A Participatory Design Approach for Re-engaging HBCU Students in Gaming Curricula

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***Abstract*—Attracting and retaining underrepresented minorities to computing is difficult, particularly African-Americans. Interest in interactive computing techniques like gaming, mixed reality, and user experience design has helped to spark interest in undergraduate computing majors by more African American students. Undergraduate computing students rarely participate in designing their own learning experiences in game-oriented computing courses. This paper discusses the use of participatory design techniques to improve the learning experience of students studying how to design and develop interactive games at a Historically Black College (HBCU). Activities included design thinking lessons, start-up activities and student reflection journals, and to understand how the gaming sequence could be improved at the university. Results of the participatory design approach showed that students were enthusiastic about creating games surrounding social issues; however a small cohort size and interruption due to COVID-19 contributed to various challenges experienced by the study. However, approaches used in the paper could be replicated across other HBCUs or other universities experiencing a decline in gaming participation by underrepresented students.**

Keywords—gaming, social impact, serious games, design thinking

I. Introduction

This paper describes a Participatory Design approach to redesigning the gaming subdiscipline within computing at an HBCU. Historically, HBCUs have continued to provide higher educational opportunities for Blacks who had otherwise not attended college. Wright (2008) indicated that HBCUs enrolled over 26% of all Black students and produced 28% of the bachelor degree holders who were Black.[1] The HBCU in observation awarded the fourth highest number of engineering baccalaureate degrees to African-American students in 2006 and consistently produces between 80 to 100 engineering graduates per year. Their gaming sequence, Video Game Development and Game Engine programming, presents a unique opportunity to re-engage students using interactive computing (IC) and human centered computing (HCC) elements in the existing courses.

Offered sequentially, Video Game Development is the prerequisite course that covers the software development process required to create a successful game and possess the programming expertise to create a simple game. After this course is completed, students are expected to take the Game Engine Programming course. It covers fundamentals of programming input capture, world integration, object motion, collision detection and audio scoring in a 2D and 3D gaming engine. Game performance metrics, code optimization and quality assurance testing procedures are also emphasized. However, while the students at this HBCU have maintained a high level of interest, enrollment in the course sequence has been low. To combat issues of retention in the courses, the researchers used Participatory Design and Design Thinking exercises to help students understand games are essential to life and the area of serious games was introduced. When students create socially conscious games with personal and cultural relevance, it encourages the students to take responsibility over their education as they are now playing an active participatory role in it. Participatory Design as defined by Stanford University is, "to encourage the active involvement of potential or current end-users of a system in the design and decision-making processes [2] When modeling this in the classroom key activities included design thinking lessons, start-up activities and student reflection journals.

This paper is organized by providing a brief historical context describing the popularity of the gaming course sequence at the HBCUs and similar programs at other universities. It also describes serious games and how serious gaming courses have been implemented at similar universities, if any. Then, the authors describe the methodology that other HBCUs or other institutions may find helpful if implementing a similar strategy at their universities. Finally, we provide a discussion of the many challenges that were encountered when implementing such a program during a global pandemic. Finally, we end with future directions of this gaming course sequence and how social impact games will be implemented in future courses.

II. BACKGROUND

A. SERIOUS GAMES

According to Kirriemuir and McFarlane (2004) digital games employed in education can be broadly subdivided in two categories: 1) mainstream games, i.e., games that are created solely for fun and 2) learning games, i.e., games that are expressly designed with explicit educational purposes. Games in the last category are also referred to as Educational Games and with a slightly different "nuance," Serious Games (SGs). (Bruerer and Bente, 2010). [3] This includes educational games but also a great deal more, such as Games for Health, Games for Change, Military Games, Games for Politics, Advergaming, and Exergaming. Serious Games (SGs) are gaining an ever increasing interest for education and

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training. SGs are able to contextualize the player's experience in challenging, realistic environments, supporting situated cognition. Thanks to their ability to compel players and present realistic simulations of real-life situations, SGs represented an important opportunity for improving the gaming education subdiscipline at the HBCU in observation.

