Games, Learning, and Society

Learning and Meaning in the Digital Age

Edited by
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21 Developing Gaming Fluencies with Scratch: Realizing Game Design as an Artistic Process

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Much of the current games research focuses on how learning to play games can engage players in various valuable practices relevant to and supportive of school learning and literacies (see Gee, 2003). We contend that learning to design games can engage youth in an equally wide range of valuable practices, all of which are complexly intertwined ecologies that help youth to coordinate multiple activities and types of meaning-making systems (Kafai, 2006a). We call this intermix of technology and gaming practices *gaming fluencies* because youth can become fluent not only in game design but also in the creative, critical, and technical aspects of working with new media. We're using game production as a way to promote gaming literacy in the broadest sense as well as to enhance technology fluency, particularly among disadvantaged youth (Kafai, Peppler, & Chiu, 2007). Our approach of gaming fluencies aligns with work in the constructionist tradition (Kafai, 2006b; Papert, 1980) that proposes pedagogies to promote technology fluency and further argues that video games are a form of twenty-first-century art (Mitchell & Clarke, 2003).

To illustrate our view on gaming fluencies, we examine the game artifacts that were designed in a place called the *Computer Clubhouse*, a community technology center located in South Los Angeles (Kafai, Peppler, & Chapman, 2009). Youth in this clubhouse had access to a wide range of design tools, but our attention focuses particularly on their use of Scratch (Resnick et al., 2009), a media-rich software design environment that we introduced beginning in 2005 as part of a larger research project. During the following two years, we documented daily design work in field notes and archived all Scratch projects. Our analyses will focus on an archive of Scratch projects created over a two-year period by clubhouse members. A large percentage of these designs were games that imitated standard game genres or were interactive narratives and are the subject of this chapter (more than 68 percent of the total archive, n = 430) (Peppler & Kafai, 2010). Scratch games were categorized in a wide range of genres, including sports, adventure, and racing games, but also included mazes or puzzles.

The focus of this chapter is to further investigate how these games encapsulate multiple professional practices, including expertise in areas relevant to game design, such as "graphic design (visual design, interface design, information architecture), product design (input and output devices), programming, animation, interactive design (human computer interaction), writing, and audio design" (Salen, 2007, p. 318). We categorize this array of professional practices into three distinct groups of creative, technical, and critical aspects of game design (Peppler & Kafai, 2010). Using a case-based approach (Dyson & Genishi, 2003), we identified various creative, technical, and critical aspects (e.g., design choices, interface features, and narrative elements) used by youth in their creation of original games and examine their development over time by comparing first- and second-year game designs and approaches. These investigations allow us to address the following two questions: What kinds of fluencies do youth engage in while in the process of designing games? and How do these young designers develop over time? Such in-depth analyses of game-making activities and artifacts in informal settings have been rare and will provide a window into the complexities of learning involved in game making. In our discussion, we consider how our approach to gaming fluencies builds on prior conversations about "gaming literacies" (Salen, 2007; Buckingham & Burn, 2007).

Background

Gaming Fluencies

Our efforts to articulate gaming fluencies draw on early work in this area (Kafai, 1995; 2006a) and a series of related studies. A recent review of the research literature (Games & Hayes, 2008) identified four different goals to making games: (1) learning programming (Bruckman, 1997), (2) interesting girls in computer programming (Flanagan, 2006; Denner & Comb, 2008), (3) learning content in other academic domains (Good & Robertson, 2003; Kafai, 1995), and (4) understanding design concepts (Hoyles et al., 2001). All these approaches saw special value in engaging youth as game designers for the sake of developing their interest in and knowledge of technology skills, design thinking, and academic domains. But the proposed distinctions between approaches failed to take into account that making games for learning often incorporates two or more purposes rather than just one. In fact, early studies were specifically designed to leverage the mutually beneficial aspects of game design, emphasizing that learning programming is integrated with the learning of, for instance, mathematics in the design of artifacts and representations and providing motivational benefits through personalization (Kafai, 1995).

More current developments situate game making in the field of new media literacies (Gee, 2010) and emphasize benefits such as system-based thinking (Salen, 2007) and critical engagement with media (Buckingham & Burn, 2007; Pelletier, 2008). Those interested in gaming literacy or literacies have proposed and developed game-specific toolkits such as Missionmaker (Buckingham & Burn, 2007) or Gamestar Mechanic (Salen, 2007) that allow young game designers to focus on design elements and processes. We, in contrast, see game making as part of a larger do-it-yourself (DIY) effort in which youth engage (Guzzetti, Elliot, & Welsch, 2010; Lankshear & Knobel, 2010) and provide a model of observation that expands the palette of previously conceptualized literacies to include a broader spectrum of design activities that are important to youth culture. In particular, we add the artistic and creative ends that games take as well as the critical aims of production that are often left out of the discussion of youth game-production efforts. In this effort, we distinguish three different dimensions that we see as essential to youth game production that comprise of technical, critical, and creative practices.

Technical practices. The technical aspects of game design are what have received the most attention from previous explorations into youth gaming literacies (for an overview, see Games & Hayes, 2008). Youth technical practices when they are engaged in game design include the acquisition of information technology concepts, information technology skills (e.g., sustained reasoning, managing problems and finding solutions, and using graphics and/or artwork packages to express ideas creatively), and high-level skills such as algorithmic thinking and programming. Game design projects often use programming as a means to understand the production and manipulation of familiar media (Kafai, 1996, 2006a). Programming within the context of game design is particularly important because it allows individuals to manipulate the computer as an artistic medium of expression (Reas, 2006). Effective use of the medium and taking advantage of the affordance of digital media for interactivity, immersion, and transactivity are other important technical practices as game designers learn how to make games more engaging for the player (Saltz, 1997; Ryan, 2001; Jensen, 1998). In an effort to introduce the essentials of software design to youth, we argue that learning to code is important but by no means the only building block for understanding how media games are designed; it can provide an additional venue to originality and expression in digital media.

