2014

From Consumers to Producers: African American Middle School Students as Game Designers

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ABSTRACT
Given the low number of African Americans in Computer Science, we recognize the need to take effective measures to build and sustain a pipeline between K-12 education and institutions of higher learning with the hope that more African American students will pursue careers in computing related fields such as gaming. To support this effort, we engage African American middle school students in a 4-day game design workshop with the intent of transitioning these students from being consumers to being producers of technology. We create and evaluate scaffolds to assist middle school students with designing their first video games using Scratch. Preliminary findings suggest that most of the students are able to define the formal elements of their games, including number players, game objectives, and rules, but struggle with the concepts of procedures and boundaries of the game. These same students also demonstrate a basic understanding of dramatic elements (e.g. challenge, play, and character), but struggle with the concept of storyline. Finally, African American students have very explicit ideas about the kinds of games they want to create, choosing to create games that promote a more inclusive gameplay experience.

Categories and Subject Descriptors
K.3.2 [**Computer and Information Science Education**]: Computer Science Education

General Terms
Design

Keywords
African American middle school students, game design

1. INTRODUCTION
Recent statistics indicate that 4.6% of Bachelor of Science degrees in Computer Science, Computer Engineering and Information in 2011 were awarded to African American college students compared to 64.8% of Bachelor of Science degrees which were awarded to Caucasian students or 15.3% to Asian students enrolled in U.S. institutions [34]. Because of the low numbers of underrepresented minorities, specifically African Americans in Computer Science, the U.S. federal government, private industries and concerned American educators seek effective measures to increase the number of African Americans in Computer Science programs across the nation. As a result, many voices representing different perspectives have begun to engage in a discussion of different approaches that stimulate African American students' interest in Computer Science and other computer related disciplines [4-5, 9-10, 28].

However, within the African American community, the discussion is very different from mainstream's perception that African American students are not interested in doing Computer Science or gaming in particular, as African Americans make up less than 5% of the workers in the game design industry [3-4]. Instead, the discussion among African Americans in Computer Science is one that reveals that African American students of all ages are interested in Computer Science and welcome opportunities for exposure and access to computing technology. Furthermore, many professional African American Computer Scientists engage in community outreach as a mechanism for exposure and access, and utilize pedagogical strategies that mobilize African American students' interest and success in Computer Science as well as other STEM related disciplines [4-5, 28].

One particular pedagogical strategy leverages African Americans students' interest in video games to enable the paradigm shift from being consumers of technology to becoming producers of technology [28]. The Pew Internet & American Life Project's survey revealed that among young people, ages 12 – 17, 97% of respondents play video games on a regular basis [14, 28]. Game design is a domain with which middle-school students have a great deal of familiarity as consumers [16, 18]. As such, this domain can provide motivation for learners "to look under the hood" of their favorite games to understand how they are designed. This paradigm shift from one of consumer to one of producer emphasizes students' interest in video games, and more importantly, their creative ideas as the entry point to game design. Thus, learning and applying game design concepts becomes a means to an end as African American students transform their ideas into reality.

The purpose of this paper is to present a case study of a game design workshop that leverages African American middle school students' interest in creating their own video games [12]. We integrate a system of scaffolds called the Design Notebook, which are pencil-and-paper scaffolds that support and coach middle school students through the game design cycle [27]. We analyze the Design Notebook artifacts that participants created to identify the concepts that African American middle school students understand and identify which ones prove to be more problematic even with support. Preliminary findings motivate and inform three areas: 1) revisions to the Design Notebook to better support

middle school students as producers of game technology; 2) an understanding the kinds of games that these African American middle school students want to create, and 3) insights that address mainstream's perception that African American students lack interest in game design and subsequently Computer Science.

2. BACKGROUND

Game design has been shown to be an effective approach to broadening participation by groups who are normally under-represented in Computer Science (i.e., women and minorities) and in improving computing capabilities, interest in Computer Science, and retention [1-2, 9-10, 24, 30, 37-38]. Rooted in Constructionism, and project-based learning, young people can construct, or design, their own games and "create new relationships with knowledge in the process" both in informal learning environments and classrooms settings [18, 20, 30].

