Uncovering Literacies, Disrupting Stereotypes: Examining the (Dis)Abilities of a Child Learning to Computer Program and Read

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Abstract

The experiences of children learning through multimodal production and interactive computer programming have been well documented and include accounts of youth from diverse ethnic, cultural, linguistic, and socioeconomic backgrounds. However, little attention has been paid to the role of creative technology use by children with cognitive disabilities, focusing instead on either assistive devices or computer-assisted tutorials. This study examines how "Brandy," a nine-year-old girl with cognitive disabilities and little reading or writing ability, made use of new technologies for creative and artistic purposes as she produced new media in an after school community technology center. Over a two-and-a-half-year period using the Scratch programming language and software, Brandy transitioned from being a marginalized member of the community to becoming a skilled and esteemed multimedia artist and mentor. As she engaged in creative media production, Brandy's metalinguistic awareness gradually developed, helping her to better understand the structure and function of language and become a more confident and skilled reader and writer. Brandy's development of a new identity as a multiliterate artist occurred despite the community's well-intentioned efforts to guard and reinforce her "special" status. We discuss the implications of this study for understanding the relationship of media production to early literacy development and for considering how this relationship may be put to advantage in special education programs.

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Introduction

The experiences of children learning through multimodal production and interactive computer programming have been well documented and include accounts of youth from diverse ethnic, cultural, linguistic, and socioeconomic backgrounds (see, e.g., Parker 2008; Watkins 2009; Mahiri 2011). However, little attention has been paid to the role of creative technology use by children with cognitive disabilities, who are often viewed as lacking the requisite skills to participate in the new digital media landscape. Instead, studies of such youths' technology use typically focus on either the role of assistive devices or the effectiveness of computer-assisted instruction (for a review, see Woodward and Rieth 1997).

This study considers how youth with cognitive disabilities make use of new technologies for communicative and artistic purposes. In order to illustrate the possibilities of such a stance, we present the development of literacy practices of one child, whom we call "Brandy," within the context of the Computer Clubhouse, a community design studio and technology center in South Los Angeles and a part of the Intel Computer Clubhouse Network (http://www.computerclubhouse.org), and we contrast Brandy's abilities with the common misperceptions of such youth as being preliterate or illiterate. Our study examines Brandy's initial entry points and mediators to participation in creative digital production, documents her evolving literacy practices over time, and illuminates the interplay between new literacies and traditional literacy development. In our analyses, we draw upon sociocultural views of literacy development (e.g., Cole 1996; Gee 1996), anthropological work on the cultural construction of disabilities (e.g., McDermott and Varenne 1995), and constructionist theories of learning that are commonly used to look at learning through design and creative production (Kafai 2006; Peppler and Kafai 2007). By examining key literacy events, we are able to track Brandy's development over the course of two and a half years. For Brandy, multimodal creative production led to some important connections, a renewed interest in traditional literacy development, and marked shifts in her social participation over time. In our discussion, we consider the implications of the study for early literacy development, for special education, and for understanding identity development among students with special needs.

Sociocultural Views of Early Literacy Development

This study is guided by a sociocultural view of early literacy and development, one that conceptualizes literacy as a socially mediated process inextricably linked to the forms of mediation available (Vygotsky 1978), the developmental context (Rafzar and Gutiérrez 2003), and the nature of participation in various cultural practices (Rogoff 2003). The role of mediation and the available forms of assistance in early literacy development are particularly important in this perspective. Vygotsky (1978) first wrote about the role of mediation in his reflections on learning and human development, defining *mediation* as one's participation in activities through the use of tools as a means to change one's self or surroundings and potentially even the tools themselves. In Vygotsky's view, the paramount tool mediating human development is the use of signs, including the semiotics of oral language, writing systems, and number systems. Barton (1994) and others explain that books, films, computer software programs, and other texts act as tools that mediate our experiences. Considering this range of potential mediational means, Kress's (2003) work on the social semiotic theory of multimodal representation becomes an especially apt lens with which to examine youths' explorations of communication in environments that include many culturally shaped resources for making meaning. Collectively, these tools then mediate an individual's participation and engagement in local social practices.

Vygotsky (1962) also describes a process of internalization of external signs that, over time, become internal thought (or inner speech). The use of inner speech as a mediator of thought demonstrates the importance of cultural tools such as language or new technologies in cognition. A second type of inner speech, called *metalinguistic awareness*, defined as the ability to think about language and its purposes, is linked to conventional forms of literacy (Olson 1994). In early literacy development, learners can benefit from an array of mediational means and forms of assistance as they learn to participate in and internalize semiotic systems. Moreover, as they come to internalize these systems and develop a metalinguistic awareness, they come to have a better understanding of the rules and function of the system.

Accordingly, sociocultural views of early literacy development have expanded our definition of

literacy beyond the acquisition of discrete skills. We must now think about reading and writing in its sociohistorical and political context. Commonly, researchers in what has come to be known as the *new literacies studies* (Gee 1996) posit that literacy is best understood as a set of socially and culturally situated practices (Barton 1991; Gee 1996; Moje 2000; Bruce 2002; Street 2003), arguing that *literacy events* and *literacy practices* are useful concepts for studying literacy in context. A literacy event, as first characterized by Heath (1983, p. 93), is "any occasion in which a piece of writing is integral to the nature of the participants' interactions and their interpretative processes." Literacy events are social but, more important, culturally situated, an observation that led to Street's (1988) conception of a literacy practice. Literacy practices are situated in power relations and tensions among and within communities so that certain ideologies privilege some literacies, discourses, and forms over others. Thus, all literacy practices are necessarily situated in social relations and a broader historical context.

Moreover, the new literacy studies have demonstrated that as youth are socialized into particular literacy practices, they are also being socialized into discourses that position them ideologically within the larger social landscape (New London Group 1996). As youth become socialized into these various discourses, they can become inbound and/or outbound participants (among other trajectories) of particular communities, being apprenticed to new social practices. As Rafzar and Gutiérrez (2003) point out, when we consider the contextual and cultural influences on literacy development, we are able to understand and analyze the microprocesses (e.g., shifts in roles and participation over time), as well as the larger sociological practices and processes that allow us to understand that literacy events have a social history, linking individuals to larger sociohistorical practices and processes. In addition, the shifts in roles and participation over time are one indicator of learning and development (Rogoff 2003).

Sociocultural views of early literacy force us to shift from thinking about the acquisition of literacy skills to focusing instead on the cultural forms of assistance and mediation available to the learner. In these views, culture and context take on primary roles and present an alternative conceptualization of early or emergent literacy. Early or emergent literacy involves the reading and writing concepts, behaviors, and dispositions that precede and develop into conventional reading and writing (Hall, Larson, and Marsh 2003). In particular, Kress (1997) and others have shown that young children take whatever is at hand to make meaning, including toys, crayons, and paper. In today's digital culture, what is at hand is a wealth of digital material that youth shape and fashion in their creative activities, including online Web communities such as Webkinz (http://www.webkinz.com/); software aimed at creative production, such as iMovie or paint applications; and video games such as *The Sims* or *LittleBigPlanet*. As we emphasize making meaning in early literacy development, our focus thus shifts to digital media design and creative production. This entails a shift from the new literacy studies (which attempts to study literacy in a new way) to *new literacies studies*, which attempts to study "new types of literacy beyond print literacy, especially digital literacies and literacy practices embedded in popular culture" (Gee 2010, p. 31). A parallel shift has occurred in media scholarship—from the earlier *media studies*, which examines how people get meaning from media, to the *new media literacy studies*, which examines the value people get from producing media (Gee 2010). Because of the work of both the new literacies studies and the new media literacy studies, recognition of the value of creative production in learning is growing. Both help us understand that, as youth design and create their own webpages, video games, and other digital media, they develop a wide range of literacies, including technology fluency, media literacy, visual literacy, and aural literacy (Peppler and Kafai 2007, 2008). Both lenses are of value in helping us understand learners like Brandy.

Culture, Power, and the Social Construction of (Dis)Abilities

A particularly salient example of the ways in which larger sociohistorical practices and processes work to socialize and position individuals is seen in the role of (dis)abilities in contemporary American culture. Our work is aligned with those who seek to move us away from an emphasis on disabled persons and instead focus on "the power of a culture to disable" (McDermott and Varenne 1995, p. 327). McDermott and Varenne (1995) argue that disabilities are best approached as a cultural fabrication to maintain power and control, particularly in the American

educational system, and they highlight how learning disabilities and illiteracy are particularly tied to school failure and maintenance of the status quo. They point out that the social construction of a disability can blind us to the capabilities of particular individuals, including youth who are struggling to read and write. Wortham (2006) further demonstrates how social identification and academic learning can become deeply interdependent for such youth, whose exclusively remedial instruction makes the development of robust identities in other areas difficult. We believe this is particularly true in relation to technology use, which potentially could be an area of comparative strength for learners with disabilities, because digital media involve a wide range of modalities and skills and thus should in theory be widely accessible.

Research that integrates new creative technologies for literacy development among students with cognitive, learning, or social-emotional disabilities looks promising, both for fostering new literacies and for supporting traditional literacies of reading and writing. Recent research suggests that working with multimedia increases the self-efficacy of students with disabilities, indicating that creative activities provide additional avenues to develop and demonstrate their expertise (see, e.g., Warschauer 2006). A handful of studies in the arts further illustrate this point, documenting the impact of creative activities such as dance, drawing, and drama on early literacy development and positive identification of students with disabilities. For example, Mentzer and Boswell's (1995) study demonstrates the effects of a creative movement program on the writing and drawing abilities of two boys with learning disabilities. In addition, Wilhelm (1995) found visual arts to be useful in helping students with learning disabilities begin to enjoy reading. These studies suggest that the arts provide a pathway toward metalinguistic awareness, allowing youth to better visualize what they understand about language.