B. GAMING AT SIMILAR HBCUs

At similar HBCUs, Table 2, gaming courses focus on technical skills using project-based learning approaches. Gaming is primarily taught from the perspective of the strategy employed in the game and the potential profitability of the game. In addition, there is also significant involvement from industry professionals in the gaming courses at the observed comparable HBCUs. Unfortunately, there is not enough publicly-available information regarding how the course curriculum is created and whether it incorporates user centered design approaches or design thinking activities to help the students understand the gaming process from the user perspective. Also, it is also not known if the courses allow the students to create games designed for social impact of society.

Table 2: Characteristics of Gaming Courses at Similar HBCUs [4], [5], and [6]

HBCU	Course	Characteristics
HBCU 1	*Introduction to Game Design and Development*	• Learn Game development techniques • Create several projects using game development tools(ie. Unit 3D) • Create a basic game
HBCU 2	*Gaming I, Gaming II, Gaming III and Animation, and Gaming IV*	• Work in teams to learn how to design, implement and evaluate a 2D game in a interactive process • Present semester long game project in a game showcase • Learn game design and computer animation concepts through readings, presentations, play testing, and hands-on development • Spans simple single player to multiplayer games
HBCU 3	User Experience Game Design I and II	• Develop user experience expertise in the context of game design • Learn game design, animation, heat mapping, human to computer interaction, user intuition, ease of use, motivation, and purpose in the highly interactive game environment. • Corporate sponsors include IBM among others

C. DESIGNING AN IMPROVED GAMING SUBDISCIPLINE

Participatory Design and Design Thinking exercises are commonly used to redesign curriculum in higher education. It is becoming increasingly more recognized that, "if you use a participatory curriculum development approach, your training will be more effective, and the benefits (the learning which takes place, and the change in behaviour which results) will be more sustainable."[7] A participatory approach provides the educator with a structured process for developing context - specific curricula, involving students at every step of the way. The design thinking framework ensures that the participatory exercises go beyond simply generating ideas to actually developing and testing them, both in the participants' communities and with other key stakeholders. The participatory approach to curriculum development is centering instruction around content that is engaging to students. A participatory approach involves students in the process of uncovering themes and issues as an integral part of classroom interaction. This co-investigation is critical because:

1. I**t assures relevance of content:** if the issues come from students' lives, the interest level is higher than if they are imposed. The author found over and over again that even issues that teachers thought would be interesting often fell flat if they hadn't concretely emerged from the classroom interaction.
2. **It shifts the balance of power in the classroom**: when issues are identified with students rather than for students, they gain a measure of control over their own learning. They become the researchers of their own lives instead of the objects of someone else's research. [8]

When redesigning the Computer and Video Game Development and Game Engine Programming courses, the Design Thinking framework is used as a participatory tool to increase student engagement and comprehension when creating and developing their games. Design thinking is a systematic approach to problem solving and the innovation process. [9] It reduces the ambiguity and risk present in innovation by involving the end users on a series of prototypes to find, test, and improve concepts. There are seven distinguishable stages in the design thinking process, in which changes are made iteratively, based on user feedback in order to best understand the product and ensure it is best serving the user. These stages while described in Table 1 in a sequence are not bound to this particular linear order. Stages of the design thinking process, Table 1, are often done in parallel and iterations. Design thinkers can choose to redefine, elongate and even further divide the steps in each stage into more stages, while still maintaining the goal and integrity of the design thinking process.