Critical practices. More recently, several approaches have examined game design as a way to involve youth in critically viewing media and using this understanding when creating original work. As youth began to take advantage of living in a digital world by capitalizing on the wealth of images, sounds, and videos accessible as "materials" to reuse in their own work, media educators grew particularly concerned about the ways in which youth were either reinscribing or questioning existing dominant norms (Buckingham, 2003; Buckingham & Burn, 2007). These critical practices of game production include youth being able to reflect critically on and evaluate media texts, understanding references made in popular texts and deconstructing and interpreting the meaning behind such texts (Buckingham, 2003; Buckingham & Burn, 2007). By observing the critical practices of game designers in this way, we gain an understanding of the extent to which young designers understand and question the popular texts that they incorporate in their work, apart from what they learn about software programming and the arts. For instance, critical choices can take the form of game designers intentionally removing all shooting features and enemies while keeping other features of a run-and-gun game genre intact (e.g., side-scrolling engine, smooth-action animation, core mechanics, etc.) to create a peaceful setting in a once-violent video game (Peppler & Kafai, 2007).

Creative practices. What perhaps has been most conspicuously overlooked in prior research efforts in this area are explorations into how youth participation in game production involves expanding beyond technical and critical considerations toward creative or artistic ends. Many of these creative practices are rooted in the arts but overlap with visual literacy goals, such as the importance of being able to interpret and express original ideas in a variety of modalities (e.g., through music, dance, sculpture, or dramatization) and frequently are able to make meaningful connections between two or more of these modalities (Kress & Van Leeuwen, 1996; Gee, 2003). In observing creative practices as they pertain to youth game design, we are particularly interested in the ways that youth learn about and appreciate artistic principles within any particular modality (e.g., visual, audio, or kinesthetic) or through their connection of multimodal sign systems, which is the practice of crossing between two or more modalities (e.g., visual and sound, visual and movement or gesture, and sound and movement) to convey an artistic idea. For example, choosing an image of a castle and then finding colors to augment the idea that the castle is scary versus making it a friendly

space is considered to be working within a single modality. Importing an audio file of "Take Me Out to the Ballgame" into an illustration of a baseball diamond in order to make the scene appear "real" is an example of connecting multimodal sign systems (in this case, visual and sound). While the first practice creates the opportunity for learning traditional skills in any one discipline (e.g., perspective, movement, and melody), the latter practice demonstrates the ability of the youth to depict objects and ideas as a combination of stimuli and is an important aspect of meaning-making and learning how to convey certain ideas across modalities.

Games as Interdisciplinary Practice

We thus propose gaming fluencies as consisting of three interrelated practices (i.e., the technical, critical, and creative practices) in game-making activities rather than having a single disciplinary focus. Building on our prior work, we have represented youth gaming practices in Figure 21.1 through the intersection of three circles. The three inner circles represent the domains that provide a foundation for our conceptualization of the ecosystem of game design based on the observed practices at the Computer Clubhouse (Peppler, 2007, 2010). Any overlap of two or more circles creates an area that best describes the domain of gaming fluencies. This conception grew out of our earlier explorations of youth media arts and design practices (Peppler & Kafai, 2007; Peppler, 2010) and is especially relevant to current perceptions of video games as a form of artistic creation (Mitchell & Clarke, 2003).

We argue, along with others, that video games are a form of twenty-first-century art. Often defined with regard to having an explicit goal and a win/lose state (Salen, 2007), video games are fundamentally expressive creations, representations of worlds real or imagined as seen through a game designer's subjective "lens." Our view of gaming fluencies pays homage to the artistic processes that shape game designers' visions and recognizes that hard-and-fast distinctions between the artistic processes that support game production versus other forms of artistic production are counterproductive because the technical, critical, and creative practices that support the creation of both video games and their related forms of expression in new media are inextricably linked. Furthermore, this conceptualization has resonance with youths' more inclusive definitions of what makes a "game" and expands our definition of games from something that requires a win/lose state to a view of gaming artifacts as a set of rules, core mechanics, components, considerations of space, and goals (Torres, 2009) that are

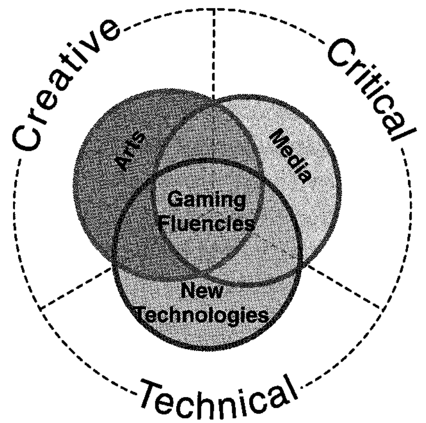

Figure 21.1. Situating *gaming fluencies* as a transdisciplinary field, heavily drawing on our understanding of the arts, media, and new technologies.

deeply rooted in the aesthetics of the medium in which they're produced. Further, as youth engage in game design, they are connecting with the authentic and meaningful practices of experts in professional game design, including graphic designers, programmers, and other professional fields (Peppler, Warschauer, & Diazgranados, 2010).

A key component of this model is the focus on the alignment between the overlapping practices and the authentic practices they reinforce, drawing connections between youth game-design practices and the various professional fields that assign them value. As such, this conceptualization of the field represents a mixture of emic (insider) and etic (outsider) perspectives on the local culture (Erickson, 1979). Although practices that would be recognized by experts in each field are distinct, they also share similarities with the other fields. This is reflected in Figure 21.1 by lines stemming from the outer circle dividing the circle in thirds but not entirely on the boundaries of each field. For example, programmers with design experience and the ability to think critically about interface and relationship to the user help to increase marketability and productivity. Accordingly, creative practices are not entirely the domain of the arts; they can be a part of the practices of those working with new media and technologies.