To a large extent, a deficit model still exists when we talk about youth with special needs. Consequently, youth with cognitive or learning disabilities are usually not portrayed as or invited to be creators in the larger media culture. Descriptions of youth with cognitive disabilities being producers of culture are largely absent in educational research. In contrast, our study of Brandy examines her creative digital projects and the process she went through to produce them. We focus on the abilities of a child considered to be disabled.

Informal Learning, Creative Production, and Literacy Development

Scholars in the new literacy/literacies studies have sought to move beyond the school environment to document how the social organization of out-of-school settings can promote literacy and language development (Nicolopolou and Cole 1993; Gutiérrez, Baquedano-López, and Asato 2001; Hull and Schultz 2001). After school spaces offer opportunities to engage in an array of literacy practices not usually found in schools, as well as a stimulating setting for the development of alternative identities.

One promising model of after school learning can be found in the Computer Clubhouse Network (Kafai, Peppler, and Chapman 2009). Guided by a constructionist theory of learning (Papert 1980; Kafai 2006), the Computer Clubhouse engages youth in creative production through the use of new design technologies in a socially mediated setting. Constructionism suggests that we place learners in the role of designers (Papert 1980, 1993). The Computer Clubhouse provides learners with opportunities to create artifacts that are of relevance to a larger community. With equal importance at the Clubhouse placed on the individual learner and on the role of social participation, the individual, the artifact, and collaborative input of the community shape learning, participation, and sharing. Sociocultural constructionism further argues that at sites such as the Computer Clubhouse the individual and the community can develop reciprocally through "shared constructive activity that is resonant with both the social setting that encompasses a community of learners, as well as the cultural identity of the learners themselves" (Pinkett 2000, p. 4). In this process, the learner's identity evolves concomitantly with the production of shared artifacts that are taken up by the larger community. Tools that promote the developmental relationship between the individual and the community should thus (a) enable youth to express their cultural heritage, (b) have broad communicative value, and (c) allow for information and resource exchange (Pinkett 2000). Design takes on a particularly important role in forging the relationship between the individual and community because in principle it embodies both creative and reflective practice (Schön 1983; Rose 2004). For these reasons, practices that involve creative media design and production are highly valued at the Computer Clubhouse, with youth

engaged in a wide array of design-based learning activities that help cultivate technology fluency, media literacy, and artistic expression (Peppler and Kafai 2007, 2008; Maloney et al. 2008; Peppler 2010).

Methodology

This study was guided by sociocultural and social semiotic (Kress 2010) views of early literacy development and sociocultural constructionist theories of learning to investigate the following three areas of inquiry:

1. *Learning to be Literate.* To what extent do youth with cognitive or learning disabilities and limited literacy identify with the literacy practices of an after school community focused on creative production with new technologies? Do these youth identify with some literacy practices more than with others?
2. *Mediating Participation.* What serves as an initial entry point of involvement in creative production and/or emergent literacy for individuals with cognitive or learning disabilities? What mediates and sustains involvement over time?
3. *Making Links between Traditional and New Literacies.* What opportunities exist in a technology-rich, after school community for youth to engage in both print literacy and new literacies? And what constitutes *ability* in these contexts? Further, do youth leverage new literacies for traditional print literacy development? If so, how?

We used these guiding questions to investigate a subset of the data that was collected as part of a large, two-and-a-half-year ethnographic field study (Peppler 2007). The larger study aimed to assist the development of the visual computer programming language Scratch, as well as to document and analyze how this tool was taken up in one particular community—a Computer Clubhouse in South Los Angeles (Kafai, Peppler, and Chapman 2009). Moreover, we chose to follow a single student throughout the period of the study to further illuminate some of the microdynamics involved in the intersection of literacy development and (dis)ability.

Site

The site for this research was a Computer Clubhouse located in South Los Angeles. This Computer Clubhouse is part of a larger network of more than 100 community technology centers worldwide that services high-need youth in low-income communities in the after school hours. At the time of the study this Computer Clubhouse was situated at a storefront location in one of Los Angeles's poorest areas and served over 1,000 high-poverty African American and Hispanic youth. The Computer Clubhouse offered youth spaces to design creative projects with professional equipment (including 2D and 3D image editors, animation software, video editing software, music recording software, game design software, and other computer programming software) as well as the opportunity to participate in an online social network, called the Computer Clubhouse Village (colloquially known as the Village; http://www.clubhousevillage.org/), with thousands of youth all over the world.

Scratch as a Tool for Literacy Development

The most commonly used software at the Clubhouse was the media-rich programming environment Scratch (Maloney et al. 2004; Resnick et al. 2009). Scratch is a visual programming tool that uses text-based blocks that snap together to control on-screen objects called "sprites" (see fig. 1 for a screenshot of the user interface, highlighting the easy-to-use building-block structure). Programming objects can be any imported graphic image, an item that has been created or drawn by the user, or something chosen from a personal archive. Designers can create or incorporate existing sound files, images, and other input/output devices into new design projects, making them multimodal and often layered with meanings from popular culture. Youth engage in computer programming as a way of creating games, art, and digital stories. Scratch is intended to allow youth a high degree of creative freedom. With it they can create their own software rather than using something that is off the shelf.

Traditional print literacy plays a large role in one's ability to create with Scratch. Like those in any computer programming language, the commands in Scratch require the ability to read and, to some degree, write. To create a string of commands, one needs to be able to combine blocks of code in semantically meaningful ways. This process is made easier by the building-block interface in Scratch that helps to illuminate the relationships between the commands by making some (but not all) of the blocks snap together in what can be seen as "grammatical" combinations.

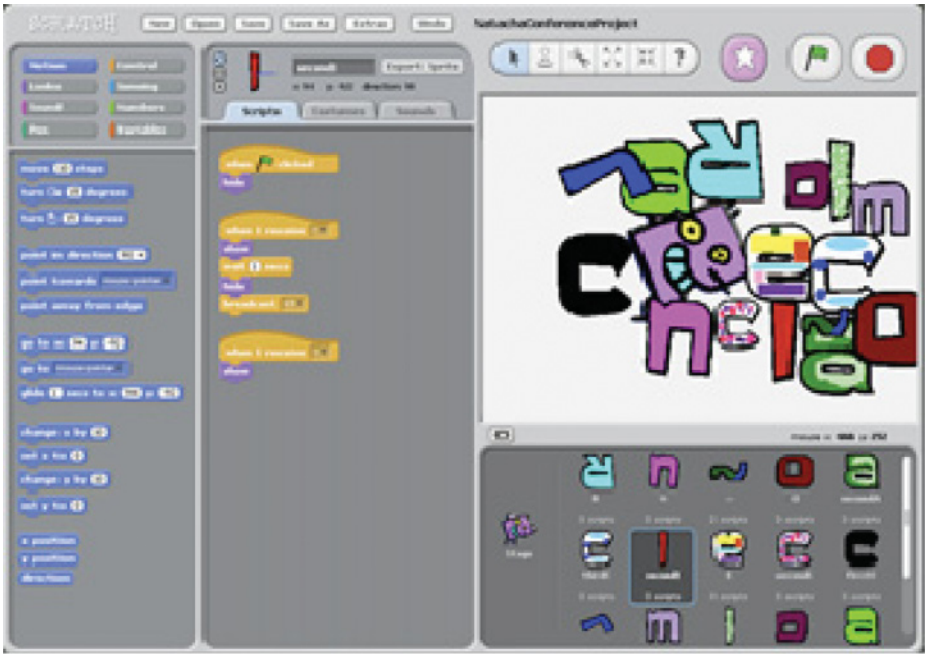

Fig. 1 Screenshot of the Scratch user interface. The leftmost portion of the screen lists available commands, the middle panel lists commands chosen to control the objects listed in the bottom-right panel, and the top-right panel is the design screen.

These building blocks scaffold the novice programmer by facilitating easy debugging and enable learning through tinkering.

Scratch allows for the mixing of a wide variety of media, including sound, music, images, and animated gestures, which opens the door for learning about multimodal meaning-making. In a similar vein to what Kress (1997) describes of youths' meaning-making with realia, the youth at the Computer Clubhouse used whatever was at hand in their Scratch projects. In doing so, they incorporated a wealth of material from their everyday lives (e.g., their mothers' drawings and pictures of low-rider cars that they had downloaded) as well as from their interests in popular culture. Learners regularly brought in images and theme songs from their favorite pop and rap stars, television shows, movies, video games, and toys and were able to layer meanings by remixing them in novel ways and adding their own audio files and animations. In this way, they not only developed technological fluency but gained an array of new literacies, including aural, visual, and multimodal forms of literacy, as they created their products.

After Scratch was introduced at the South Los Angeles Clubhouse, a programming culture took root over time within the community, and local practices emerged around the use of the tool (Kafai, Peppler, and Chiu 2007; Peppler and Kafai 2007, 2008). Scratch became a central marker of participation within the community. As it gained in popularity, it also increasingly served to define what was considered central participation in the Clubhouse and who were considered central participants. While after school venues offer marginalized youth a separate space to learn, succeed, and expand their identity, marginalized youth often find that this new environment still has in place many of the norms, values, and biases of their school environment, creating a barrier to development. This is particularly true for individuals viewed as having special needs within a community.

At first glance, the Computer Clubhouse may seem like the kind of place that would make the participation of people with cognitive disabilities difficult. One might assume that both a sophisticated understanding of technology and proficient literacy skills would be needed to fully participate. The current study takes a close look at a child within the Clubhouse community who was viewed at the outset as lacking the necessary skills and literacies to participate. The study examines which practices she identified with over time and the mediational means that supported her participation.