Table 1: The Seven Stages of Design Thinking[9]

Stage	Characteristic
Define	A precise understanding of the problem and its constraints which allows more exact solutions to be developed.
Research	The stage reviews information such as the history of the design problem, end-user research and opinion-led interviews, and in this stage we can identify potential obstacles.
Ideate	In this stage end-user motivations and needs are identified and ideas are generated to meet these, for example through brainstorming.
Prototyping	In this stage we should resolve ideas, which are presented for user-group and stakeholder review, prior to being presented to the client.
Selection	In this stage the proposed solution is reviewed against the design brief objective. Some solutions might be practical but may not be the best ones.
Implementation	In this stage, we should design development and its final delivery to the client.
Learning	The stage helps designers to improve their performance and, for this reason, designers should seek client and target audience feedback and determine if the solution met the goals of the brief. This may identify improvements that can be made in the future.

The author recognized Participatory Design and Design Thinking supports innovation in K-12 classrooms. Through in class activities and semester long and quarter long projects, students are inspired to change their surrounding environments. "With project based learning, the content is baked inside of a long-term project, a real-world problem students need to solve in a creative and authentic way."[10] Historically, Games for Change has been a great way to engage students through project based learning. " Games for Change is a 501(c)3 nonprofit that empowers game creators and social innovators to drive real-world impact through games and immersive media." [11] Via their annual Games for Change Festival, they gather industry experts, encourage young people to explore civic concerns and STEAM skills through their Student Challenge, and showcase leading impact-focused games and interactive experiences for the

public through live arcades. The author required students to participate in Games for Change, as an interactive way to inspire them to create games for society's betterment through a long term real world purpose. In the discovery phase of this study they were able to identify that, "underrepresented students are more likely to pursue STEM degrees if they believe they have the potential to produce or create technologies that can change their communities." [12] In the participatory design session, they encouraged the participating students to pitch a game surrounding an idea or issue they genuinely care about. "It has long been said that engineering programs should graduate engineers who can design effective solutions to meet societal needs."[13]

In the redesigned gaming subdiscipline you will read about next, the courses were intended to be taken in sequence and each class counts an elective for computing majors. The professor for both courses rarely enforces the prerequisite requirements for the Game Engine course. Therefore, not all of the students in the Introduction to Game Design continued on to the Game Engine course. Only one student enrolled in both courses; therefore student performance in the courses could not be compared and contrasted. Additionally, enrollment numbers in the courses vary depending on popularity of the course, but the professor caps the total enrollment for each course to be around twenty students. With these factors in mind, we tried to involve the students in creating experimental lessons that could engage the students in wanting to complete the course gaming sequence, create materials that other students could use in future gaming courses, and learn what motivates students to create social games that may directly impact their community.

III. METHODOLOGY

This work incorporated two different strategies 1) analysis of the gaming curriculum and 2) implementation of participatory design approaches into the two course gaming sequence at an HBCU. The courses are presented and analyzed separately as students did not always take the gaming course sequence in the correct order as the instructor allowed students to join the Game Engine Course without taking the Game Design course.

A. EVALUATING THE GAME SUBDISCIPLINE AT THE OBSERVED HBCU

The Curriculum development model [14] was used as a basis to analyze both the current curriculum at the HBCU and those at similar HBCUs. By comparing and contrasting the gaming curricula at similar universities, the author was able to identify 4 key elements of improvement for the current observed university subdiscipline. Historically offered sequentially, Computer and Video Game Development is the prerequisite course. The course spans the software domains embedded in computer and video games, game computational infrastructure, design, engines, and motion. The course is delivered in an assignment and discussion format. It has been expected that students who have completed this course, "have an understanding of the software development process to create a successful game and possess the programming expertise to create a simple game." [15] After this course is completed, students are offered the Game Engine Programming course. The material introduces Game engine programming, "as a critical element in compelling game creation. Programming activity will feature input capture, world integration, object motion, collision detection and audio scoring." [15] Delivered in the same assignment and discussion format of the previous course, game performance metrics, code optimization and quality assurance testing are key takeaway skills. To dynamically evaluate students' understanding of the material, the course is completed by submitting a game project using any 2D or 3D game engine introduced in the course. The 4 key opportunities for improvement are design thinking, IC and HCC elements, industry involvement and the enforcement of the prerequisite requirement.

