What Makes Competitions Fun to Participate? The Role of Audience for Middle School Game Designers

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ABSTRACT
Though recent efforts have focused on creating tools and communities for youth game designers, the emergence of online competitions is a recent phenomenon in engaging students in such activities. In this paper we describe and analyze how a class of middle-school students participated in a national STEM video game challenge. Using Scratch, students designed, debugged and submitted their own video games over a three-month period. In analyzing the game designs, we paid particular attention to the role different authentic audiences and what we learned about supporting participation in online competitions.

Categories and Subject Descriptors
K.3.1 [**Computers and Education**]: Computer and Information Science Education - *Computer science education.*

General Terms
Human Factors

Key Words
Game Design, Collaborative Learning, Scratch

1. INTRODUCTION
Local and national competitions such as the Google Science Competition, First Robotics, and the Microsoft Imagine Cup have become popular venues to inspire students in K-16 to excel in STEM. It is widely believed that participating in these kinds of public activities, where students prepare, display and share their learning artifacts can be a valuable learning experience [2]. In the context of robotics, a recent study by Brandeis University [8] reported positive influences on youth participants' attitudes, skills, knowledge of science and technology, and self-confidence. Game design competitions such as Games for Change, the *National STEM Video Game Challenge*, or Scholastica seem like a logical next step in amplifying levels of youth participation in that such activities offer children another authentic learning opportunity.

This paper examines participation of middle school students in the context of a game design competition, the *National STEM Video Game Challenge* henceforth called the *Challenge* (http://stemchallenge.org).

We describe and analyze how a class of middle-school students participated in the *Challenge*, navigating the design and development of their own unique STEM-based video games for both an audience of their instructors and peers as well as a wider audience consisting of their fellow competitors, experts within the field, and ultimately the judging panel itself. Our findings present the resulting games programmed in Scratch, the instructional design, and the role of authentic audiences in the creation, revision, and submission of one's video game. In the discussion, we address how audiences for designs provide a key element in making competitions a rich learning environment.

2. BACKGROUND
More than thirty years ago, Malone's [6] seminal paper "What Makes Things Fun to Learn?" articulated a series of design principles from game play to inform the design of learning environments. Central were the principles of challenge, curiosity, and fantasy that Malone developed into a taxonomy of intrinsic motivations that could help instructional designers create activities that are "fun and rewarding for their own sake rather than for the sake of some external reward" (p. 162). While challenge and competition have always been considered an essential part of game play, the recent emergence of game design competitions (e.g., the *Challenge*) presents an interesting twist, explicitly linking effective game play as the product of mindful game design and development. Though Malone considered that "computer programming itself [is] one of the best computer games of all" (p. 168), the idea of making--or programming--games for learning did not initially receive much attention [1] but now is a vibrant area of activity inside and outside of schools [7, 9]. The emergence of online game design challenges extends these activities from the local context of individual classrooms and after school clubs into the wider, gaming community. While we know some about designing construction tools and activities [11], the design of online community events and activities for learning [4] is a relatively new phenomenon.

While knowing the audience for youth contributions has been recognized as relevant in other contexts such as writing [5], it might also play a special role in online technical communities where contributions define recognition and, by extension, membership. The online community can become a potential audience as well as a place of belonging to a collective of programmers (and how they think, program, and provide feedback). As Magnifico [5] elaborates, thinking about audience requires critical reflection on "how to align themselves with these practices and values, portray themselves as members, and communicate these ideas to an outside audience" (p. 180). Applying concepts of audience to programming opens up possibilities for how a massive online programming community can influence students locally. Developing such a community is not easy. Previous research indicates that leveraging the Scratch website, for example as a means for participants to share their own work with wider audiences and download others' creations has been met with challenges [3].