Participants and Case Study Selection

The particular field site for this study serviced more than 1,000 low-income, predominantly African American and Latino youth. Participants ranged in age from 8 to 18 years but were primarily in the 10–14 year age range. The study was ethnographic in nature. The larger study followed a core group of 30 young people to learn more about the local culture and about youths' media arts practices from their own perspective. As part of the larger study, we conducted interviews, captured field notes, and collected copies of production portfolios. Ten of the youth were chosen as case studies for further analyses because they represented a range of participation at the Clubhouse, including central and peripheral participants in a host of activities. At the start of the study, we purposefully chose case studies from among the many capable high-ability youth in the Clubhouse community so as to offer discourses counter to the predominant views of minority, low-income youth in South Los Angeles (see discussion in Peppler and Kafai 2007). Over time, we realized that this silenced other important voices in the community, and thus we widened our lens to include emergent readers and writers as well as youth who were labeled as "disabled" and enrolled in special education courses at school. The case study discussed in this article represents one student from the latter group. She was selected for the study and for analysis here because she was one of the younger members of the community, she lacked traditional literacy skills, she appeared to have a cognitive disability, and she was not readily accepted as a core member of the community but nevertheless fought to take part in design practices. Her case illustrates how barriers to change were put forth by the community, how someone came to computer programming before she could read and write proficiently, and how a marginalized individual came to take on a new identity through her social participation.

Sources of Data

As part of the larger ethnographic study, we collected data from a variety of sources over a two-and-a-half-year period, including field notes from graduate and undergraduate mentors, videotaped observations, an extensive project archive, external evaluations of the archive, interviews with youth, and interviews with professional media artists. The current study uses a case study approach to literacy research (Dyson and Genishi 2003) to examine a subset of the data pertaining to one particular case, an individual we call "Brandy."

Observations

Participant Observations

Written field notes from more than 40 undergraduate and graduate mentors were collected on a weekly basis over a two-year period. A greater number of observations were made during the winter and spring months, when more Clubhouse members were present at the site. The graduates and undergraduates documented a broad range of Clubhouse practices and encouraged any activity Clubhouse members chose, including socializing, gaming, Web surfing, homework, and a range of design activities. Field notes from all participant observations were entered into a central database, which was available for further examination by members of the research team but was not explicitly created or theorized for the purposes of this study.

Undergraduates volunteered as mentors on a weekly basis for an average of 7–8 weeks as part of a service-learning course (for more details, see Kafai et al. 2008). A total of 284 written field notes were collected over the course of the study, 37 of which contained information pertaining to Brandy. Both graduate and undergraduate mentors participated in in-class workshops, engaged in graduate-level theoretical readings and discussions, and received continuous training, support, and feedback in order to heighten the quality and specificity of their field observations. This approach to participant preparation and data collection was modeled after research conducted during the Fifth Dimension after school project (Cole and the Distributed Literacy Consortium 2006). All field notes were entered into an NVivo database for further qualitative analysis.

Videotaped Observations

During the final six months of the study, we were able to augment our observations with video (something that had not been permitted at the site earlier in the study). Forty-two videotaped observations augmented the participant observations, and six contained information about Brandy. Audio and gestures from

these six videos were transcribed and entered into the NVivo database for further analysis.

Project Archive

The youths' work in Scratch—including animated stories, video game art, and interactive or playable art using popular culture images and sound—were collected on a weekly basis over a two-year period and entered into a project archive for analysis. We archived youths' Scratch projects in order to track the extent to which the new Scratch culture was taking root in the Clubhouse (see discussion in Maloney et al. 2008). Over the course of the study, 643 projects were collected; 22 were created by Brandy. The projects also had exportable project summary files that contained text-based information, such as the date, file name, and author of the project, information that was used to inform further analysis.

External Assessment

To investigate the resonance that Clubhouse participants' work had with the professional community, a random selection of 20 percent ($n = 95$ projects) of Scratch projects in the archive was evaluated in greater depth by an external panel of four professional media artists. The sample contained six projects made by Brandy. The panel quantitatively evaluated the work in the sample and provided a short explanation of its rating for each of the projects (see more details in Peppler and Kafai 2008; Peppler 2010). Together with the first author, the committee of media artists came up with five coding categories, including (1) originality of concept, (2) criticality, (3) use of medium, (4) technique, and (5) overall success (Peppler and Kafai 2008). The panel scored all projects on a 0–5 scale for each of the criteria (0 = low and 5 = high). Panel members were also asked to briefly comment on the works with an open-ended response. During the entire coding process, the committee was blind to each project's creation date and author. To increase interrater reliability, the committee first scored 20 projects as a group to create a consensus on how to rate the projects. Once the group came to a consensus, the projects were then divided equally and randomly assigned to each of the four artists with some overlap in 25 percent of the remaining projects to serve as a reliability check. Interrater reliability for the independent coding was found to be 93 percent.

Interviews

Interviews with Participants

Interviews were conducted with 30 youth, including Brandy, who had a range of experience at the Computer Clubhouse. Sample questions asked during the interviews included "What is Scratch?"; "Does Scratch remind you of anything at school, at home, or off of the computer?"; and "Does Scratch remind you of dance, drama, music, or visual arts?" The interviews were transcribed and coded for recurring themes (Maxwell 2005) to better understand how youth situate media art–making among a repertoire of production practices, including their prior experiences in the traditional arts. Brandy's interviews were further analyzed for this article.

Focus Group Discussions with Media Artists

Finally, we turned to the insights of four professionals in the field of media arts in order to better conceptualize and situate the youths' media artwork. These artists were interviewed and surveyed to gather an outside perspective on the work produced by the youth and the relative strengths and weaknesses of the media artwork coming from the Clubhouse. The four media artists participated in two three-hour focus-group sessions and discussed questions such as, "What do you see or notice about the youths' media artwork?"; "What's absent from the youths' work?"; and "Overall, how would you rate a particular piece of media art?" Although the focus group was not explicitly asked about Brandy's work, her work nevertheless became a subject of conversation. These conversations were subsequently analyzed for this article.

Data Analysis

Analyses of the Participant Observations and Videotaped Observations

The participant field note database and video transcripts were analyzed using a coding scheme derived from our theoretical framing (Glaser and Strauss 1967; Strauss 1987) to better understand the early literacy development of an individual who had been labeled as disabled by the staff of the after school program she attended. All field notes and supporting documents were imported into the NVivo software program for qualitative analysis, including identification, coding,

and extraction of literacy events. In line with this approach, we coded the field notes ($n = 37$ documents) and videotape transcriptions ($n = 6$ documents) that contained literacy events involving our case study.

Five sets of codes emerged as useful in the current study. Once all literacy events that involved Brandy had been identified, one set of codes was used to document events related to traditional literacies, including practices such as writing, reading, letter identification, spelling, typing, and oral storytelling. The second set of codes documented new literacies, spanning technology fluency practices and multimodal meaning-making practices, including practices such as computer programming, remixing, visual meaning-making, decoding symbols other than traditional print, and animating. The intersection of these two codes was particularly helpful in determining what relationship, if any, existed between the development of new and traditional literacies. For all literacy events, mediational means such as mentor support, help materials, or peers constituted a third set of codes. Finally, two sets of codes were used to capture perceptions of our case study by community members (both adults and peers) and to capture Brandy's participation (e.g., peripheral participant, active participant, mentor, collaborator) in Clubhouse activities over time. Data were coded primarily by the first author and an outside coder and discussed during research meetings. Throughout the coding process, theoretical memoranda guided the inquiry and reflection process. If disagreement existed on the meaning or application of codes, differences were debated until consensus was reached on 100 percent of the coded data. This enabled accurate counts of the literacy events and relative frequencies of particular codes, both of which informed the current work (see discussion in Wohlwend 2009).

Project Archive

Brandy's Scratch creations in the project archive were the subject of further qualitative analyses. We used the project summary files to identify when and with whom the projects were created and plotted that information along a timeline. We then carried out a qualitative developmental analysis of the project content, project complexity, and programming complexity of Brandy's products.

External Assessment

An external assessment created a quantitative assessment of project quality along several dimensions, including (1) originality of concept, (2) criticality, (3) use of medium, (4) technique, and (5) overall success. The quantitative assessments were further analyzed using SPSS software to quantitatively describe and analyze the data set. The results of this assessment are featured elsewhere (Peppler and Kafai 2008; Peppler 2010), but the relative evaluations of Brandy's work ($n = 6$) contained within the random sample ($n = 95$) inform the current work.

Interviews

Interviews with Participants

Interviews with all participants were transcribed, entered into the NVivo database, and thematically coded. This study further analyzes the interviews conducted with Brandy. Her interviews were coded in a manner similar to that used with the participant and videotaped observations—that is, by coding for her interests in Clubhouse activities, for the ways in which she positioned herself, and for her traditional and new literacy abilities. The interviews provided a first-person account of Brandy's learning experience and helped us to triangulate what we noted from our observations.

Focus Groups with Media Artists

The focus groups with media artists were transcribed and entered into the NVivo database for further analyses. This article focuses on segments of the interviews pertaining to Brandy. Focus-group conversations were coded for any direct comparisons the panel made of Brandy's art to the work of her peers and of professional artists, as well as the ways in which panel members characterized Brandy's work despite not knowing anything about her situation. The focus groups provided an outside perspective on Brandy and her work and helped us to triangulate our observations and interviews.

Introducing Brandy

At the start of the two-and-a-half-year study, Brandy was an eight-year-old African American girl, a regular member of the Computer Clubhouse. She attended the Clubhouse two to three times per week and was

initially one of its youngest members. Brandy stood out in the Clubhouse community for a number of reasons. First, she was extremely eager to work with adult mentors. Additionally, the extent and nature of Brandy's disability were much discussed around the Clubhouse. By Brandy's own account, she was nicknamed "Special Ed" by her friends at school and often talked about how she was frequently teased by others in class or dismissed by members of her family. She struggled in school, especially in core subject areas such as reading and mathematics. As Brandy turned nine and entered the third grade, she was unable to read or spell more than a handful of words, including her name. During the bulk of the study, Brandy was unable to recognize simple three-letter words like *you*. We later learned that she had been tested as having an IQ of 60, had been diagnosed as having intellectual disabilities, and was three years behind in the school curriculum. At school, she had an individualized education program (mandated for all learners with disabilities) and received daily pull-out special instruction for reading and mathematics.