As stated in our prior work (Peppler & Kafai, 2008), we take a stridently disciplinary approach to understanding literacy and learning in making games by aligning youth game-design practices with professional practices in related fields, namely, those of the arts, media, and new technologies. Youth game-design practices could be described as "authentic practices" (Sawyer, 2006) because they parallel what professional game designers do in all three disciplines. This serves multiple purposes, but aligning youth game practices with current professional practices in closely related fields allows us to identify potential overlaps and envision integrating game production with existing school curricular activities and goals. Although it's somewhat artificial to separate and dissect youth practices and map them onto traditional understandings, much can be learned from this undertaking, such as observing how the entire ecology of game-design practices fits together and not only how youth engage in technical and creative practices but also how those practices can intertwine in interesting ways with other critical practices.

Others have proposed frames for understanding the field by looking at consumption and participation in online spaces (Jenkins et al., 2006), yet these perspectives downplay the role of production in the gaming literacy landscape and instead highlight participating in online social networking spaces. However, this is of limited practical relevance to youth in urban or disenfranchised communities who, although potentially adept at skills pertaining to virtual online networks, are largely unsupported in the post-secondary or professional realm to use those skills to their advantage. By contrast, our framework for understanding youth game-design practices is, to our knowledge, the only known conceptualization rooted in the work currently produced by youth communities while also aligned with professional practices (Maloney et al., 2008; Peppler, 2010; Peppler & Kafai, 2007, 2010). By aligning youth gaming fluencies with professional practices, youth who have specialized in particular practices over time can consider evolving their identities (e.g., in programming) to think about how those practices align with opportunities in computer science, for example.

At the same time, this framework allows for multiple trajectories; others who have developed fluency around making artistic choices by creating unique onscreen characters, for example, then can see how those practices prepare them for pursuing careers in fields such as graphic design. As we align youth practices with authentic participation, we further examine what constitutes participation or learning in each of the individual domains that make up game production (i.e., arts, media, and new technologies). Below we examine how gaming fluencies were developed within a particular after-school community and showcase a range of work created in Scratch, a new tool that is amenable to game design.

For this chapter, we concentrated on the game designs such as sport, adventure, action, and shooting games, as well as puzzles and mazes, produced by youth in the Computer Clubhouse game design studio. We also have included in our analyses what we consider to be *interactive narratives* or *playable fictions* (Barab et al., 2010) that include short animations, choose-your-own adventure stories, and other types of art projects with interactive components. Based on our earlier field work with youth (Peppler, 2007; Peppler, Warschauer & Diazgranados, 2010), youth claimed these projects to be "games," and we felt that they also were the first steps toward narrative-based gaming or interstitials in video games (i.e., short video animations that progress the stories in games).

Scratch Game Design Studio: Participants, Tool, and Context

Participants

Our field work at the Computer Clubhouse in South Los Angeles was driven by a desire to better understand youth media design practices (Peppler & Kafai, 2007). The Computer Clubhouse, which also functioned as a game-design studio, was situated at a storefront location in one of the city's poorest areas and served over a thousand high-poverty African American and Hispanic youth. Youth worked individually and in small groups on projects and ranged from eight to eighteen years of age, but most were between the ages of ten and fourteen. A community of mixed-age and mixed-ability learners consisting of novice and expert youth and an array of local and partnering university mentors supported game-design efforts. It's essential to note that mentors were novices with computer technology and had little to no programming or game-design experience themselves (Kafai et al., 2008). However, many of them were avid game players on console and PC platforms.

Game-Making Tool: Scratch

Our work focuses on Scratch as a tool for game making. It's unique because it uses programming as a means to engage youth in facets of game design. Scratch in particular differs from other visual programming environments (Guzdial, 2004; Kelleher & Pausch, 2006) by using a familiar building-block command structure (Maloney et al., 2004; Resnick, Kafai, & Maeda, 2003),

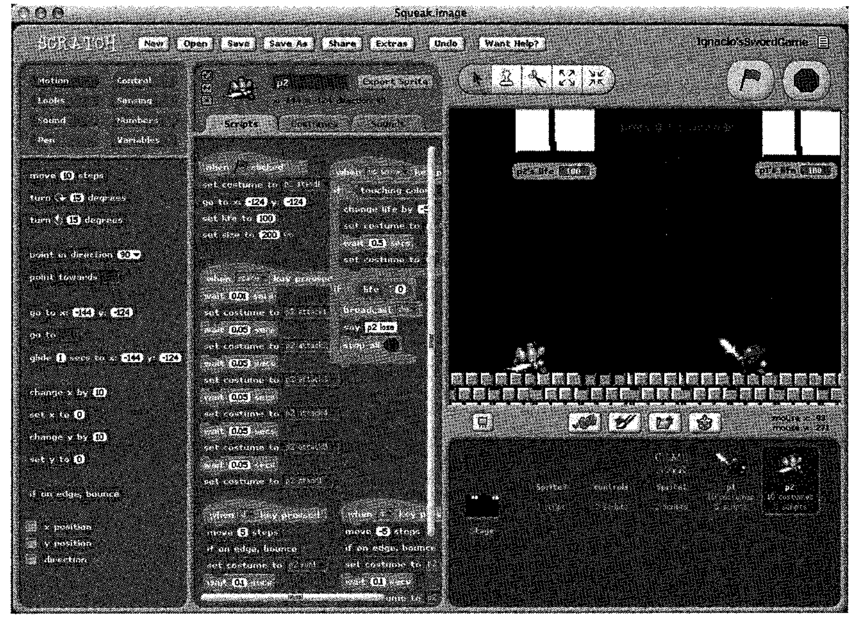

Figure 21.2. Screenshot of the Scratch user interface with the sample game *Ignacio's SwordGame*.