B. IMPLEMENTING PARTICIPATORY DESIGN INTO GAMING SUBDISCIPLINE

Computer and Video Game Development Study

Participants. Ten students, 7 females and 3 males, enrolled in the Introduction to Game Design course. All students were computing majors and had taken the prerequisite Computer Science II course. All students were from historically underrepresented groups. It is assumed they had basic knowledge of computing concepts, data structures principles, and algorithmic thinking.

Materials. The instructional materials used in the experiment consisted of 3 modified lesson plans from the Code.org supplied Unit 4 of Computer Science Discoveries (CS Discoveries) curriculum. The modifications were related to the schedule and the computer and video game development environment. For example, the university setting where the course was taught utilizes a traditional fall/spring sixteen-week semester schedule however the author had a constraint of 3 weeks to conduct the study. The Computer Science Discoveries (CS Discoveries) Unit 4 has 16 lessons and is designed to be delivered over an entire semester. Due to this three week constraint, the author divided the course into weekly lesson plans which could fit into a three-week period as shown in Table 2. The experimental lesson plans were modified to include design challenges with the objective to teach students how to better understand the needs of others while developing a solution to a video game instead of a digital product. Students had the opportunity to identify a need that they cared about and prototype solutions for games on paper.

Procedure. For each experimental lesson, the author helped facilitate by first setting the tone for the class with start up activities. After which they moved into a quick lecture using the modified slide presentation, which served as a lesson primer. The rest of the lesson consisted of all the students completing group design challenge activities in break out

groups with a size no larger than 2 - 3 people. At the completion of each design challenge activity, the students moved into the sharing component of the lesson, where they quickly shared their decision-making process and received oral constructive feedback from the group. To conclude each lesson, every student completed a written reflective journaling prompt to express their understanding of, reflections on and response to the intervention activity at hand. There were 10 students enrolled in the course, and all 10 students completed the reflective journaling. The reflective journaling prompts had open-ended questions, designed to elicit themes under qualitative analysis.

Week	Lesson Topic	Lesson Brief Description
1	Introduction to Design Thinking	The class explores a variety of different teapot designs to consider design choices. Building on this, students explore the relationship between users, their needs, and the design of objects they use.
2	Looking Through a User's Eyes	Using user profiles, the class explored how different users might react to a variety of products. Role playing as a different person, each member of the class got to experience designs through someone else's eyes.
3	User-Centered Design Micro Activity	In small groups, students use the design process to come up with ideas for smart clothing and video games. From brainstorming, to identifying users, to finally proposing a design, this activity serves as the first of several opportunities for students to practice designing a solution for the needs of others.

Table 3**: Introduction to Game Design Class, N = 10**

Game Engine Programming Study

Participants. Six students, five males and one female, enrolled in the Game Engine Programming course. All students were computing majors and had taken the prerequisite Computer Science II course. It is assumed they had basic knowledge of computing concepts, data structures principles, and algorithmic thinking.

Materials. The instructional materials used in the experiment consisted of 3 different lesson plans that covered information on topics related to Design Thinking, Game Design and Game Mechanics. In addition, a subjective qualitative closed ended questionnaire also known as the "Post Class Reflection" was used in the experiment to measure what the students thought worked and found engaging. Both the experimental lesson plans and the "Post Class Reflection" were created in collaboration with the teacher of the class and the research team. The lesson plans that were part of the intervention are noted in Table 3. Whereas, the "Post Class Reflection" had a total of 10 questions and was administered as an online google form survey after each experimental lesson. There were 6 students enrolled in the course, however only 5 students completed the "Post Class Reflection." A sample of one of the "Post Class Reflections" used in the experiment has been included in Table 5.