3. PARTICIPANTS, CONTEXT, & METHODS

3.1 Participants

A group of 17 middle school students 6th through 8th grade self-selected to participate in the school's first *Challenge* elective class. The workshops were held in the school's 3rd floor computer room and ran twice a week on Tuesday and Thursday from 2 - 3 PM, beginning in the last week of October and running approximately three months to the first week in February. The class consisted of 13 boys but only 4 girls, even though considerable effort was taken to recruit female students. The group was representative of the racial and ethnic diversity characteristic of the school with approximately 40% of the group describing themselves as "white", 35% as "black", and 25% as "Asian" or of "Mixed" race/ ethnicity and also characteristic of the school's socio-economic diversity. 52% of the school's total population of 550 qualifies for free-or reduced lunch.

3.2 Context: National STEM Video Game Challenge

Now in its second year, the *Challenge's* goal is "to motivate interest in STEM learning among America's youth by tapping into students' natural passion for playing and making video games" (http://stemchallenge.org). As a national initiative issued by President Obama himself, this competition engages youth and young adults at the middle school, high school, collegiate, developer level. On the middle school level, each individual winner or each member of a winning team receives a personal laptop computer installed with game design software, plus an additional $2000 for their respective schools. In 2010, 10 winners were chosen at each level from a total pool of six hundred entries, and two used Scratch to program their games.

3.3 Data Analysis

During the workshop, we collected and analyzed a variety of data sources including (a*) individual participant's perspectives* based on pre/post surveys and post interviews, (b) *external observations* based on daily field notes, (c) review of *online exchanges* at the Scratch website (http://scratch.mit.edu), (d) *video recordings* of all workshop sessions some of which were subsequently transcribed, and (d) the *digital artifacts* themselves in the form of the various iterations of each participant's video games, which were saved and uploaded to the Scratch website at the end of every session.

4. FINDINGS

4.1 Games

Sixteen out of 17 participants completed and uploaded a game by the close of the three-month workshop indicating a high level of persistence. Six participants developed their individual video games intrinsically around a particular STEM theme specifically a scientific phenomenon and/or mathematical relationship, while 10 started with a particular type of gaming genre (e.g., a "platform game" or "first-person shooter") and then subsequently "tacked on" the STEM theme into game play, extrinsically. An intrinsic example is Barney's "Enderbuild" game (see Figure 1). The player must survive in the wilderness using basic agrarian knowledge to

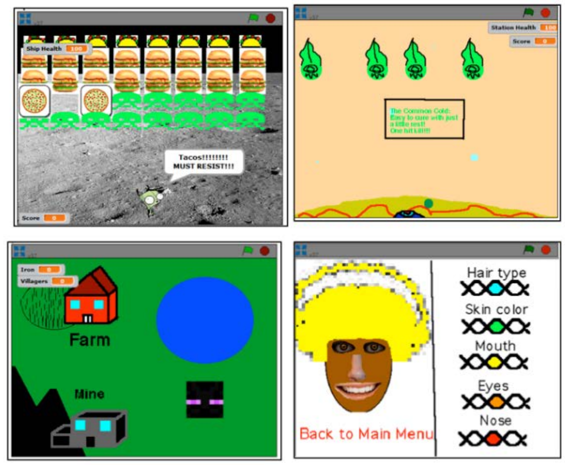

Figure 1: **Images of completed games from the STEM Video Game Challenge; clockwise from the top left, "Food Invaders", "Lysome Assault", "Genome Face", & "Enderbuild"**

determine when to plant as well as metallurgy to develop a local mine to create more resilient tools with which to farm. While not overtly scientific, to play Enderbuild successfully an individual must have some simple—but crucial understanding of farming and material craft. The STEM theme in this case is absolutely intrinsic to game play. On the other (extrinsic) end, games such as Adam's "Food Invaders" had some element of STEM learning, though less thoroughly incorporated into game play. Based on the popular Atari game "Space Invaders", "Food Invaders" replaces the aliens with junk food items such as tacos and burgers, which the protagonist must dodge in preference for healthier alternatives like apples and bananas. Once a player's cholesterol reaches a certain level, the avatar keels over, the body's health entirely depleted. This game is extrinsic in that while one may learn fast food is detrimental to the body's health, gameplay never addresses the actual biological processes that cause cholesterol to clog arteries.
Nonetheless, all projects effectively addressed the technology element through their use of a wide range of essential coding concepts in Scratch: 69% of projects used coordination and synchronization as well as loops; 63% used event handling and conditional statements, and variables, and 19% used Boolean logic.

