the narrative, “*I think Ms. G is a big old mean lady, because she has to deal with theater and kids...She has glasses and wrinkles, average height. Sometimes she is nice, but mostly she mean, and she don’t smile a lot. Short hair, gold necklace.*” Another references a former teacher in her description: “*I think she looks like a teacher that used to work here, Mama April. She was my complexion.*”

There were also frequent mentions of race and ethnicity when participants described how they imagined the characters. One student said she thought that the main character was “*Caucasian.*” When asked why, she responds: “*I don’t know how to describe it...she wasn’t snooty; she was like regular and girly*” (School B). Another student chimes in and says, “*She might have been mixed, because sometimes she acts black and sometimes white.*” Another says the main character has to be a “*blue-eyed blonde.*”

Additionally, participants made comments that suggest biases by linking certain personality traits to physical attributes. When reflecting on the character that could be viewed as the nemesis in the narrative, one girl describes the character as “*real, real, real light skinned and she thinks she is everything, but really she not, and she needs to talk to somebody and she wants all the attention.*”

When audio or visual versions of the narratives did not align with what the students imagined based on what they had read, they voiced their concerns: “*I thought some of their voices would be very different. I didn’t think their voices sounded right. Roshonna, I thought her voice would be different. She sounds like a girly girl always doing sketches.*” This suggests that participants formed attachments to who they believed the characters to be as they read, which were problematic when more descriptive modes of narrative delivery did not align with their vision.

Comments about identity and race indicate the importance of open discussion of these issues with young girls in STEM programming. This also points to the need for designers to deeply understanding the characteristics that young minority girls attribute to certain physical attributes in order to create narratives that lead to positive self-images and STEM identities.

B. Narrative and Situational Interest

Our preliminary results suggest that narratives may trigger situational interest in STEM learning for middle school girls that are underrepresented in STEM fields. Participants demonstrated situational interest by describing how the e-textile projects they completed related to the narrative story. When the girls were asked if they understood why they were created an LED-embedded fabric ring, one participant responded “to relate to [the character] Roshonna and to be a part of the story.” Another student describes a desire to act out the story instead of simply reading it, saying “It’s easy to follow the story, but I just want to do it for fun.” While we plan to continue examining the relationship between interest and narratives in the future, these quotes from the pilot implementation are encouraging, suggesting that narratives may trigger interest by providing context and purpose for girls to complete activities associated with STEM learning. Furthermore, the latter quote suggests that students have an intrinsic motivation and desire to act out the narratives simply because they found the narratives fun. While role-playing was not a part of the Digital Divas objectives, the students’ desire to “be” the characters prompt questions about the function of role-playing narratives in interest development.

In one narrative installment the main character, Roshonna, receives a mysterious note in her locker consisting of various colors representing a coded message. Girls responded to Roshonna in the online environment to help her decode the message using design principles. In addition to solving the problem, a number of girls included personalized responses, such as “*hi Roshonnah im [participant name] i read the story and what i think the preson [sic] is trying to tell you is that you should be more nice friendly , calming, cheerful,and dont let Mackenzie and Caitlin or anger get to you*” and “*Be calm and don't care what people say.*”

These in-person and online responses suggest that narratives sparked some initial interest in the Digital Divas

program with these girls. This is evident in the intrinsic motivation shown by the students to engage in the narratives and in their personal connections and interactions to the characters and the story. In future work, we aim to explore the level to which interest is triggered and to identify the specific features of the narratives that play the most significant role in effectively engaging our target population.

V. DISCUSSION AND FUTURE WORK

Hidi and Renniger's work suggests that deep individual interest is not inherent but rather can be developed over time [6]. However, even when initial interests triggered through situational opportunities, interest can fail to develop any further and that this can happen at any level. The challenge for program designers is to create learning experiences across time and place that stitch together opportunities for young learners to consistently engage in supportive environments with peers around activities they find meaningful. If program designers are successful, students will have opportunities to move from triggered situational interest (Phase 1) through to well-developed individual interest (Phase 4). We know this is currently not the case—not only are most opportunities not designed to engage a variety of learners, but in fact environmental factors are barriers in spaces that are dominated by traditional communities and activities. We need more approaches to designing computational learning environments rich with opportunities and connections for a wider variety of learners, paying special attention to underserved populations such as young women and minorities. Results from our study suggest that not only can narratives trigger interest, but there also may be opportunities for narratives to guide young learners from one phase to another. We imagine narratives that are very defined and engaging at the initial learning phase (Phase 1) and then allow learners to have more autonomy over the narratives as they increase their STEM knowledge and participation, where they eventually craft their own storylines and suggest new project artifacts. Our co-design process provided some insight into the use of narratives at the initial interest phase; however, future work should explore narrative creation and development in later phases.

Furthermore, our findings suggest that young learners link identity of self, others, and race to the narratives. Unpacking young women's thoughts about identity as it relates to the narrative can provide insight into STEM identity and the impact that various stereotypes, perceptions, or identities may have on self-efficacy, interest, and motivation to participate in STEM learning. By co-creating narratives that effectively allow students to engage in discussions about identity, where they can explore, examine, and dispel myths of stereotypes of people with STEM careers or young STEM learners in their narrative story, we seek to connect girls to ways to envision increased interest over time in STEM learning.

Our ultimate goal for the Digital Divas is the development of girls who are empowered, confident, and capable of continuing participation in informal and formal STEM programming. Given that decreased dependency on external factors signals more mature, self-driven interest, but knowing also that identity of self and others play a strong role in the continuation of interest in STEM learning, we must not only consider how the narratives impact phases of interest development but simultaneously look at impact on identity and agency.

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