At home, Brandy was a single child with a strong and supportive extended family, which included several cousins her age and active grandparents. Brandy usually came to the Clubhouse along with three or four cousins. Each day, she arrived having paid meticulous attention to the way she dressed, ensuring that her barrettes, T-shirt, pants, and shoes were all the same color. Often she would note whether the mentors had good taste in clothing and make remarks about color and style, frequently remarking that a mentor's clothes "don't match." In one of the informal interviews, Brandy stated that she aspired to become an art teacher when she grew up. However, her professional aspirations did not appear to carry much weight for others in her environment. Although the Clubhouse organized three or four college visits a year, Brandy was, for most of the study period, not invited on these trips because she was not seen as college bound by her family or the Clubhouse staff.

At the start of our observations, Brandy was seen as "extremely needy" by the Clubhouse community because of the amount of hugs and one-on-one attention she demanded. On a typical day, Brandy would meet mentors at the door, grab one by the hand, and ask him or her to "do something," which usually meant starting some sort of design activity that was a highly valued local practice. However, her unwillingness to persevere in activities for extended periods frustrated many of the mentors who worked with her, especially those who tried to sustain her attention over a three-hour time span. At the start of the study, Brandy was observed losing interest in most activities, including board games and design activities, after 5–7 minutes. The following is a typical reflection taken from a field note recorded by a Clubhouse mentor in fall 2004:

> [Brandy] is very needy. For the past couple of times that we have been there, she is constantly asking us to do things with her and refuses to initiate any activities on her own. . . . Brandy is constantly poking you, grabbing you and/or in your face asking for your attention. . . . Today . . . she refused to work by herself and just kept standing next to me trying to get my attention. Since she is younger than the other members, she doesn't often play with them (although she also doesn't try to play with them). [September 2004]

Brandy's inability to participate independently in activities was a principal factor in how she was viewed by the university students throughout the study, as evidenced by the field notes. Unfortunately, potential entry points to literacy-building activities were often overlooked. For example, one mentor's engagement with Brandy during a transcription activity in Microsoft Word illuminated Brandy's emergent understanding of the relationship between oral and written language, a moment that was both fleeting as well as foundational for her future literacy development:

> Brandy was looking for a picture of a cat [in the clip art image library]. . . . I controlled the mouse and she made the artistic decisions. . . . She chose to work with Word but wasn't sure how to open the program or maneuver within it. I think her original intention w[as] to create a book . . . but was inspired by rap lyrics, which led us to writing rap songs. [Brandy] had never used or seen clip-art before. Brandy . . . rapped a song to me. I typed the lyrics as fast as I could . . .
>
> My name is Brandy
>
> I like to play with cats and I like to pet my dog
>
> With my cat

They like to play together and they fight together

And I tell them to stop doing it

My name is Brandy

I like to play around with my cat

They bite, they kill.

They never going to stop

They never going to stop

And I'm sorry that you're never coming back home

Oh no

And they never going to tell me no more

Brandy rapped very fluently and was impressed that I was able to read it back to her. She wanted to read her own lyrics as well but it was too difficult for her. She performed them from memory several times—faking reading them. She did this for her cousin, the coordinator, and other members. Immediately, she wanted to write another one. [August 2004]

What is striking about this excerpt is the fact that Brandy acted surprised that her mentor could recount, by reading the transcript on the screen, the rap Brandy had just improvised. The moment illustrated a disconnect Brandy appeared to hold between oral speech and the written word. Also interesting is Brandy's experimentation with clip art as a way to express herself, using images to augment the meaning of written text. The fact that Brandy later performed a "reading" of this Word document numerous times for her family and peers reveals the pride Brandy felt about what had transpired during the transcription exercise and her desire for recognition either for appearing to have the ability to read something herself or for creating a satisfying combination of text and image in the Word file. The sequence of events also seems to underscore Brandy's discovery of a previously unknown source of power: her unique ideas could be immortalized in textual form. Having her rap written down (at a time when she herself was struggling with the ability to write down her own ideas, let alone read what she wrote) also might have hinted at a skill set that she found both powerful and, perhaps, suddenly within reach.

The transcription exercise marked the start of a string of explorations, lasting the remainder of August 2004, into the mechanisms and utility of Microsoft Word. By September, Brandy could open the application on her own by double-clicking the icon on the desktop as well as create blank documents for writing and practicing her spelling words for school. As discussed regularly in field notes, Brandy's lack of typing experience and difficulty finding the letters on the keyboard made typing her spelling words a challenge. But her curiosity about the software program—or perhaps her recognition of the cultural capital that mastery of technology carried in the Clubhouse environment—caused her to persevere despite the obvious obstacles to success. Thus Brandy insisted on continuing to use Word for her projects—as opposed to writing anything out by hand. Once Brandy had mastered the typing of a few familiar words (e.g., *mom*, *said*, *you*, *are*), she would use them in projects alongside invented spellings. Of a spelling list activity, one mentor wrote (in September 2004), "Brandy opened Word [on her own] and was trying to type her spelling words . . . at the end of the day today (5pm), she passed me a sheet of paper . . . as a sort of gift":

Momqwwertyyuuiioopasdghklzxcvbm,,l.;

Mom said oooyyydddand you are ./.1212

Sdfgfvfhhlkxxxcgbbjkmn.

Youinonfhdisenajkfakdine1212

Dfgffhghtjrttgasdfghj1142004

Jneknje4ne585666e56ne525k22d2id5k22en
5i2d2n63d6n6sk89a6uf4jlk8ajfl;58jdio5f

uealn58cv2

njkl6sd2jklf56u3ioe6jf2klsd26fjsdaklf5jwioe
25fjl3ksdg9hgnm9,.2vn9cv5x2nzbm,5gj1kl

eigf4kllj8asdl8f5kdl;sk87afl;4sdkf/7 as4dfop7
weia4f7as 5fm58asd,.2fmweop5925acm2sdkl4
adi216k;sdgl2kaop6sdfi2sdl;afk63aw;e 5r6
wop2ivp6sd2vm54df2mk5asdl;60fipweo5k
2sdf54mfa,.2sdm56fl;as2ig52oh5as0d,f.ad,
anm2.ghk[p0do1k d2vgh][5g12jop1sGgfk51
fkg04f,d vds5pg[ero7s8b,58df./5sbvo22525
[September 2004]

Here, too, Brandy took pride in her print-based activities in Word, eagerly sharing the printout as a gift for her mentor. Also interesting is the nature of the gibberish spelling, which, by appearing alongside words she typed correctly, may reflect Brandy's desire to appear fluent at typing quickly or to be able to produce documents that more closely resemble a story or a textbook than a short list of words.

Brandy's interest in using computers extended beyond print-based activities. Around this same period, Brandy was inspired by seeing the work of other members of the Clubhouse, and with the help of the mentors she began exploring other applications loaded on the local desktops. The culture at the Clubhouse clearly valued design projects—ones that could be printed in color with the Clubhouse's laser printer and hung on the walls. One of the applications that caught Brandy's early interest was Bryce5, a 3D landscape modeling, animation, and rendering program. The following field note excerpt describes how the project of a Clubhouse youth named Alex served as a source of inspiration for Brandy's initial exploration with the Bryce5 program:

> [Alex] held control of the mouse and let us (mostly Brandy) do the designing. . . . Alex left and Brandy took control of the computer. She wanted to create more pictures. She was limited by not being able to read when she was trying to import the characters. I read them to her but she always wanted the characters that she had seen before in Alex's design. [August 2004]

Brandy was motivated and eager to use technology toward creative ends despite being limited by not being able to decode print and having to rely on an adult mentor to read the text for her. Within two months of her introduction to Bryce5, she began to create projects on her own and to explore new areas of the application, even impressing the Clubhouse mentors. The following excerpt shows Brandy taking control of the Bryce5 activities, navigating the opening of a file and creating a new image, and demonstrating her understanding of aspects of the program that were not widely known in the Clubhouse community:

> Brandy . . . took me to a computer. [OC: I should note that there has never been a finished project there (or even one in progress).] . . . She was in charge of the computer and took me to Bryce5. She opened the program herself . . . and began inserting land, water, and objects. She even did two new things that I had never seen before within Bryce5 —dropping a geometric shape into the virtual world and pressing a button to look at the world in 3-D space. [October 2004][1]

Brandy's fast learning curve with technology was for the most part overlooked in the field notes. No one at the time was aware of the rate at which Brandy was accumulating skill with various computer applications. That she took an early liking to Bryce5 is probably not a coincidence. Although the software is difficult to master (and is used by professional artists to develop digital art that sells for hundreds of dollars), the Bryce5 interface requires little to no reading, which allowed Brandy to engage with the software on her own. Brandy did struggle with navigating the system of labeled folders in order to import new objects into a project (Bryce5 contains no preview window for users to peruse files before importing them). Most of the functions on the application, however, are controlled by general buttons shaped like well-known objects (e.g., tree, mountain, pond), shapes (e.g., cone, sphere, cube), and arrows that allow users to build and render a 3D world. Brandy's perseverance and relatively quick learning curve in using this software (similar to the speed with which she adapted to Word) revealed a technological aptitude that transcended the expectations others held of Brandy and also revealed her comfort using the computer as a viable mode of expression and creativity. She eventually amassed enough expertise in Bryce5 to intimidate undergraduates with her work in the program. One mentor who was a former computer engineer was "amazed at how much she already knew about Bryce5 and that she knew how to import objects to quickly move and manipulate them" (February 2006).