Source: Created by Scratch as a sample game. Scratch image provided under Creative Commons share alike license. Scratch comes from the Lifelong Kindergarten group at MIT.

eliminating thorny debugging processes and the risk of syntax errors that can impede a novice designer from creating games (see Figure 21.2). Programmed objects can be any imported two-dimensional graphic image, hand drawn or chosen from a personal archive. Two-dimensional game design holds several advantages for youth wanting to make their own video games. For example, two-dimensional programming facilitates easy incorporation of third-party images, enabling greater creative expression and allowing for easier entry for novices than three-dimensional programming.

The Scratch vocabulary of roughly ninety commands includes commands for motion, image transformations (i.e., rotation, scaling, and effects such as fish-eye), stop-motion animation (switching between images), recorded-sound playback, musical note and drum sounds, and a programmable pen. From a programming standpoint, Scratch has a number of control structures, including conditionals (*if*, *if-else*), loops (*repeat*, *forever*, *repeat-until*), and event triggers (*when-clicked*, *when-key-pressed*). Communication is done via named broadcasts. For example, one sprite might broadcast, "You won!" causing another sprite to appear on the stage and play a victory song. One broadcast then can trigger multiple scripts. A variant of the broadcast command waits for all triggered scripts to complete before going on, thus providing a simple form of synchronization. In addition, Scratch supports two kinds of variables. *Sprite variables* are visible only to the scripts within that sprite, whereas *global variables* are visible to all objects. Global variables sometimes are used in conjunction with broadcasting as a way to pass data between sprites.

Figure 21.2 is a full screenshot of the Scratch user interface for game making. On the left side of the screen is the palette of *programming command blocks*, allowing youth to control and manipulate sound, images, motion, and various types of input from the players. In the lower right side of the screen there is a library of *sprites*, which can be any imported or hand-drawn character or object in the game. Above the library of sprites is the *stage*, displaying the games that are in the process of being created or edited. The middle panel contains three tabs with information about the selected sprite. In this screenshot, stacks of commands that the creator has stacked together to control a particular sprite are displayed in the center panel. If the other two tabs at the top of this panel were to be clicked, information about the sprite's costumes (see also Figure 21.2) or sounds would be displayed. The game also can be converted to play mode with the touch of a button. In this mode, the game can no longer be edited or changed by the player.

Context

The Computer Clubhouse provided youth with an impressive variety of software, including the programming environment, Scratch, as well as Microsoft Office, Bryce 5, Painter 7, RPG Maker, and video, photography, and sound-editing software. We know from our observations that the design culture was present before the introduction of Scratch: Seventy percent of all activities were dedicated to design projects (Kafai, Peppler, & Chiu, 2007). The clubhouse coordinator introduced Scratch in the fall of 2004. Although Scratch was loaded on several of the computers at that time, fewer than ten members took advantage and created anything using the new software. Beginning in the winter of 2005, a steady stream of undergraduate mentors joined the clubhouse, and the first explosion of Scratch activity was seen starting in early January 2005 (Kafai et al., 2008). Youth were encouraging one another to try out the program, and mentors worked with youth to create the first Scratch projects. Frequently, mentors would engage youth who had never worked in Scratch before by suggesting they import some of the pictures they had stored in their folders on the clubhouse server. At this point in time, the archive of projects represented a predominance of graphics-only projects with many game ideas that lacked any computer programming, which was due in part to the high volume of youth opening the program without any official orientation.

In the winter of 2006, there was an even greater interest in *Scratch*, and some new things began happening within the clubhouse culture. Printouts of projects quickly began to cover the walls, and Scratch slowly became the leading design activity within a few months of its introduction. Scratch was used among the youth as a measure of membership in the local culture: New members who wanted to establish clear membership in the community had to first create at least one Scratch project and store it for others to play on the central server. For the first time, more expert youth were seen mentoring other youth in Scratch. Scratch experts had a high-status position within the local culture, and some youth emerged as general experts that mentors, coordinators, and other youth consulted for help; other youth had specialized in certain genres or tricks within Scratch, and they too were called on by their peers and mentors. In addition, groups of youth had begun working collaboratively to create projects, posturing together as a unit and creating flashy team names such as DGMM, for the Dang Good Money Makers. Youth also began to work independently of mentoring support, reflective of the high volume of projects beginning in June 2006, on complex projects and problems that they encountered in Scratch.

Documentation of Scratch Game Designs Archive

At the particular clubhouse where this study was conducted, all computers were networked to a central server, where youth had a personal folder that served as an image archive and repository for finished and in-progress game designs. This facilitated long-term projects as well as sharing. Youth game designs in Scratch were collected on a weekly basis from the central server and entered into an archive for further analyses ($n = 430$ games). In addition, field notes that describe literacy events and practices were collected by a team of forty graduate and undergraduate mentors that visited the field site on a regular basis over the period of the study (Kafai et al., 2008).

Analyses of Game Designs

In the following sections we describe in more detail how we selected and analyzed game designs from the archive. We chose to focus on a representative sample of fourteen case studies for further analyses. This selection was analyzed for the creative, critical, and technical dimensions of game designs. In a previous study we had already coded the entire Scratch project archive for game genre (Peppler & Kafai, 2010), as well as for media arts conceptual understanding (Peppler, 2007). We used these analytical codes to illuminate a fuller range of gaming fluencies.