Repenning et al. (2008) [29 – 30] employ scalable game design as an approach to help a diverse population of students learn about Computer Science through game design. Here the idea is to use game design as a vehicle to help students, ranging from middle school to undergraduate and graduate students, understand the process of design rather than the act of programming. Scalable game design has been employed as an approach in summer programs, computer clubs, undergraduate design courses, and in middle schools. Werner et al. (2005, 2008) [36-37] help promote IT fluency, or the capacity to think systematically and creatively with technology, among middle-school students through 2-week summer courses in game design and programming using Storytelling Alice. Maloney et al. (2004) [24] use Scratch to help young people, ages 10 – 18, *develop technological fluency, mathematical and problem solving skills, and a justifiable self-confidence that will serve them well in the wider spheres of their lives* by working on Scratch projects that are personally meaningful to the students and based on students' interests. Scratch is a networked, media-rich programming environment designed to enhance the development of technological fluency in youth at after-school centers in economically-disadvantaged communities [24]. They achieve the aforementioned goals through a small subset of after-school centers and community-technology centers, such as the Computer Clubhouse network [30[which focuses explicitly on the development of technological fluency and helping young people learn how to design, create, and invent with new technologies rather than focusing on basic computer skills.

Barnes et al.'s (2007, 2007) [1-2] Game2Learn project teaches introductory programming to undergraduates using game design and involves the design of an educational framework that immerses computing instruction in game-based learning environments. Here, students design and implement games for others (e.g., middle-school students) and engage in the game design cycle with a focus on rapid prototyping and playtesting to inform iterations of game designs. Doran et al. (2012) [21] developed a game design curriculum via three iterations that enables strong connectivity of game design activities with students' academic performance in math and English Language Art skills. DiSalvo et al. (2009) [10] take a slightly different approach, encouraging young African-American males to see the computation behind digital games by training and employing them to be game testers. This particular research allows African American high school males to contribute to the game design cycle by testing video games under development by game companies.

These research projects have been shown to improve participants' programming skills, technology fluency, algorithmic thinking capabilities, retention and interest in Computer Science, modeling capabilities, and abstraction capabilities at a number of different levels (K – 16). However, there is a scarcity of research that focuses specifically on African American middle school students, particularly effective pedagogical strategies that transition African American middle school students to becoming creators of technology.

3. DESIGN NOTEBOOK

Although the facilitator is a critical component to the learning environment, she cannot provide constant attention and assistance to each student. In addition, the ability to think through the game design process is critical to middle school students being able to design and develop their own video games. Given the limitation of one facilitator for the entire group of students and the required support that these students need to design their games, we have developed a Design Notebook that guides middle school students through the game design process. The design notebook contains paper-and-pencil based thinking activities to scaffold middle school students' understanding of the game design process groups [6, 27, 35]. Each scaffold addresses a particular game design construct (e.g. formal elements of video games) by asking questions to assist middle school students with their critical thinking skills

The system of scaffolds consists of five parts [27, 35]. First, the activity sequences make the game design process salient. This scaffold addresses the structuring of activities as a direct correlation to the step-by-step process of game design that the students complete. Second, within each activity, prompts assist students with understanding basic game design concepts ("What is the story behind your game?"). This scaffold uses questions or statements to focus students' attention on carrying out game design tasks. Third, for each prompt, hints about how to complete the task are provided. Fourth, for each prompt, examples are provided to the students. Examples are exemplars that can be used to model a process or a specific step of a process. Fifth, for some of the tasks in the game design sequence, a template or chart is provided. Figure 1 shows the My Game Idea – Formal Elements Design Notebook page that features the structural elements of video games.

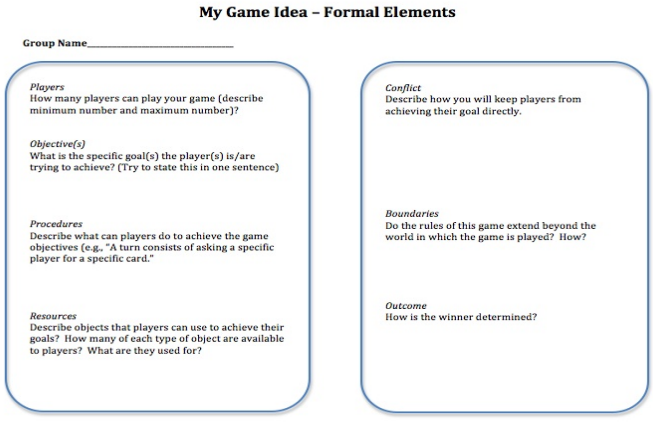

Figure 1: My Game Idea – Formal Elements Design Notebook Page

4. METHODS

4.1 Participants

Eleven African American middle school students expressed interest in learning how to create video games and with parental permission, self-selected to participate in a four-day game design workshop. Six of the eleven African American students were females and five were males. Ages ranged from 10 years old to 13 years old, typical middle school ages. All of the students attended different inner city middle schools in a surrounding metropolitan southeastern city.