As Brandy gained expertise with Bryce5, she gained confidence to try out other applications, including the media-rich programming environment Scratch. In October 2004, about the time Brandy began working with Word and Bryce5, the first beta version of Scratch was loaded on the Clubhouse computers. At first few youth explored the application because the interface's emphasis on programming made it appear too complex to navigate independently. Not until a handful of mentors provided a few one-on-one introductions did the program take

root in the community, beginning with a small group of early adopters who became aware of the program's capabilities (Kafai, Peppler, and Chiu 2007). Though computer programming with Scratch requires some traditional print literacy, Brandy was one of the first to explore the program, interested primarily in its paint editor and audio recording functions. The media mixing capabilities of Scratch enabled Brandy's sustained peripheral participation before she became more accustomed to the programming aspects of the program. This entryway to the program became a path that many others would take before a Clubhouse programming community was established. The following field note captures Brandy's first exploration with the program:

> The computer had very few programs loaded, so I suggested Scratch. Brandy didn't know what it was. . . . I introduced her to Scratch by showing her first how to set a background color. I imported the commands and let Brandy choose the color. Then I asked her what would you do if I wanted the background to be green? She chose green, then chose blue, and continued to upload the colors. . . . Then she was attracted to the cat [that appears by default] and clicked on it. I told her that this program was to create games. She immediately wanted to make a cat and mouse game. We next imported a few sprites. Brandy was able to easily draw the characters that she wanted in the paint program. . . . She used the cartoon "Tom and Jerry" that she watches at her grandmother's house to inspire her. . . . When we were done creating the mouse we uploaded the image and Brandy immediately didn't like the size of the mouse in comparison to the cat. I imported the right commands to resize the mouse and told her that this mouse is size 100. Does it need to be smaller or larger? She said smaller. I told her to type a smaller number. She typed 1. It was way too small for her taste. I told her to try something larger. She moved to 2 . . . 3 . . . 4 . . . 5 . . . 6 . . . 8 . . . 9 . . . 0. It was a bit shocking that 0 was smaller than 9 for her. . . . I moved straight ahead to [programming] motion, but I realized that it interested her far less than creating new images and allowing the images to co-create the game. . . . Brandy just wanted to make the scene more realistic. . . . Having a cat and the mouse called for a house for the mouse. . . . When Brandy moved the mouse over the house, she wanted it to go inside. Recognizing that we would have to program it to go the back layer, I started to think about how we would do that. Brandy then clicked on the house and moved it on top of the mouse. This low-tech version really excited her. This stimulated her to create a story about the scene, again drawing on her knowledge of Tom and Jerry. . . . Brandy used these images to create a story line—albeit a simple one—a "cat is chasing a mouse that hides in a house and wants to get the cheese." . . . At this time, it was time for me to leave. I saved Brandy's work and told her that we would continue to work on it next week. . . . She wanted me to leave it open so that she could continue with her work or make another game. [October 2004]

Brandy's aesthetic decisionmaking and narrative/storytelling vision drove her exploration of Scratch's capabilities. In this case, by leveraging her math skills to control the size of her mouse-drawn images in the animation screen she was introduced to the logic of the program, thus extending the user experience beyond the basic interaction of a stand-alone paint program. Additionally, hand moving the sprites as though they were Colorforms provided a brief introduction to the way objects could move on their own when automated. For the time being, however, Brandy was content to use the program as an interactive storybook, using a combination of live narration and mouse movement to extend the narrative functionality of her drawn objects. Until she became more familiar with the mechanisms of Scratch, this was by and large the extent to which she utilized the program.

Brandy's explorations in Scratch continued into January 2005. One mentor described an interaction with her during this time period, suggesting that Brandy was becoming more aware of her print literacy limitations when working in the program. Still wanting to appear proficient with the technology, however, Brandy would continue working as self-sufficiently as she could. When her limitations became apparent, she would attempt to mask them by switching activities. Sometimes, she would act out as

a distraction. Brandy was reported from time to time as acting "crazy"—walking off or losing interest in the activity—when an activity called for her to read and write. Sometimes her hand seemed to act on its own accord as she typed random keys. Other times Brandy fell on the floor so as not to be in view of the screen. In one field note, a mentor writes, "[S]he wanted to do everything by herself. . . . I observed that Brandy did not know how to read very well because she had to repeatedly ask which buttons to click on, which I assume was because she couldn't read the labels" (January 2005). Within 10 minutes, Brandy closed out the program to start a different project. When Brandy opened Word, the mentor suggested they write a story. She hesitated, then said, "No, I wanna type." She proceeded to type "gibberish," and the mentor again urged her to write a story. She began to say something quietly about her best friend, but after a minute she looked at the mentor and said, "I can't." The mentor asked Brandy if she wanted help, but she decided to give typing another try. After a short time, Brandy again switched activities and opened *RollerCoaster Tycoon*. Clicking on one of the premade coasters, she told the mentor, "That's my rollercoaster," even though it was a model created by the game's designers, not her. Brandy revealed in this series of events that the holes in her knowledge made her feel vulnerable and that her strategy for dealing with such moments was to switch activities to something that highlighted some level of proficiency with technology, even if this involved claiming work that was not her own. This switching was often diagnosed by her peers or mentors as indicative of a short attention span, when, in retrospect, it appears to have been an attempt at ego preservation. These behaviors also show Brandy's identification with the values of the local community and her desire to become a full participant in the community's design activities.

Despite the challenges of limited print literacy, Brandy persisted in Scratch, finding new strategies to succeed in the spring and continuing to create new projects in the program. In one instance, she impressed a graduate mentor by taking a binder of projects created by other members in order to search for new ideas:

> Brandy impressed me today. . . . She took the Scratch binder, the one that has recommendations and shows commands, and tried using it to create a project. I approached her and asked what did she want to make. She wanted to make a mermaid project. I showed her where to get images, but she could not find a mermaid. . . . When I suggested we try to make some scripts, she did not want to. . . . I left Brandy to spend time with another member, and she did not like this. I was not trying to hurt her feelings but wanted to pursue another activity. [May 2005]

Turning to sources outside of the computer interface to help her navigate the program, Brandy demonstrated a resourcefulness that the mentor apparently had not expected. And yet expectations for Brandy's participation with the program had risen now that the technology was becoming more established in the Clubhouse, and the mentor viewed use of only the paint functions as not fully engaging with the software. When Brandy resisted programming, she lost mentor assistance, illustrating the high value members and mentors placed on programming within Scratch and the high stakes of not participating (i.e., losing one-on-one time with mentors, a highly valued commodity, especially for Brandy). This may have impacted Brandy's decision to push her explorations in Scratch to the next level.

By the start of 2006, Brandy began to show interest in programming through a series of collaborative projects in Scratch. These projects could be seen as Brandy's own literacy-building exercises, because they emphasized the identification of specific letters on the keyboard to activate movement. While the animated components of these projects were created by mentors who compiled stacks of code as a learning exercise so that Brandy could engage in slight modifications (such as changing the numerical value of the variables), this was the first time Brandy had shown an interest in programming, and her repeated choice to include programming functions emphasizing letter decoding suggests a concerted attempt to overcome the print literacy obstacles that limited her involvement with technology. During one of the semiannual "Scratch-a-thons"—mornings devoted to creating and learning with Scratch—Brandy began working with an adult mentor on a project. For this self-titled project, Brandy chose which objects to include: the letter *s*, a baby, an eagle, two Scratch cats, and a female bust. The mentor led Brandy in the creation of short stacks of commands that responded to key presses on the keyboard. In the screenshot shown in fig. 2, the baby

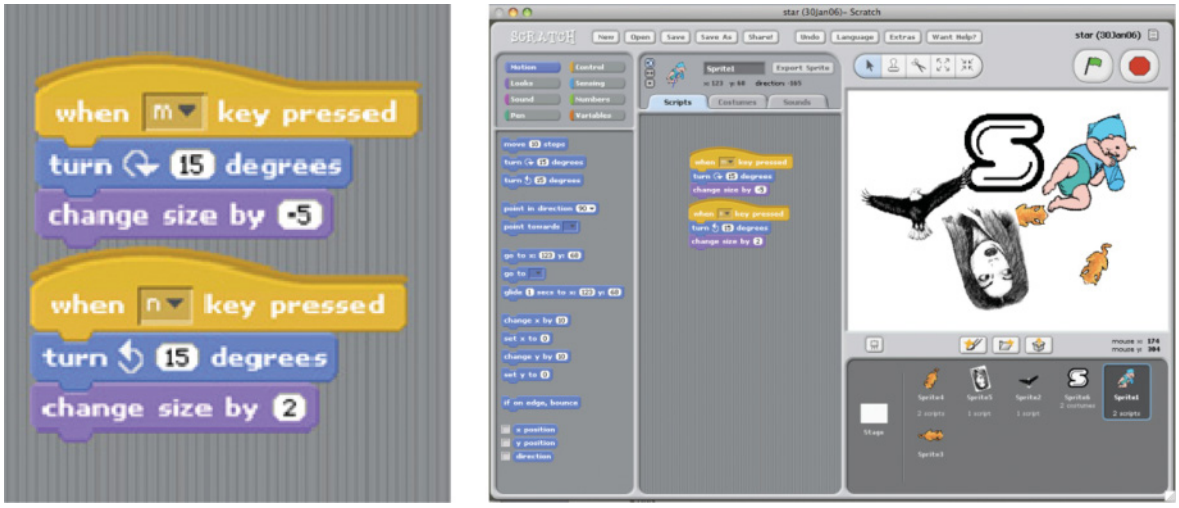

Fig. 2 Screenshot of Brandy's self-titled project "Brandy" and a close-up of the command blocks used to control the baby object.

is controlled by pressing the "m" and "n" keys. The stacks of commands tell the reader (1) when the "m" key is pressed the baby will turn 15 degrees clockwise and decrease in size by 5 units (the default size is 100 units); and (2) when the "n" key is pressed the baby will spin in a counterclockwise direction 15 degrees and increase in size by a factor of 2.

This represented a turning point in Brandy's development in the community, where she was first compelled to delve into stacks of code to make objects move. This practice formed a link between traditional print literacy and Scratch for Brandy, encouraging and engaging her in a way that made her want to learn more. Through projects like "Brandy," Brandy opened, played, and created new games, forcing her to engage in simple print reading.