A top-down approach to coding (Chi, 1997) was derived from the literature on game studies to code and categorize the genres of game designs in the archive into several subcategories (e.g., sports, adventure, racing, mazes, puzzles, etc.). We then asked an external panel of five design and media artists to reliably score the projects along five dimensions, including (1) originality of concept, (2) criticality, (3) use of medium, (4) technique, and (5) overall success (see Peppler & Kafai, 2008). The external panel scored all projects on a 0 to 5 scale for each of the criteria (0 = low and 5 = high), and the average scores were used in later analyses. Panel members also were asked to comment briefly on the works via an open-ended response.

These coding categories align with the aforementioned framework for gaming fluencies in the following ways: *Originality of idea concept* refers to the visual or conceptual uniqueness of the piece in relationship to previous works and is related to the creative aspects of game design. In the context of game design, this refers to the originality of the game produced. For example, games produced that imitated (sometimes painstakingly so) existing video games scored low on originality, which prized new games or mods of existing games. *Criticality* is the degree to which the piece makes a critical comment on other art works, theories, genres, and/or pop cultural representations. Panel members assessed the extent to which a work actively questioned standing norms and expectations and whether it addressed, consciously or subconsciously, an issue present in the medium or social strata. Examples of projects that would score high in criticality include games that were a social commentary on violence, race, or class found in commercial video games.

Use of medium is the degree of success in choosing a medium and style to convey the overall game design and is one dimension of the technical aspects of gaming fluencies. This could mean whether the player made good use of human-to-computer or human-to-human interaction. For example, a well-designed game in Scratch takes into account the use of the keyboard and other methods of interaction for game play. In other words, a game that makes good use of the arrow keys for directional controls would score higher than a game that uses a random set of four keys. *Technique/skill* refers to a project's level of technical sophistication and successful skill execution, which is the second technical aspect of gaming fluencies. This goes beyond the programming or code to include issues of visual design and user interactivity, etc. For instance, Scratch game designers often use images found on the web in their designs. A game that would score high on this dimension would have artfully repurposed the image, cleanly cut it out, and perhaps created several frames to make a smooth-action animation. By contrast, designers that chose an image from the web and were sloppy in cutting the image out, losing some of the detail in a nonpurposeful manner, would score lower on this dimension. Finally, *overall success* allows for an overall assessment of the aesthetic success of the project, independent of the measures of the preceding categories, that is a dimension of the artistic or creative aspect of gaming fluencies. As games go beyond each of these elements to include whether they are fun and challenging to play, we included this fifth category, which is inclusive of how the other four elements come together.

To illustrate application of the coding scheme, we present three vignettes of Scratch game designs from the Computer Clubhouse. In addition, we further analyze the work of selected game designers who had produced more than one game over the course of the two years to further explore whether these clubhouse members became more knowledgeable in their gaming fluencies over time. The gaming archive consisted of more than 430 projects (about 68 percent of the total Scratch projects produced in a two-year period), of which we were able to identify fourteen longitudinal case studies of game designers for analyses. Two pieces for each of the fourteen cases were chosen (chronologically, their first and last game that was contained in the gaming archive), serving as a pre- and post score. On average, there were about four months between pre and post assessments. To further determine if there were significant gains in the case study's gaming fluencies, paired-sample t tests were used to determine whether the individual cases demonstrated any growth in their gaming fluencies.

The Creative, Critical, and Technical Dimensions of Gaming Fluencies

In previous analyses of the Scratch game archive (for more detail, see Peppler & Kafai, 2010), we found a range of game genres produced by the youth, but by far the largest group included narrative games (50.8 percent), followed by sports games (7.3 percent) and simulation games (2.3 percent). The remaining games (11.1 percent) were categorized as "other" and included mazes, rhythmic games, role-playing games, interactive shooter games, racing games, and platform games. The remainder of projects (more than 30 percent) defied categorization because they were graphics-only or empty files with titles only and thus could not be coded for game genre. These projects were excluded from the gaming archive because they did not adhere to our expanded definition of *game* and were removed during further analyses.

In order to illustrate the technical, critical, and creative dimensions of gaming fluencies, we begin our report with three vignettes that represent a variety of game designs within the archive. We selected these vignettes because they were representative of the large number of games created in Scratch by Computer Clubhouse members. While in many of these the game designs are not fully fleshed out, in some instances even unfinished, they still provide insight into the game designers' intentions for game genre, mechanics, artistic choices, and critical designs. We have reported previously on a series of more full-fledged game designs implemented by one clubhouse member (see Peppler & Kafai, 2007). We then move on to a general review of game-making activities before expanding on the creative, critical, and technical dimensions of gaming fluencies in a select group of game designers that produced more than one game over the two-year period.

Vignettes of Gaming Fluencies: Three Scratch Designs

The first example comes from a ten-year-old Latino male named Carlos who designed the baseball-themed game depicted in Figure 21.3, which was created in coordination with an older male mentor at the club. At the outset of the game, there is a player standing at home plate, ready to bat and surrounded by a team of opponents in the field. Like a typical baseball game, the object of the game is to hit the ball and round the bases to score when crossing home plate. While this game was not fully finished (e.g., no scoring system was included, and the fielders do not respond to the ball being hit in their direction), there are several features worth noting. At the start of the game, the baseball starts at the pitching mound and is pitched when the player presses down an arrow key. Once the ball is "thrown," the hitter can bat at the ball using the "Enter" key. If the hitter makes contact with the ball, the baseball bat then flies at the umpire standing on the sidelines, and the player rounds the bases to make a home run, using a combination of number keys and arrow keys to direct the runner's movement. This game was categorized as a sports game because of the baseball theme.