It is important to note that the game design was held on the campus of a Historically Black College/University (HBCU) during the summer of 2011. Hosting the workshop on the campus of an HBCU promotes an appreciation for African American culture since the middle school students are given tours of three HBUCs and are exposed to the rich history of each institution. Such activities provide a basis for affirming the contributions of the African American community and play a role in attracting students via word of mouth as opposed to paying students to participate in the camp. Furthermore, the game design camp facilitator and staff are all African Americans, giving students easy access to African Americans who "do Computer Science."

4.2 Procedures

According to Fullerton et al. (2004), the game design cycle consists of four phases: 1. generating ideas, 2. formulating ideas, 3. implementing game ideas, and 4. evaluating the player experience. During the 4-day game design workshop, participants brainstormed several game ideas and chose one idea to pursue during the workshop. The middle school students created storyboards of their chosen idea, built and playtested a physical prototype, and implemented their games using SCRATCH. We chose this approach because each phase (brainstorming, storyboarding, physical prototyping, software implementation and playtesting) allowed participants to think about their games in more fine-grained detail, modify their original game ideas as needed, and set achievable goals during the implementation stage. Consequently, students created functional software prototypes representative of their game ideas. However, we choose to emphasize the design process more so than the Scratch games created for the specific purpose of understanding the difficulties that the middle school students experienced during the game design process.

4.2.1 Integrating the Design Notebook

Students were given a series of five paper-and-pencil scaffolds to support them as they engaged in the game design process. First students completed the *My Game Idea – Formal Elements* design page that briefly explains the structure of a game (Fullerton et al. 2004). The *My Game Idea - Formal Elements* design page asked students to identify: 1. the number of players; 2. the objective(s) of the game; 3. the procedures for how to play the game; 4. list of resources to help the player achieve the goals of the game; 5. the conflict in the game; 6. the boundaries of the game; and 7. the outcome or winner of the game. Next, participants completed the *Rules of My Game Idea* design page, indicating what players could do or not do during the gameplay experience. The third design page, *My Game Idea – Dramatic Elements*, emphasized the creative aspects of game design that engage players in the gameplay experience (Fullerton et al. 2004). The *My Game Idea – Dramatic Elements* design page asked the middle school students to identify the challenges to be implemented in the game, the element of play (e.g. "How will players use their imagination or use fantasy to achieve the achieve the goals of the game?"), the premise or story (if one exists) behind their game, how the story develops over time, and any characters that would be part of the gameplay experience. To further aid character development, students were given the option of completing the *Characters in My Game Idea* template. The *Characters in My Game Idea* template required the middle school students to name their characters, determine the type of characters (Player Characters known PCs or Non Player Characters known as NPCs), the physical appearance, attitudes, and behaviors of their characters, and their roles in the game.

4.2.2 Storyboards as Physical Prototypes of Video Games

Once the students had identified the formal and dramatic elements of their respective game ideas, participants created paper-based storyboards to reflect the ideas described in their respective design notebooks. The storyboards represented a physical 2D prototype of their video games and served as a gateway for participants to demonstrate their game ideas to others, facilitating the presentation of those ideas.

4.2.3 Putting It All Together

Next, participants completed the *My Design Algorithm* design page, which was designed to help them articulate in a step-by-step approach the instructions for playing their respective video games and how players should interact with their games. The design page explained that an algorithm is a step-by-step process for completing a task and has 4 characteristics: 1. It is specific as possible; 2. it is doable; 3. it produces a result; and 4. it halts in a finite amount of time [32]. Consequently, students attempted to outline a step-by-step process for how players would invoke their respective games. As they implemented their games, participants referred to the My Design Algorithm page if they needed to flesh out more details of their game (e.g., more rules needed to be added, use of resources needed to be described, etc.) or if they got stuck as they were implementing algorithms in SCRATCH (e.g. putting blocks together to enact certain behaviors of sprites).