Print reading facilitates programming in Scratch for users wanting to realize specific ideas in a project, especially ideas that involve animation or interactivity. Each Scratch block has the appropriate action written on it. Without knowing what actions are written on a block, a user can still create grammatical combinations of blocks by piecing together the uniquely shaped blocks (each category of block has a distinctive shape and color to facilitate proper syntax) like a puzzle. However, the result of such combinations (when the program is run) will most likely be a surprise to the coder. On the other hand, commands that involve at least two steps, such as the combinations used to create if/then functions, are less conducive to nascent exploration (e.g., nothing animates if the user does not know to assign a character to an "if ___ key pressed" combination of blocks and then use that same character on the keyboard to activate the sequence).

Brandy opened her self-titled Scratch project independently over the course of the next few months to practice decoding the stacks of text and find keys on the keyboard, increasing her letter awareness in the process. Inspired, she began making her own projects with different key presses and a variety of images over the same time period, in the process gaining the attention of the lead researchers by amassing a collection of Scratch projects that was more numerous than that of any other member of the community. As Brandy's letter recognition grew, she began to save her work on her own for the first time. This required her to type and spell short words. To help herself better navigate Scratch, Brandy created a naming convention that involved incorporating her name into the title of every file she saved—hundreds of projects and 22 Scratch projects in all (19 of which included her name with an additional small word or some slight variation in the way she spelled her name). This naming convention enabled her to find her Scratch projects out of the more than 600 projects in the archive folder. Her strategy proved more successful than most of the other members' strategies, which involved opening a project to see if it was theirs or naming their projects only with their first name and thus continually overwriting their prior work.

During this time, Brandy was pulling together meaningful stacks of commands on her own. One mentor noted that while he was working on a project, "Brandy passed by and showed interest on my project.

She said with an exciting tone, 'I know how to make it better!' Then she started pulling some commands to my original scripts" (February 2006). For the first time, Brandy was sharing her programming expertise with adult mentors. Subsequent analyses of her portfolio confirmed that Brandy was able to computer program on her own at this time.

Despite her impressive progress, Brandy was still viewed as someone who knew little about core Clubhouse practices. The Clubhouse coordinator, in a well-meaning effort, alerted the new crop of mentors about Brandy and explicitly told the new undergraduate mentors, "Always tell Brandy to save her work." One mentor remarked, "After she had said that . . . I was curious to find out why she mentioned just Brandy, not anyone else" (January 2006). Another reflected,

> Admittedly I was uneasy about working with Brandy since [the Clubhouse coordinator] told us about her. I had been harboring mixed feelings about interacting with Brandy as I was excited to see the energy and was ready to be challenged with harnessing this energy . . . but wondered if I was truly capable of doing that. [February 2006]

The coordinator, however well intentioned, managed to paint Brandy with a reputation before the mentors had a chance to formulate their own opinions, reinforcing the image of Brandy as less than capable at the Clubhouse, despite clear evidence to the contrary from the type and extent of her creative production in Bryce5, Scratch, and other programs.

Another of the Clubhouse's semiannual college tours was scheduled for March 2006 at a prestigious local public university. The youth were going to have an opportunity to display their Scratch projects in a public gallery and answer questions while college professors, undergraduates, and graduate students passed by. The Clubhouse commonly chose older, more-likely-to-be-college-bound students for the college tour, but this time an additional requirement was added: youth had to have engaged in Scratch to be eligible. Initial lists were made and checked with the graduate mentor team to see if anyone had been left off. The graduate mentors mentioned that Brandy should be included, because she had made the most projects and had been one of the few to successfully use voiceovers in Scratch. The Clubhouse coordinator was initially shocked to hear this, saying "Nah, really?! You're honestly telling me you want to take Brandy?" (January 2006). When it was argued that Brandy's work was of equal or greater quality than that of her peers, the coordinator consented but did not expect Brandy to take the experience seriously.

Her family and teachers were amazed that Brandy had been selected to participate. On the day of the college visit, she was excused from school and, contrary to expectations, arrived early and eager to get started with the tour. Brandy was quiet and restrained during the trip, taking it all in. As she presented her Scratch work informally to passersby, she spoke softly but assuredly, easily answering questions about the choices she had made. The mentors and coordinator remarked at how "well she was behaving" and how "surprised" they were that "she wasn't acting crazy."

Following the campus visit, marked changes were observed in Brandy's demeanor, sense of self-confidence, and amount of production, particularly in Scratch. Brandy continued to produce more work but now spent more time exploring new commands and making projects as gifts for family members and the Clubhouse coordinator. Brandy also began working more independently, aided in part by a new set of Scratch cards in the Clubhouse. Using the cards, Brandy learned new commands and functions, including how to program an object to move up, down, right, or left by pressing the arrow keys; to change colors when a key is pressed; and to dance to a beat. Brandy successfully used one of the cards (pictured in fig. 3) at a literal level, using the images, sounds, and commands suggested on the card to create her project. The following field note describes how Brandy's familiarity with the program allowed her to find the commands listed on the card:

> Brandy was already looking for the girl sprite. I said go to people, and then John said "now go to female." Brandy had asked me to do it for her, but I responded, "I'm not going to do your project for you . . . you can do it." She pouted, but then started getting the blocks for the project. . . . The project was done, and Brandy looked at it for what seemed like a long time (ten minutes). She even danced a little to the repeating beat. . . . I then took the mouse and tried adding a swirl to the character. I think I used +30 swirl and −30 swirl. However, the character actually did not react

Fig. 3 Image of one of the Scratch cards Brandy used to inspire her projects.

> as expected. It seemed like she shook her bottom and mid-body, once, and then her top body. Brandy and John started to laugh. They called the Coordinator over. The Coordinator responded, "What!? Why is she shaking like that?" Brandy then walked away from her project. Emmy came by and saw her project, and asked me how they did that. I then said, "Look at the script." [O.C.: Even though Emmy is older, about junior high age, she seems to understand less than Brandy. Brandy can import characters on her own, and did a great job of finding blocks to match the cards . . . this shows that she knows where to find the scripts.] [May 2006]

In this process, Brandy worked to decode the text depicted on the card, practicing her literacy in two ways. First, she demonstrated the ability to read the exact words and commands from the card, as well as search for the same ones in the program and recreate the card's syntax in her coding. Second, in choosing her Scratch commands and combining them in meaningful ways, she began to make a broader meaning. This ability aided her development of the semiotic awareness associated with programming code; that is, the knowledge and ability needed to combine in meaningful ways such modes of meaning-making as understanding the commands and reading the words, colors, and shapes Scratch uses.

Through these types of activities, a connection between reading the blocks and combining them in semantically meaningful ways was formed. Through understanding what each of the blocks meant and playing with how to combine them in meaningful ways, Brandy began to be able to use the Scratch cards independently and experimented with inputting other variables, objects, and scripts instead of those prescribed by the cards, essentially writing her own texts. An older Clubhouse member, Emmy, who was new to the space and unaware of Brandy's previous reputation, was impressed and inspired by Brandy's work. However, Brandy's disappearance from the computer station after the Clubhouse coordinator made a disparaging remark about the implementation of the swirl command indicates her investment in Scratch and the stakes it held for her at this time. Brandy did not want to be associated with mistakes in her programs, even when the mistake, as in this case, was not her own.

Throughout this time period, Brandy's participation shifted in two meaningful ways. First, she began working productively with other members on projects, creating in one instance a "news reporting" video along with an older Clubhouse member. This was the first time Brandy was seen working with other members, let alone an older member, on a project. Presumably, the interaction occurred in part because the older member had noted Brandy's sophistication with Scratch and other computer programs in the preceding weeks. Second, Brandy began to take on mentorship roles, teaching the adult mentors in the Clubhouse and thus reversing the traditional mentor-mentee relationship. One mentor acknowledged in her field notes that while working with another member they "programmed [their project] to change colors (a trick Brandy had taught me a couple weeks before), and walk across the screen" [May 2006].

This interest in making texts was also reflected in Brandy's other activities during this time. Beginning in April 2006, Brandy began bringing in and publicly displaying her homework and carrying around her textbooks as well as books of Bible stories she had elected to read. She also engaged in short book-writing projects. Although she would often get the dates wrong, she began writing and illustrating short documents on her own. In the following example, from April 2006, she wrote a row of hearts by hand followed by:

> December 04 2006 Brandy
>
> 1. This is your uncl
> 2. book

These writings were the first hand-written texts Brandy was seen creating outside of school. Brandy was also seen carrying around books she was able to read independently, including the following text about a monkey named Hip:

> Hip has a hat.
>
> Hip tips his hat.
>
> Hip taps.
>
> Hip stomps.
>
> Hip hits his hat.
>
> Hip sits. (Thomas 2002)

These events demonstrated the first marked improvement in Brandy's traditional print literacy. For the first time, she was reading and writing texts. Although these events were undoubtedly connected to what was simultaneously going on in her school classroom, Brandy's after school work seemed to have paved the way for her increased identification with print literacy. In particular, a relationship seemed to exist between her developing understandings in new programming literacies and her interest in decoding print. Working with Scratch seemed to illuminate for Brandy the mechanics of language and stimulate her metalinguistic awareness of how language operates, as she made connections between the Scratch programming language and her spoken (and increasingly written) English language.

External Evaluation

Near the end of data collection, Brandy's work was included in an external evaluation aimed at assessing any link between youths' creative practices in the digital domain and authentic professional practices in media arts (Peppler 2007). As part of this effort, four professional media artists were invited to evaluate the entire archive of work produced at the Clubhouse (Peppler 2010). Whereas the digital project archive housed numerous projects created by older Clubhouse members and involving more complex stacks of code, professional-quality interactivity between user and computer, and multitudes of sprites, costumes, and backgrounds, the piece that captured the unanimous attention of the media artists was "Star Millk," created by Brandy shortly after the college visit in April 2006.