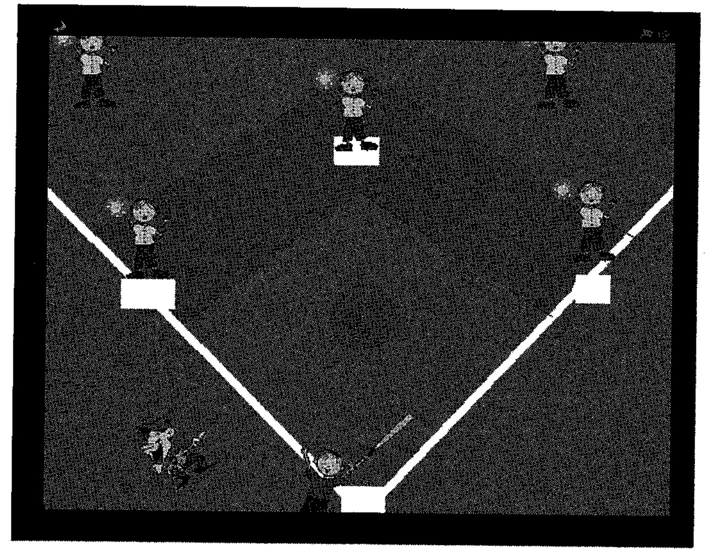

Figure 21.3. Screenshot from the game entitled *Baseball* by Carlos in play mode.

Source: Created by Carlos. Scratch image provided under Creative Commons share alike license. Scratch comes from the Lifelong Kindergarten group at MIT.

When a panel of external raters scored the project along five dimensions on a 0 to 5 scale, the overall success of the piece was rated as emergent (a 2 in the scoring system) because of the quality and thought of the visual regularity of the image and the narrative that was suggested by the piece. Additionally, the project had an undeveloped sense of criticality and seemed to be imitating a scene from a popular sports game and not commenting on other art works, theories, genres, and/or pop cultural representations, which is why it scored a 1 for criticality. By contrast, the originality of idea, the use of medium, and technique/skill (i.e., the technical aspects), scored 3's across the board because the technical difficulty of the piece was high, and the design was slightly better than most projects found in the archive in terms of its originality. In terms of gaming fluencies, this project was strongest in the technical aspects of design, followed by the creative aspects, and then finally scored lowest in the critical aspects of design, which is a pattern that was similar to most of the projects in the archive.

A second example, *Andre's Game*, was created by a nine-year-old African-American male named Andre with limited help from a Computer Clubhouse mentor (see Figure 21.4). This game is based on the fairly well-known game called *Pong*, which was first made popular in the mid-1970s. *Andre's Game* was one of the first *Pong* games to be made in Scratch

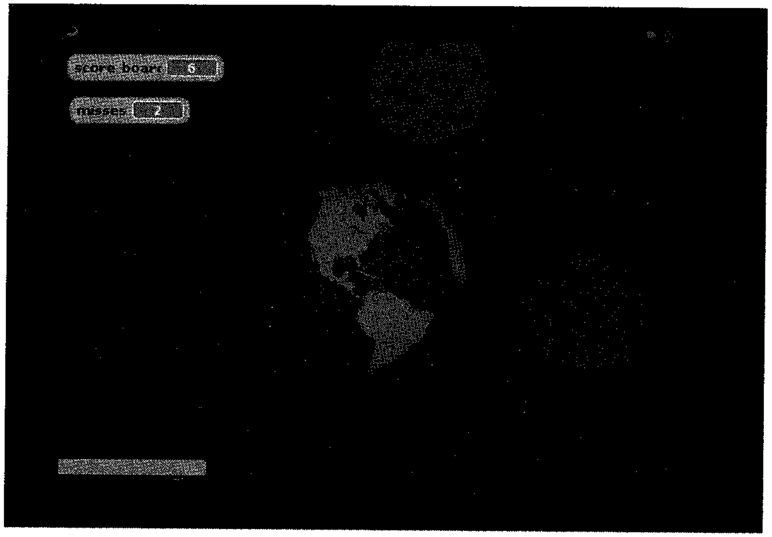

Figure 21.4. Screenshot from the game entitled *Andre's Game* in play mode.

Source: Created by Andre. Scratch image provided under Creative Commons share alike license. Scratch comes from the Lifelong Kindergarten group at MIT.

but was later adopted by the Scratch community, which circulated a similar version of the game (based on the original) among the sample projects that were downloaded with every new version of Scratch. This game was classified as a sports game because it is loosely based on table tennis in the original arcade version of *Pong*. To underscore the relationship to sports, Andre chose sports themes for the other backgrounds of the games that are not depicted in the figure, including a tennis court and a basketball court.

Similar to *Pong*, *Andre's Game* includes a ball that randomly falls from the top of the screen toward the bottom (depicted here as the solid spheres). The player is able to move the paddle at the bottom of the screen using the right and left arrow keys. If the ball hits the paddle at the bottom of the screen, then it disappears, and a new ball falls from the top of the screen from a random position and a point is scored on the board. This is a slight variation on the original owing to the difficulty of programming a bouncing ball. As the number of points increase in the game, the background changes to a new level (of three possible levels), and the size of the paddle decreases, which makes it harder to hit the ball. As the levels increases, the paddle also begins to fade into the background, making it harder to see for the player. If the ball misses the paddle, the number of misses increases

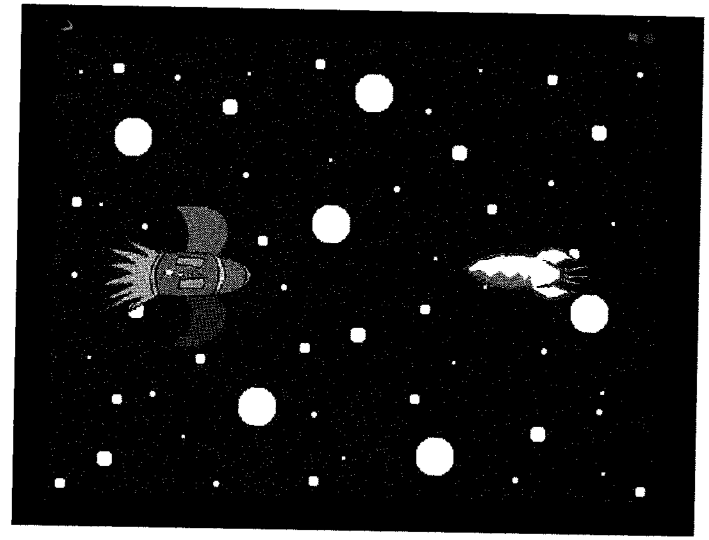

Figure 21.5. Screenshot from the game *Stop* in play mode.