4.2.4 Implementing Game Ideas Using Scratch

Once the participants presented their storyboards and received feedback, they were introduced to Scratch and used Scratch to iteratively implement their game ideas, playtesting along the way. As a result, their 4-day workshop experience enabled them to engage in game design as producers (game creators) rather than just being consumers (playing video games) of technology.

5. EVALUATION OF THE DESIGN NOTEBOOK

To gauge the participants' understanding of the game design process, we analyzed all of the game design notebook and storyboards per participant along three trajectories: 1. the number of pages completed per category; 2. the content provided

for each page; and 3. the correlation of the storyboards to the ideas presented in the game design notebooks.

5.1 Students' Understanding of Formal Elements

Ten of the eleven students completed the *My Game Idea - Formal Elements* design page, which consisted of 7 elements. Nine of the participants successfully defined the number of players, the game objective, the resources needed to achieve the goals of the game and the element of conflict. However, three of the ten students who completed the *My Game Idea - Formal Elements* design page did not understand that the outcome of a game ("How is the winner determined?") is based upon a sequence of events, choosing instead to rely on a screen message (e.g. "You won!") to determine the winner. Two of the ten students who completed the *My Game Idea - Formal Elements* design page confused boundaries of the game ("Do the rules of the game extend beyond the world in which the game is played?") with constraints of players' actions (e.g. "You don't have to battle only sludge creatures; you can battle other players too."). One student simply left the boundary question blank. In contrast, one student who created a restaurant theme game indicated that the boundaries of the game do apply in real life (i.e., "You can cook, clean and provide good customer service in real life."). Concerning the concept of procedures, two of the middle school students did not define any procedures for their respective games.

Nine of the eleven participants defined rules for their video games using the *Rules of My Game* design page. Seven of the nine students defined rules that explained how the player could use resources to achieve game goals (e.g. "All players will be given $20 to buy things…"). Interestingly enough, four of the nine students who completed the *Rules of My Game* design page took the time to define rules that also governed players' behavior during gameplay and outside of the game world (e.g. "No cursing at NPC," "No inappropriate love behavior," No hacking peoples' account", etc.).

5.2 Students' Understanding of Dramatic Elements

Referring to Table 1 below, in terms of the dramatic elements, 9 of the 11 participants completed the *My Game Idea - Dramatic Elements* design page, which consisted of 5 dramatic elements --- challenge, play, premise, characters, and story. The majority was able to define the elements of play, premise and character in their respective games. However, 4 of the 9 students struggled with the concept of story ("Describe how your premise develops over time throughout your game?"); two students left this section blank and the remaining two confused the concept of story with the concept of challenge ("How does your game create conflict and how does that affect the level of difficulty that players will experience?"). Two of the nine students did not adequately define the element of challenge in their games (i.e. "...the player needs to get the star but there are obstacles.").

We noticed that only 6 of the 11 African American middle school students completed the *Characters in My Game* design template, and out of those 6 students, four were females and two were males. Four of the six students defined both PCs and NPCs but two of the six students only defined one type of character. This raised the question as to whether or not these two students understood the difference between PCs, human players, and NPCs, computer generated players.

5.3 Students' Storyboards

Ten of the 11 African American middle school students completed their storyboards. All ten storyboards featured character sketches, including name of characters, options for selecting facial features and clothing, and in some cases, gender selection. Eight of the ten storyboards consisted of at least one level of the game environment. We noticed that most of the African American males drew more detailed characters sketches whereas more African American females drew more levels of their game. Remember that only two of the males previously completed the Characters in My Game design page, suggesting that the storyboard activity helped the males to visualize the details of their respective characters. Figure 2 represents a character sketch storyboard for the *AniMayhem* game created by an African American male student. Only one storyboard failed to reflect the ideas outlined in the students' design notebooks. The remaining 9 storyboards represented cohesive game ideas derived from the students' design notebooks.

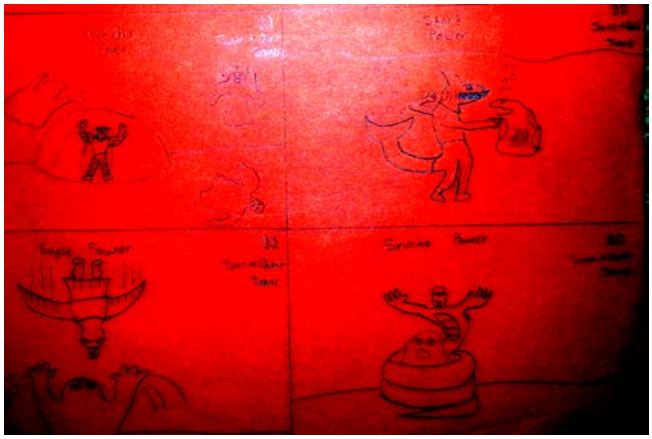

Figure 2 Student's character sketch storyboard of their game.