Intended to be a birthday present, the piece features a picture of a glass of milk, a hand-drawn cookie, and some of Brandy's clip art images that are programmed to rotate and change colors at dizzying speeds when the viewer clicks on the background (see fig. 4). At the same time, a recording of Brandy's loose rendition of "Happy Birthday" is programmed to play for a minute and a half. Not knowing anything about Brandy at the time, one of the professional media artists commented that "Star Millk" "is very successful as a piece of art . . . informed by the vocabulary of Scratch" (April 2007). The other professional media artists commented on the quality of the artistic choices in the piece, noting that the "milk glass is amazing. . . . Look, there's no cake or

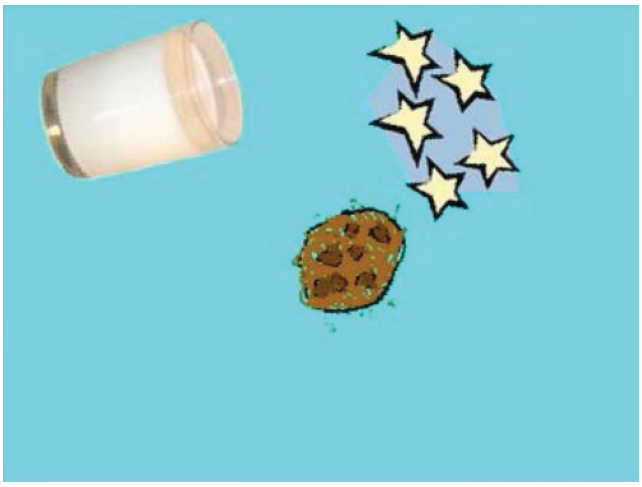

Fig. 4 Video of Star Millk.

present. Nothing like what one would expect at a [birthday] party" and "this [work] is so off the wall; it's making something that's beautiful to her without any notion of what is supposed to be beautiful. It's very compelling" (April 2007). The media artists compared Brandy's work with that of professional media artists like Ben Benjamin, demonstrating that creative digital production had presented Brandy with opportunities to create expressive artwork that has qualities similar to those found in professional work. Time and again the professional artists unknowingly discovered Brandy's work in the archive and called attention to it as exemplary of youths' creative digital production.

In stark contrast to these outside evaluations, mentors at the Clubhouse during this time still held to reductive notions of Brandy's abilities, as exemplified by the following field note:

> She quickly lost interest and moved to the next computer. She sat down and began looking for Scratch, and was disappointed to see that it was not on that computer. [OC: It was interesting to see Brandy sit down and say, "Where's Scratch?" . . . I've often seen Brandy sit down at a computer and open Scratch and just start playing around with it. However, most times her exploration is limited to what she already knows how to do. Rarely have I seen her try out new commands or begin projects that require more involvement than a few minutes to draw a picture.] [June 2006]

Despite her great progress, Brandy was held to high, if not impossible, standards within the community. For example, the June 2006 mentor's field note portrays Brandy's interest in the program negatively, even though the mentor's own description elsewhere of what Brandy could do in the program indicates that her work met or exceeded that of her peers, including those who were years older than her. Yet Brandy's seeming disabilities framed the way she was seen in the community and the way her work was positioned, thus highlighting what others have called the social construction of disabilities (McDermott and Varenne 1995).

Post-interviews with Brandy

In interviews during the spring and fall of 2006, Brandy positioned herself differently in the community and credited much of this change to the work she had done in Scratch. In June 2006, Brandy was interviewed by the first author about her general interests at the Computer Clubhouse as well as her interests in technology. The following excerpt suggests Brandy embraced the general values of the Clubhouse Network (e.g., in creating design projects) and the local Clubhouse community (e.g., in using Scratch as a tool for creative production).

> **Interviewer:** What's your favorite thing to do here?
>
> **Brandy:** Do a project.
>
> **Interviewer:** What kind of project?
>
> **Brandy:** Scratch.
>
> **Interviewer:** So what do you like about Scratch?
>
> **Brandy:** It's fun. [June 2006]

Although Brandy said Scratch was fun and her favorite thing to do at the Clubhouse, this is an example of what Papert (2002) calls *hard fun*. Ostensibly, we might not guess that someone struggling to read and write at grade level would enjoy computer programming in the after school hours. Many adults would not even choose to introduce such a tool to preliterate readers and writers. Brandy's case suggests this might be a mistake. Not only could she use Scratch; she could program with it proficiently and in the process gained a great deal of satisfaction.

In the fall of 2006, the first author held another round of post-interviews with the members of the Clubhouse community to better understand how the youth viewed Scratch's relationship to the traditional school curriculum. In spite of evidence to the contrary, Brandy's success with Scratch left us wondering whether she had found ways to work around having to read and write while programming in Scratch. However, Brandy affirmed in her interview that she had to engage in reading while creating in Scratch. She also indicated her perception of how Scratch related to her schoolwork and learning:

> **Interviewer:** Okay. Does Scratch remind you of reading or language arts?
>
> **Brandy:** Reading. . . . I read [in Scratch].
>
> **Interviewer:** . . . Does Scratch remind you of Social Studies?
>
> **Brandy:** Yeah.
>
> **Interviewer:** Okay. What kind of things in Social Studies?
>
> **Brandy:** Um with the map. . . . Scratch is like a map because it helps me learn. [September 2006]

This interview supports what we saw developing in the field notes. Brandy pointed to her experiences in Scratch as being seminal to her learning: "Scratch is like a map." For Brandy, Scratch became a tool that mediated and helped her to internalize the rules of language. This excerpt provides further evidence of the link between Brandy's learning to computer program and learning to read and write print.

When interviewing Clubhouse members about the whole of their portfolios, we were particularly interested in whether they could articulate their reflections or formulate a critique of their work. In the first part of the following excerpt, Brandy reviews the portion of her portfolio not containing Scratch projects. During the interview she became dismissive and embarrassed about this work, laughing and giggling awkwardly and asking the first author to turn down the sound and look away. Within a few minutes, she was disinterested in talking further about the projects. She instead wanted to focus the interview on Scratch projects, perhaps because she sensed that these were her most highly valued contributions within the community. After she went to her Scratch work, she sought affirmation from the interviewer about the number of her contributions—so numerous, they are not easy to count. This reflected Brandy's feelings of accomplishment about her work in Scratch. As the interview continued, Brandy recalled her work and highlighted projects she had not needed help to create—a developmental milestone for Brandy in the community. She also quickly spotted something she wanted to change about the "Brandy" project (see fig. 2) and made the change on the spot. Over the course of the interview, she began to position herself differently, reflecting her more central participation at the Clubhouse.

> [Brandy giggles and points at the screen.]
>
> **Interviewer:** I think those are movies, if you wanna watch those.
>
> **Brandy:** Naw, naw . . . what's that one? . . . [Four minutes go by looking at movies and other items in her folder.] . . . I wanna see this one!
>
> **Interviewer:** Well this one is just a picture. We gotta go to Scratch to see them.
>
> **Brandy:** Ohhh. Ok. Go to Scratch.
>
> **Interviewer:** Where's Scratch?
>
> **Brandy:** Mmmm right there . . . I done a lot. Didn't I? . . . I don't know how many . . .
>
> **Interviewer:** . . . Remember this one?
>
> **Brandy:** Oh yeah, the sports clown one. I did that one. . . . I wanna see the spider one.
>
> **Interviewer:** I'm opening it right now. . . . Which one do you wanna look at next?
>
> **Brandy:** Mmmm. I wanna see . . . the one with the milk. [singing] "Cookie and milk. Cookie and milk." That one!
>
> **Interviewer:** I think you did this one all by yourself.
>
> **Brandy:** Oh yeah it said "happy birthday" on that one. I want the song! . . . Yeaaahhh!!! . . . [Brandy sings and dances to this one for three minutes and then goes to look at others.] . . . Not that one. Not that one. Not that one. Not that one. Not. Not that one. THAT ONE! . . . On this one I didn't need help. . . . No go to

this one! I needa do one thing. Oh. [Brandy types something in.] Look I did this thing. [Brandy makes the eagle on screen spin for two minutes.]

Interviewer: . . . Alright. So Brandy, which one was your favorite Scratch project. . . . Just pick one. Tell me about it.

Brandy: [singing] Cookie in the milk, cookie in the milk, cookie in the milk.

Interviewer: Cookies and milk? This is your favorite? Alright. So why is this one your favorite?

Brandy: Cuz its cookies in the milk . . . [singing] Cookie in the milk, cookie in the milk, cookie in the milk. [October 2006]

In this interview, Brandy was still unable to justify or articulate what makes "Star Millk" a successful piece. Brandy's interview, like all the portfolio interviews conducted at the Computer Clubhouse, reflected her lack of verbal articulation. As discussed previously at greater length (Peppler and Kafai 2007, 2008), what we saw emerging in the community was a great deal of sophistication and criticality in the work itself (expressed through visual, aural, and kinesthetic/interactive modes) that contrasted with youths' underdeveloped ability to talk or write about their work. Commonly we, as educators and researchers, privilege written text and spoken words over other modes of communication. Informal communities, because of their drop-in nature, are not usually well positioned to develop verbal and written communication practices, tasks that are better suited for classroom communities or more formalized out-of-school communities. In the arts, critique often puts into words what has been expressed in dramatic, visual, or musical form (Soep 2005; Peppler, Warschauer, and Diazgranados 2010). Because critique was not a well-cultivated practice at the Clubhouse (see Peppler and Kafai 2008), Brandy's difficulty discussing her work articulately with others was not surprising. Nevertheless, when asked, Brandy chose "Star Millk" as her favorite project, thus matching the selection made by the external committee, even though Brandy had no knowledge of the committee's findings at the time of the interview. This alignment points to the media sensitivities Brandy had developed over time through her creative production in Scratch.