Source: Created by Gerardo. Scratch image provided under Creative Commons share alike license. Scratch comes from the Lifelong Kindergarten group at MIT.

by one. The player has a bonus opportunity to hit a second ball that will decrease the number of misses by one to give the player extra time when the player accrues exactly ten points. Once the player has three misses, a voice announces, "Oops! Game over!" and the game comes to an end.

This game was rated highest in terms of its technique and scored a 4 – the programming, for example, was highly sophisticated and made use of variables in the scoring system as well as conditional statements to create the various levels and interactivity between the balls and the paddles. The project also was rated highly for its overall success and its use of medium, scoring a 3 for both areas. And it scored lowest in terms of criticality and originality, scoring a 2 in both areas because of heavy similarity to the game *Pong* without critically commenting on this history of games. The game did vary slightly from the original, which is why it earned a 2 overall on the scale. Similar to the first example, this game scored highest in its technical aspects of game design, followed by its creative aspects, and it scored lowest in its critical aspects of game design.

The third and last vignette depicts a scene from the unfinished game *Stop*, made by a twelve-year-old Latino male named Gerardo, that is set in outer space (see Figure 21.5). The game is fairly simple because the player controls both the space shuttle and the rocket with keyboard strokes. The

Table 21.1. *Development of fourteen game designers at two different time points*

Scale	14 Case studies		
	N	Mean score	Significance
Originality of idea			*
Pre	14	1.86 (±0.89)	
Post	14	2.71 (±0.78)	
Criticality			
Pre	14	1.11 (±1.16)	
Post	14	1.43 (±1.36)	
Use of medium/ approach			*
Pre	14	2.07 (±1.00)	
Post	14	3.11 (±0.94)	
Technique/skill			*
Pre	14	2.14 (±1.17)	
Post	14	3.18 (±1.09)	
Overall success			*
Pre	14	2.04 (±0.77)	
Post	14	2.93 (±0.92)	

Note: Paired-samples *t* tests were used.
* Significance $p < 0.05$

object of the game is to keep the spacecrafts from colliding, preventing the outer space disaster. As the player pushes the buttons, both spacecrafts move forward on a collision trajectory, and one changes color. When the two spacecrafts touch one another, an explosion should occur. While the visual image for the explosion was pasted into the game, the vehicles were never programmed to react to one another, making the game incomplete. This game was categorized as "other" in the genre analyses because it does not clearly adhere to one particular genre type and is similar in several respects to both a racing game and action games. Because it was unfinished, this project scored a 1 across the board in all aspects of the technical, creative, and critical aspects of gaming fluencies because it did little to advance a critical agenda, to investigate technique, to use the medium successfully, or to have what the panel would call "originality" in the design.

These vignettes illustrate the diversity of game designs found in the Computer Clubhouse community and how technical, creative, and critical criteria apply to them. In order to understand how the quality of designs varied over time, in the next section we examine longitudinal trends across

five dimensions – originality of concept, criticality, use of medium, technique, and overall success – that are important to game design and media art more broadly.

Development of Gaming Fluencies in Productive Scratch Game Designers

Within the Scratch game archive, there were fourteen individuals who had authored two or more projects in the random sample. Two designs for each of the fourteen designers were chosen (chronologically, the first and last piece that was contained in the random sample), serving as a pre and post score. On average, there were about four months between pre and post scores (see Table 21.1).

We find that this productive group of game designers gained on all five measures. It's important to note, however, that not all designers partake in *all* the aforementioned practices, and even central participants engage in these practices unevenly. Pre and post scores differed significantly ($p < .05$) on four of the five measures except criticality. Again, this indicates that critical dimensions of game designs, while not being absent in the archive, were more difficult to develop in the absence of direct instruction.

Over the course of the two years of the study, the Computer Clubhouse game designers significantly increased in their ability to design and create original games. While initially youth began to create games that imitated ones they had experience playing (e.g., versions of *Metal Slug*, *Pong*, *Mortal Kombat*, and basketball), over time, they began to venture out to create more unique games. Second, the youth began to use the Scratch programming environment more effectively over time, employing greater human-to-human and human-to-computer interactions. Additionally, games made greater use of the multimedia features in Scratch (including sound and various forms of animation), as well as use of gaming components (e.g., score boards and timers). Third, technique and skill were seen to increase significantly in the case studies as well as the larger Scratch community. This was due largely to the increased facility that youth had with the Scratch image editor to create clean avatars and smooth animation sequences. Additionally, the case studies became more adept at their use of programming, making better use of a wider array of commands and engaging the big ideas of computer programming over time for effective game play. The gains in these areas also contributed to significant gains in the overall success of the games. This was due largely to better game play over time. In short, the games were becoming more fun to play and more challenging owing to successful use of gaming levels, a balance was struck between games being too hard or too easy, and the games' goals and directions became clearer.