Procedure. In Game Engine study, each class was started with icebreaker activities. After these activities, a 15 minute lecture was provided using the modified slide presentation, which served as a lesson primer. The rest of the experimental lesson consisted of all the students completing group design challenge activities in break out groups with sizes no larger than 3 people. At the completion of each design challenge activity, the students quickly shared their decision-making process and received constructive feedback from other groups. This part of the lesson was designated as the Sharing Component. To conclude each experimental lesson, the students were provided with a subjective qualitative closed ended questionnaire also known as the "Post Class Reflection." They were asked to list what elements of the experimental lessons they felt worked and added to their engagement. In the next section we will take a look at how the two studies played a part into re-engaging students by crafting their own learning.

IV. RESULTS

Participatory design is used in developing technologies, but rarely used to engage students in crafting their own learning in gaming courses. This study sought to redesign the gaming sub discipline to include interactive computing learning modules that provided a highly engaging and culturally relevant experience for all students. The results were heavily impacted by the instructors of the courses schedule as well as the COVID-19 pandemic. The crisis lowered students morale and confidence in completing the course. Due to low class enrollment of only 6 students per course, qualitative analysis was used to determine if the studies performed were effective in involving students in their learning through participatory design. The authors reflected on this experience, for future improvements, by examining student artifacts. As a result, each class will be treated separately in the analysis below:

Table 4: Game Engine Programming Class Experimental Lesson Plans, N = 6

Week	Lesson Topic	Lesson Brief Description
1	Game For Change Introduction	The class was introduced to the Games for Change Competition. Students were shown examples of past submissions. In addition students were asked to choose 1-2 past submissions and remix the game idea of their choice.
2	Game Design vs. Game Development	A quick overview on the concepts that make up the difference between Game Design and Game Development.
3	Game Story Development	In small groups, students completed the Game For Change Ideation activities, where they were prompted to write down 4 issues they saw headlined in the news and generate different ideas for a game to solve each issue.

Table 5: Sample of Post Class Reflection Questionnaire that was administered after each experimental lesson.

1. What is the main objective/goal of the game idea you have for Games for Change?
2. What theme/issue are you trying to address in the game for change?
3. What are 3 examples of preexisting games that have similar game dynamics to your game idea?
4. Links to the 3 preexisting games that are similar?
5. In class today, what did you think worked? a. Examples of Games for Change Games b. Games for Change Idea Generation Activity c. More activity less lecture d. Class configuration e. QR Code Sign in
6. Please explain why it worked?

Computer and Video Game Development Study

As noted in the Methodology section, students were required to complete a reflective journaling prompt to express their understanding of, reflections on and response to each intervention activity at hand. Due to external reasons, the author cannot report on the qualitative analysis of the hand written student reflections. However, video observations of

students orally explaining their decision-making process and receiving constructive feedback from the group provides a more informal evaluation of the intervention activities. For example, in the sharing component of the intervention activity, Looking Through a User's Eyes, a student takes on a user persona and explains why they made a decision choice *"I'm more fond of fish because they don't require a lot of care. I'm never at home so I don't think I would have the capacity to take care of a dog or kitten so I picked a fish,*" which hints at the students ability to build empathy and critique a design. While another student describes their user persona's choice of a dog "*because I'm very busy, I go to my soccer classes and attend dance classes. But I come home tired and I like to see a happy cheerful dog to cheer me up."* These comments suggest that the design thinking activities were effective in teaching the students to identify how specific user needs might inform a design decision of game. Similarly, a different student reacts as their given user persona to a series of video games and states that *"I chose D but I could have easily chosen B,*" indicating their ability to categorize their persona's needs and choice to focus on one. In general, the feedback suggests that using design thinking as a participatory tool engages students to see how taking a user-centered approach to designing games can make those games more useful and usable. Further study may be able to quantify the effect on student learning compared to other activities.