4.2 Design

In a group roundtable each day, students considered and described particular games that they wanted to create in brainstorming sessions. Instructors demonstrated examples of STEM games to help students connect their initial design to the STEM video game spectrum and inspire new ideas. It became apparent that the scope and nature of the Challenge was difficult for participants to fully grasp and consequently, barriers to brainstorming emerged: (a) First, there was the difficulty in helping participants understand what ideas would essentially "work" in the Scratch format (i.e., how many levels they could include and how long the game could last). While a significant portion (53%) of participants had used Scratch before only one student—8th grader Aaron—had used an extensive application of the software to create a video game. (b) Second, there was difficulty in clarifying how STEM could be used in the *Challenge*. While we regularly explained what the acronym meant and students understood it in terms of classroom subjects, targeting a particular STEM concept around which to develop a game was a significant hurdle, and the *Challenge* website offered no list potential topics.

To clarify the requirements of the *Challenge* and facilitate the brainstorming process, we focused on utilizing sample projects. The website did list last year's winners, one of whom—screen name: "Cooler-Than-Ice"—utilized Scratch. We demoed her project, "An Alien of My Own," involving an alien exploring its surrounding ecosystem. The reactions were mixed ("It's not that good," grumbled 8th grader Ira, while 6th grader Alan repeatedly questioned, "That really won?"), but this single project became the video game to either emulate or surpass. We then distributed game design templates over the next session, which encouraged students to map out the various threads of their game by drawing out snapshots.

We continued these "sample-and-share" demos of various projects throughout the brainstorming, draft, and revision stages, modeling how to optimally give and receive feedback before eventually having the students themselves present their developing video games. These demos were a crucial element in having participants reflect upon the game-making process and discuss how to better incorporate the STEM theme into gameplay; however, there were also times—particularly early on— for direct instruction where we addressed the less intuitive Scratch coding bricks such as randomization, variables, and Boolean logic. Rarely formally planned out, these "time to-tell" moments largely arose based on the feedback of the students themselves as they struggled with certain coding concepts. As with the sample-and-share sessions though, these time-to-tell tutorials eventually fell to the class members themselves, with multiple experienced members including Aaron, Ira, and Rene leading brief how-to sessions on specific coding bricks.

4.3 Audiences

Our roles as instructors figured most prominently over the initial month of the workshop. We led all the early brainstorming sessions, sample-and-share demos, and time-to-tell tutorials, in addition to supplying direct feedback on the student's game design worksheets. This, however, began to change once other audiences entered into the design process. The draft submission, situated midway through the *Challenge*, was characterized by more collaboration among peers, more physical movement across class space as well as more online movement on the Scratch website, resulting in verbal feedback and online, written feedback among participants. Students began to demonstrate their video game for the class, which allowed for peer feedback and questions related to Scratch programming and the collaborative movement of ideas and skills across the classroom, thereby making the instructor audiences less important. During this time, we solicited online peer feedback from experienced Scratchers from a nearby magnet high school where many of our participants want to attend. A high school visitors' comments, follows:

> *This is really cool, I like how you modeled it around minecraft…a couple of suggestions, one would be keep up the good work, another would be to at the end of the game put a message like "Thank you for completing the tutorial", and…put in a background, just a small one around the "Upgrade" button so that it's not as hard to click.*

The draft submission ended with a "gallery walk" where each student circled the room to test each other's video games. They provided feedback via the Scratch website on one another's Scratch page, allowing students to become more accustomed to using this gaming social network, a skill that allowed students to tap into the wider gaming community.