The only category that didn't register significant gains within the case-study work (or the larger community) was that of criticality. While there are certainly wonderful examples of critical games that emerged in the community over time (Peppler & Kafai, 2007), the community as a whole didn't seem to be cultivating criticality over time. This could be due to several reasons. It's difficult to recognize criticality in youth work because it takes some background knowledge both about the individual and about the context of the game that the youth is in the process of designing. In viewing and evaluating a large number of designs and spending only a small amount of time with each game, this often can lead researchers and external evaluators to overlook key features that would indicate project criticality. Second, criticality is something that develops over time in the iterative process of creation and reflection. Prior field work indicates that as youth engage in the process of game design over long periods of time, the work becomes increasingly more critical as the designer has more opportunity to refine the message (see Peppler & Kafai, 2007). Since many of the games in the archive were left unfinished, it's possible that these games never reached the stage where a clear message was being sent. Lastly, it's possible that criticality is something that is better taught within formal educational communities and difficult to cultivate in informal learning communities such as the Computer Clubhouse.

Accumulatively, our analysis of these technical, creative, and critical practices of game production paint a more detailed picture of the types of learning that occurred in our study. These findings mirror results of a prior longitudinal analysis that the clubhouse community as a whole was becoming more sophisticated in their game-design practices over time but particularly in the creative and technical practices of game design (see Maloney et al., 2008). Such outcomes are nontrivial for an after-school community with little or no direct instruction or guidance from professional game designers or artists to observe this type of marked improvement over time.

Discussion

Youth within the Computer Clubhouse space engaged in various aspects of game design. In this process, game production was enacted as a set of interconnected practices that are a mix of established literacies ranging from traditional to visual to media literacies and technology fluencies. While the findings from this particular clubhouse cannot be generalized readily to the entire population of youth game designers, the framework proposed here can be a useful way of looking at any game-design activity across settings. In the following sections we discuss the significant but differential growth in how clubhouse youth gained game-design expertise in gaming fluencies and situate these findings in relation to learning in informal contexts and equity issues.

Our results indicate that individuals within the community were gaining game-design expertise over time – something that could be masked in informal learning communities, where group membership is constantly shifting. These types of individual gains also contributed to the larger community trends aforementioned. The one key difference between examining individuals within the larger community, as opposed to the general community trends, was that technique and skill were something that individuals gained on more so than the community. This suggests that game-design technique and skill are more apt to individual mastery over time as opposed to originality of ideas, use of medium/approach, and overall success, which may be more greatly influenced by the larger community. For example, the community may gain expertise over time by pushing its members to search out more novel solutions and may have ways to showcase existing solutions, contributing to the rise in originality of idea. By contrast, the community may not be as efficacious at teaching particular techniques or new media skills to new members.

Overall, youth seemed to engage less in critical game-design practices, and this was true not only in the community at large but also in our smaller sample of productive game designers. We have argued that critical practices seemed more difficult to cultivate in informal learning communities such as the Computer Clubhouse over time – or perhaps they just develop on a slower time scale than what we were able to examine in this study. It is also possible that many of the adult mentors and coordinators were not as well versed in critical examination and thus may have contributed to steering conversations into technical and creative aspects of game design. It is perhaps much easier to compliment a member on a new design feature or on finding a technical solution than discussing critical aspects. It is also possible that many game designs were not far along or well developed to reach a critical mass that would allow for critical examination.

Unlike in other studies (Pelletier, 2008; Salen, 2007), we did not tell clubhouse members to design games in Scratch or how to design them. In fact, the choice of Scratch designs, whether a game, story, or animation, was left entirely to clubhouse members' own devices. There also was no curriculum or sequence of activities that mapped out designs or structured conversations. In contrast, many designs were in production in the clubhouse – games were just one of them. As such, our study presents much more a case of game design "in the wild," on what youth engage in and practice when the choice is up to them. This allows for a fuller range of gaming fluencies to be seen of value, potentially opening the doors for youth to connect in authentic ways to an array of disciplines. Moreover, the current work has demonstrated that youth – even in informal learning settings – are learning to engage more deeply in this range of gaming fluencies over time. There is, however, one notable exception. Developing criticality seemed to be particularly difficult to cultivate in this after-school setting. While this could be so for a host of reasons, it is certainly worthy of further study. What we captured then in our analyses of technical, critical, and creative aspects is an illustration of youths' informal practices. We found evidence of sophistication, but we also found room for improvement.

Finally, gaming fluencies also present the added benefit of addressing equity issues of participation in the new media literacy landscape. Our study in particular focuses on urban youth as game designers, expanding traditional misconceptions of urban youth as consumers of new media. Thinking and producing like a game designer is a valuable starting point for our conceptualization of equity in a digital age. Historically, women and minorities have been woefully underrepresented in game production. This has been problematic for many reasons, including the lack of representation of women and minority avatars in games, the reduction of these groups to exaggerated stereotypes, and the overabundance of games marketed toward white males (for a review, see Kafai, 2009). By providing opportunities for underrepresented youth to participate in making games similar to those showcased in this study, we allow them to become vehicles of change as both critical consumers and designers in an industry that has an increasing importance for schools and society at large.

Conclusion

In this chapter we addressed how gaming fluencies represent a complementary pathway for learning and participation in today's media culture. We argue that by involving youth in game design in and out of school, we can help to extend their understanding beyond learning about games and connect them with becoming fluent in a wide range of creative, critical, and technical fluencies and, perhaps more important, can establish ties between

youth and their communities and out-of-school identities. The data suggest that if we want to improve players' critical engagement with media, we might need to include explicit scaffolds and structures to "push" them to become more critical. Both schools and well-designed multiuser virtual environments seem poised to help youth articulate these understandings. The findings presented here provide a perspective on how urban youths' informal game-making culture and practices can be used to support alternative pathways toward gaming fluencies and, more broadly, the new literacies important to twenty-first-century learning.

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