Game Engine Programming Study

As noted in the Methodology section, students were required to complete the Post Class Reflection. The Post Class Reflections were administered at the end of class where every student was asked to complete and submit via a google form. Feedback from the questionnaire offers key insights into the student's tacit knowledge that can be translated to encourage students' enthusiasm in future lessons. For example, a student wrote the object of their game was to"instill empathy in the hearts of others, concerning the homeless/less fortunate." While another student described how they wanted to create a "Save the world Simulator," which could be interpreted as being synonymous with the student's life purpose. Even though the students did not place in the Games for Changes competition, the experimental lessons helped facilitate conversations around issues/themes that students cared about. The top themes/issues students noted they cared about and were trying to address in their Post Class Reflection are noted in Table 5. In addition, the top intervention activities and strategies from the experimental lessons were ranked and notes in Table 6. This technique was shown to have a direct impact on the students' arrival of the overall theme that they ended up submitting to Games for Change. This is an ongoing process of trying to understand how to improve this class because it is not a required class. However, through the identification of the top themes, activities and strategies student's cared about the author was able to learn about building culturally relevant and engaging content curriculum moving forward.

Table 6: Themes that were identified as most important to the students

Theme	Percentage of Students
Poverty	60%
Climate Change	33%
Conflict	20%
Health/Wellness	0%

V. DISCUSSIONS AND LESSONS LEARNED

Table 7: Top activities and classroom strategies drawn from the student reflections

After reviewing the preliminary feedback results, the authors believe that using design thinking as a participatory tool engages students to see how taking a user-centered approach to designing games can make those games more useful and usable. Students were given the opportunity to build empathy and critique a design, and to identify how specific user needs might inform a design decision of a game. The author now shares the lessons learned from implementing and evaluating intervention for others who may wish to replicate the program.

1. Creating a curriculum that factors in hybrid models from the beginning, can help encourage student's morale when it becomes difficult to continue re-engaging students when forced into a virtual environment.
2. Office hours with gaming industry professionals can help support professors who have limited time and resources. They can also add a valuable perspective to the student's understanding.
3. Pre class work that helps prime students on topics that are discussed in class can help increase student participation and understanding.
4. Working on side projects to supplement the course material can connect student interest to the material. There is a higher motivation when a monetary value is attached to those projects.
5. Having a senior member in the class, to address the issue of the knowledge gap to help the new students in our intro to gaming course.

Additionally, to help feasibility for others, the authors advise to:

1. Ensure that the prerequisite course is enforced
2. Professors find a ways to boost student morale in a virtual environment

3. At the start of this process to provide ample time to allow students to iterate through the game development process.

VI. CONCLUSION AND FUTURE WORK

Overall, participation in the study seemed to prove valuable to students; although many challenges were encountered with implementation of the participatory design approaches and the social impact game theme. Feedback suggested students learned how to identify the user's perspective, their needs, and how to prioritize and categorize as they build games. Furthermore, the authors learned it is necessary to identify themes students care about and encourage students to build games centered around those themes.

Future work will allow for students to also try on different hats through research and entrepreneurship experiences integrated into the gaming sequence course. Opportunities that provide students exposure to research may help some students alleviate financial burdens and give them a long run-way to create their social impact game . Additionally, these opportunities allow professors to introduce their own research interests to the students through paid opportunities. Further, introduction of research experiences may also encourage the students to pursue the social impact game idea in graduate school.

Finally the authors recommend students to explore entrepreneurship through business case workshops, an internal departmental pitch competition to fund student's game ideas, and connecting students to alumni who are gaming entrepreneurs. The authors hope students will be encouraged to apply themselves to the gaming subdiscipline when provided with these opportunities.

In this paper we present participatory design approaches applied to a gaming course sequence at an HBCU. Although the student count for each course was small, approaches described in this paper can be applied to larger course gaming courses at HBCUs or other universities. Design thinking, user centered design, and user experience design approaches are often left out of HBCU gaming curriculum. Incorporation of these tools may help the students within the course develop games that not only they would want to play, but others in their community would want to play as well. Additionally, in this work we described how social impact games or serious games can possibly be used to provide a backdrop for the implementation of game design and programming. Although there was not a larger cohort of students to participate in the game design and game engine programming course, a future longer study will determine if the use of social impact themes contribute to the popularity of the course and the retention of students into the gaming subdiscipline within computing.

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