As students made revisions, three experts were invited to provide feedback, to discuss the game design process, and to demonstrate real world application. These experts included a computer programmer with experience in producing video games and animations for movies, a former panelist who has judged former competitions, and a former technology consultant. Of particular note is the effect that the female technology consultant had on one female student who had not been motivated by the previous male visitors or her peer audience. These experts stressed the importance of incorporating STEM in a seamless, intrinsic way, which motivated students to make more meaningful revisions.

Students also received comments on their game designs from the online Scratch community. The instructors contacted one of last year's winner of the *Challenge*–the same "Cooler-than-Ice" whose Scratch project had won the previous year. She gladly agreed to provide feedback online on the students' developing projects. One of her comments follows, well representing the enthusiasm with which she instilled into the revision process (which could be particularly hard for the students in terms of debugging code):

> *This is great! I love the idea, graphics, and the game itself! (Nice use of biology terms in the title!!) I think there's one bad guy who is missing the script to explode when the bullet hits it, but that can be easily fixed. Nice work!! It's impressive the way you get the bad guys to re-spawn... That's difficult to do!*

We set a final date for submission and held a "Virtual Arcade" where other students from the school were requested to beta-test participant projects. Over 40 middle schoolers from the school gaming community participated in the arcade celebration and gave written and verbal feedback. According to Adam, age 13, this experience was pivotal to his design.

> *There were so many people who helped me…But the really ironic thing is that the biggest of my problems start occurring as soon as people really started playing my game. And that made me realize there were still things to fix and that I had a long way to go…when we were playing they'd tell me things like "there's a glitch with this"*

5. DISCUSSION

While participation in the competition provided students with a general but anonymous audience for their game designs, the interaction with different audiences became the driving force behind both instructional and game design, persistence, and motivation The evolving design of the Scratch workshop was characterized by a narrowing specificity of each student's video game through multiple iterations to arrive at a final upload-able product at the close of the workshop (see Figure 2); this growing specificity of a particular type of game and particular type of STEM learning was coupled with an inversely broadening of one's audience, moving from the traditional dichotomy of student/teacher to a nationwide audience of peers and judges through both the Scratch and *National STEM Video game Challenge* websites.

As participants brainstormed, drafted, revised and at last submitted their own STEM-based video games, each iteration was matched with a feedback stage that sourced increasingly more authentic and broader audiences (i.e., moving from instructors, to peer-to-peer feedback, to visits from external experts, and the gaming community). The manner in which audience was utilized greatly

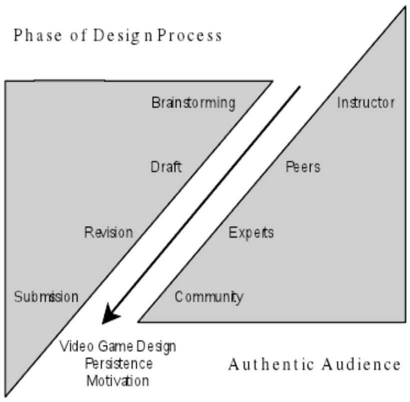

Figure 2: Audience-driven Design

affected student's game design, inspired students to seek more feedback, and motivated them to persist in the workshop.

Moving forward, in designing these type of competitions, it is important to recognize the crucial role of different audiences other than the jury panel in the game design process, motivation to compete, and the ability to persist throughout the length of a competition to create an uploadable game. Based on our observations, incorporating a broadening of audience with particular attention to a peer audience is as important as offering an external reward. What ultimately seemed to be a more powerful incentive was including different audiences in the workshop design that scaffolded the youth game designers' participation in the competition. Malone always considered the social dimension of competition as an essential design principle when playing games. For the purpose of making games, designing for the inclusion and participation of different audiences (peers as well as professionals), the social dimension needs to become a new design principle that should be considered in the design of online and offline workshop groups.

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