5.4 My Design Algorithm

Nine of the eleven African American middle school students completed the My Design Algorithm page. Six of the 9 students provided step-by-step details for playing their respective games. Two of nine the students interpreted the My Design Algorithm page to be synonymous to instructions for playing the game while another student explained how to navigate the game controls (i.e., "When start pressed, go to next screen.").

Step 1: Click start.
Step 2: Read "how to play."
Step 3: Click play.
Step 4: Play the game.
Step 5: Chompers eat player.
Step 6: Cloud gets in the way of player.

Example of one student's *My Design Algorithm* Page

	Number of Worksheets Completed	Number of Worksheets Not Completed	Content Analysis for the Completed Worksheet
My Game Idea: Formal Elements	10	1	9 students defined the number of players, the game objective, the resources needed to win the game, and the element of conflict for their respective games.
Rules of My Games Idea	9	2	9 students explained how using the provided resources could help the player win the game.
My Games Idea: Dramatic Elements	9	2	Many of the students were able to successfully complete the worksheet.
Characters in My Game	6	5	4 students defined their PC's and NPCs in the game. 2 students only identify one type of character for their game.
My Design Algorithm	9	2	Six students presented step-by-step details for their game in their design algorithm.

Table 1. Data analysis of game design scaffolds.

6. DISCUSSION OF PRELIMINARY FINDINGS

Keep in mind that though the students created games in Scratch, the end result is not the focus of this research paper but rather students engagement in the actual design process. After analyzing the students' Design Notebooks and storyboards, it was imperative that we examine how well the Design Notebook scaffolded the middle school students' ability to create their own video games, identifying what worked well and did not work so well. We asked ourselves three questions: 1. How can we improve the Design Notebook to better support middle school students' ability to create video games? 2. What kinds of games did the African American middle school students create? 3. How does our experience with conducting the game design compare with mainstream's perception of African American's interest in game design?

6.1 Recommendations for the Design Notebook

Given the results of the data analysis which revealed which design elements the middle school students did not understand, we can learn from this experience and revise the Design Notebook to better explain some of the more confusing formal and dramatic elements. We propose the following revisions:

- Provide examples of procedures so that the middle school students will understand the concept of procedures.
- Revise the question for the concept of outcome ("How is the winner determined?") to help middle school students understand outcome. Instead ask "what are the sequence of events that determine who wins the game?" and "what are the sequence of events that determine who loses the game?
- Explain the concept of boundaries of the game in terms of separation of the game from the real world. Ask students, "What separates the game world from the real world?" Is the game limited to a computer or game console?
- Engage the middle school students in sketching their PCs and NPCs as part of the character development process since this exercise helps students to visualize physical characteristics, attitude and behavior as it relates to the gameplay experience. This will enable the middle school students to devote more time to designing the levels of the game and to defining players' interactions during gameplay during the storyboard activity.
- Defining premise as a story on the My Game Idea - Dramatic Elements page creates confusion when the middle school students see story listed as another dramatic element. The suggestion is to remove story from the design page since this is an optional dramatic element.
- Eliminate the My Design Algorithm page and replace it with a My Procedures page that enables middle school students to define the steps for playing their respective video games.

Future work will involve refining and evaluating the Design Notebook to measure its effectiveness in helping middle school students to define both formal and dramatic elements of their respective video games and articulate the procedures of their game.

6.2 The Kinds of Games They Created

Over the course of 4 days, the 11 African American students designed video games that we grouped into five genres: 1. service games; 2. design games; 3. adventure games; 4. racing games; and 5. survival games.

We identified two out of the eleven games to be service games or games that require players to provide or acquire typical real-world services in the game world. For example, one game required players to work in a restaurant as wait staff, food critics, health inspectors, and cooks who aim to please the head chef. The other game expected players to be loyal customers of a nail salon and asked players to rate the nail technicians' performance while spinning the wheel to see if they had won a discount on their next nail visit. Both service games were created by African American females and indicated that certain aspects of their everyday life can be actualized in a meaningful way in video games (e.g. "The cook will have to learn how to be polite, have excellent customer service [skills] and problem solving skills.").

Two of the eleven games, both created by African American females, fell into the category of adventure games. These games required players to complete a series of missions throughout the game in order to win. Both adventure games asked users to search and collect stars while avoiding obstacles throughout their adventure. We noted that 4 of the 5 African American females accommodated gender inclusive PCs and NPCs, a good design practice for any creator of technology.

We considered two out of the eleven games to be design games. These games demanded the user to create and/or build objects throughout the game in order to achieve the game's goals. One of the games required users to build a house with a solid foundation in order to remain standing throughout the game. The other game required users to build, populate and manage a town that will attract residents for the long term. This suggests that even middle school students are interested in learning how to manage resources to maintain sustainability, a critical thinking skill that translates across multiple domains.

Only one male student created a racing game while three of the African American males created survival type games, games that required users to progressively fight supernatural enemies (i.e., zombies) to save themselves and/or the world from ultimate destruction. While these types of games typically appeal to male players, in neither of these games did the African American males accommodate gender inclusive PCs or NPCs; all of the characters were male. This noticeable difference of gender exclusion suggests that we should encourage middle school students to consider creating gender inclusive PCs and NPCs that allow players to select a gender of choice.

6.3 African American Students' Interest in Game Design

As mentioned previously, mainstream has formed the perception that African American students are not interested in doing Computer Science or gaming. However, our experience with this game design camp offers a different perspective. Though we did not explicitly survey this group of participants to see if they were interested in creating video games of their own, their behaviors indicated a sincere desire to learn how to create video games. For example, the camp hours were from 9 AM to 3:30 PM for four days and yet many of the camp participants confessed to spending additional hours at home working on their game ideas, especially during the implementation phase when learning how to use Scratch to create their games. We did not encourage the students to work at home and yet of their own free will and motivation, some of the participants did exactly that. This correlates to an attitude of persistence.

Second, whenever someone is learning something new, there are going to be bumps in the road or challenges to overcome. However, in order to understand a new concept, the student must overcome the bump in the road. We saw that each of the students met with challenges throughout the game design process. For example, all of the students initially expressed grandiose ideas about their video games (e.g. characters that fly). As the students explored Scratch and begin to understand what they could do in scratch (e.g. learning how to animate a sprite), they adjusted their game ideas to reflect achievable goals in the short time frame of the camp. Given more time to master concepts, perhaps the students could have utilized Scratch to implement their original game ideas.

At the same time, given the shorter time frame helps to keep the middle school students engaged as opposed to losing interest over a longer time period [20]. The process of game design involves an element of managing your time constraints and using available resources to complete your game design project on time. Some of the students chose to spend additional time working on their games, suggesting an attitude of persistence and definitely a degree of interest. Others asked their peers for help when they were stuck, indicating that they were not afraid to engage in the social aspects of game design (e.g. seeking support from team members). As middle school students often do, they did engage in off topic discussions with their peers and we had to remind them to return to the game design task at hand. They expressed confusion about some of the game scaffolds but definitely not a lack of interest. At no time did students complain about the doing the work required for each game design activity nor did they exhibit an attitude of not wanting to be at the game design camp. Thus, all of the students demonstrated interest in learning how to create video games despite learning difficulties encountered and successfully created at least one level of their game using Scratch.

7. CONCLUSION

We have shared our experiences in conducting a week-long game design workshop for African American middle school students. These experiences are based upon the intentional use of the Design Notebook to scaffold middle school students' ability to engage in the game design process, identifying crucial formal and dramatic elements of the video games these students wish to create. Initial results reveal that the African American middle school students are adept at defining the objectives of their games, the number of players, rules for interacting with other players and objects in the game, and the element of conflict that impedes players' ability to accomplish the goals of the game. Additionally, these same students understand that specific dramatic elements---play, premise and character---help to engage players during gameplay. However, results from our case study also reveal that African American middle school students struggle with the concepts of procedures of the game, the underlying premise of the game, and what constitutes conflict versus a challenge.

Future work will involve revising the Design Notebook to help middle school students better understand the more complex elements of design, including procedures, outcome, boundaries of the game, and story. Most importantly, we make the case that the Design Notebook supports the transition of African American

middle school students from being consumers of video games to being producers of video games with great success, a crucial first step in creating the next generation of African Americans who pursue computing related degrees and careers.

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