Overview of Research Findings

In our exploration into youths' complex relationship with new and traditional literacies, this study first considered the extent to which a youth with cognitive disabilities could identify with the literacy practices of an after school community that emphasized creative production using new technologies and whether she identified with any particular practices more than others. Second, this study aimed to investigate the initial entry points and mediational means of sustaining youth involvement. Finally, it examined the possible connections or potential disconnects between new and traditional literacies in the after school hours, contrasting the meanings of *ability* in the development of both types of literacies.

Learning to Be Literate

Over the course of the study, we witnessed a great deal of literacy development by Brandy and noted changes in her participation in the local community. Brandy learned to work on her own in programming for 15–20 minutes; to use self-help resources to create projects; to sustain focus and attention for prolonged periods of time; to take pride in her expertise as the creator of the most Scratch projects; to earn the recognition of her peers, the Clubhouse coordinator, and her family for her work; and to teach others, including adult mentors, how to computer program. All of this stands in stark contrast to Brandy's initial participation in the Clubhouse, where she was seen as a peripheral participant, unable to participate in design and game activities, unwilling to work collaboratively with peers on a project, and unable to remain engaged in an activity for more than five to seven minutes.

In unpacking what drove this *inbound trajectory* (New London Group 1996; Rogoff 2003), we see that Brandy deeply identified with the creative production practices of the after school community (see Wortham 2006; Kafai, Peppler, and Chapman 2009) that allowed for multiple modes of participation and helped Brandy leverage her visual and oral storytelling abilities. Over the course of the study, Brandy identified with a full range of literacy practices, spanning an array of new literacies, print literacies, and technology fluencies (see, e.g., Peppler and Kafai 2007, 2008; Gee 2010). Early practices included designing 2D and 3D images as well as oral storytelling. Brandy's success with this type of participation in the community allowed her eventually to identify with practices like

computer programming that were more reliant on traditional literacy practices, demonstrating the kind of alignment between academic learning and social identification that is necessary for further academic development (Wortham 2006). Furthermore, and in line with prior research on the arts, we found that the Clubhouse's emphasis on creative production provided Brandy with consistent access to arts activities that could act as a pathway to metalinguistic awareness (Olson 1994) and provide her with a bridge to traditional print literacy (Mentzer and Boswell 1995; Wilhelm 1995).

Even at the start of the study, Brandy identified with traditional print literacy activities such as writing rap lyrics, typing her spelling words, and using some of these texts as gifts. Despite this, a huge gap seemed to divide Brandy's interest in reading and writing from what she was able to do with print on her own—a potentially dangerous gap because low levels of phonemic awareness or decoding skills by second or third grade often leave students on the margins the rest of their school lives. In Brandy's case, the community's openness to younger members with emergent literacies was critically important to the development of her literacy practices. Being in a community that had an ecology of interdependent literacy practices (Kafai and Peppler 2011) created a third space for Brandy, outside of school and home, in which to safely engage in an array of activities, building a foundation for traditional literacy development as well as a more general understanding of learning how to learn (Brown et al. 1993).

For Brandy, the Clubhouse community represented an alternative space where she could demonstrate proficiency and where others could, at least at times, identify her as being an expert. New technologies can be helpful in enabling fluidity between novice and expert roles in a community (Kafai et al. 2008), as compared to the more rigid tracking of students that exists in most schooling environments. This opportunity to reposition herself as a knowledgeable expert in the community was something Brandy cherished and guarded in order to counterbalance the cultural construction of her as a "Special Ed" student (McDermott and Varenne 1995) and confirms prior findings about the value of multimedia production for students with special needs (Warschauer 2006). Technology provided an alternative pathway for Brandy to engage with many of the same concepts she would encounter in schools, but through different mediational means.

Mediating Participation

The mediational means (Vygotsky 1978; Barton 1994) available at the Clubhouse, including hardware, software, and mentorship, scaffolded Brandy's initial participation in such a way that she was able to produce an array of projects that she would not have been able to produce independently, at least initially. Brandy's entry points included working with adult mentors, particularly in transcription exercises where she would rap while the mentor typed. In this way, Brandy's participation in reading and writing practices and technology fluency activities were scaffolded and supported.

The Clubhouse community is intended to support design activities and is not a homework help site or a remedial reading center. Thus, the Clubhouse community is not a skills-based literacy community. Rather, the community supports reading and writing in context, such as through surfing websites for particular information, navigating file structures, or writing multimodal texts (for discussion of the value of context-based literacy, see Heath 1983; Street 1988; New London Group 1996). After what one could assume was a series of failed efforts in school to engage Brandy in traditional print literacies, additional remedial reading support might have further alienated her from the reading and writing process. However, the contextualized manner in which print was integrated into her design activities gave Brandy an opportunity to leverage her outside interests while engaging in a high-status activity that connected her to the practices of her peers as well as authentic professional practices.

Brandy's observations of other youth at the Clubhouse mediated her involvement in a more diverse array of design projects as she was drawn into a range of new literacy practices and multimodal text making. She initially explored activities that required little or no text decoding or, when decoding was required, relied heavily on adult mentors to provide support for her work, often using strategies to cover up the fact that she was unable to read and write (see Hall, Larson, and Marsh 2003). The high value the community placed on work done with Scratch stimulated Brandy's interest in working in the program, though initially without doing computer programming. As she began working with Scratch, opportunities soon arose to pull Brandy into the community's programming culture. Crucial events included her key-press

projects and her discovery of the newly available Scratch cards. Eventually, Brandy immersed herself in computer programming to the extent that she created more Scratch projects than any other member of the Clubhouse and produced some of the community's most aesthetically compelling pieces, according to the panel of outside experts.

Brandy's entry point into the programming culture came after several months of free exploration in Scratch, a time during which she was able to engage in the more elementary aspects of the program, drawing characters in the paint editor, dragging them across the screen, and adding her live narration. Being able to develop projects in Scratch without the use of programming was key to Brandy's entry and eventual sustained participation. Thus, the Clubhouse's use of software that allows for a wide array of initial entryways and has the capacity to engage learners in text-based literacy practices helped Brandy make explicit links between new and traditional literacies. Prior to computer programming, Brandy's new literacy and traditional literacy practices existed separately. Her activity in Scratch, however, provided a platform for bringing together such practices to create significant meaning.

Making Links between New Traditional Literacies

A few experiences appear to have been critical in helping Brandy make the connection between new and traditional literacies. First came the transcription activities in Microsoft Word, which helped Brandy understand the relationship between oral speech and writing. Then she discovered she could make onscreen objects in Scratch respond to keyboard presses. Brandy's assignment of key presses to stacks of code reinforced letter identification and knowledge of the keyboard. Afterward she realized she could decode Scratch cards to write her own programs. From there, Brandy began to rearrange and make substitutions in her coding, remixing prescribed steps on the sample cards in a way similar to the word play youth engage in when learning a new language (e.g., making rhyming pairs by substituting the first letter in a word). Soon thereafter, Brandy's interest and investment in traditional reading and writing activities in the after school hours began to grow rapidly. She began bringing books to the Clubhouse, showing her homework to people, and attempting to handwrite and type full words and phrases.

Brandy learned to computer program at a novice level before learning to read and write. Learning to program appears to have contributed to Brandy's print literacy in four ways. First, it brought her into contact with written language in a highly motivating way—for example, when she had to read command blocks or name and save files. Second, her contact with written language was scaffolded in Scratch by other modalities—for example, when she had to press a letter but could see the results her action had in onscreen movement of an image or avatar. Third, working with the program—for example, by linking command blocks to achieve a result—seemed to develop Brandy's semiotic and metalinguistic awareness of how symbols combine to create meaning, as became evident through her improved understanding of language's function. Fourth, her success in Scratch gave her a sense of confidence and self-efficacy that boosted her efforts to take on reading and writing, which previously had represented domains of failure for her. The results of all this seemed to have a very positive impact. Shortly after Brandy started creating projects via computer programming, we witnessed a surge of interest in reading and writing activities. Toward the end of the study, we were able to document notable jumps in Brandy's reading and writing ability, as she was able to decode simple texts and write partial sentences.

A lack of access to Brandy's school records prevents us from finding out the long-term impact on her performance in school and on standardized literacy tests. Nevertheless, the spikes we noticed in Brandy's reading and writing development that followed corollary spikes in the development of new media skills suggest a strong and positive relationship between the two.

Discussion

We often think about technology use, digital media production, and computer programming as being extras for students who are already excelling in the traditional curriculum. Brandy's case illustrates that these supposed extras may, at least for some learners, be just what is needed for the rest of the pieces to begin to fall into place. Though we cannot generalize from a single case, the study does at least raise questions for further consideration in a number of educational areas.

First, we might consider whether we could improve early literacy education by broadening the way

digital media are integrated into the curriculum (see, e.g., New London Group 1996; Luke 2003; Gee 2004; Marsh 2005; Warschauer 2006, 2011). In doing so, we may create opportunities for emergent readers and writers to leverage their multimodal text-making abilities. Learners usually bring with them a large repertoire of stories and understandings from their experiences in and with new media, including popular television shows, video games, board games, and other media targeting young children (Barton 1994; Kress 1997). As Brandy's case shows, creating a permeable space for young learners to bring their understandings to the fore can allow emergent readers and writers to showcase their abilities.

Beyond multimodality in general, this study suggests the specific benefits for literacy that can come from multimodal computer programming. Though Papert's (1980) earlier work with Logo programming gained a wide following in schools, in recent years computer programming among elementary school children has fallen out of favor, probably in part due to schools' narrow focus on raising test scores in reading and mathematics. Today, though, with the rising prominence of apps for smartphones and tablets, as well as the availability of simple new tools that allow children to create apps, the potential benefits of children's programming are more evident than ever. This study suggests that, in addition to introducing students to computer science, problem solving, and algorithmic thinking, programming might aid struggling students with basic literacy. The question is at least worthy of further exploration.

This study also suggests an alternate avenue for youth to learn new literacies, including visual literacy, media literacy, and technological fluency (see New London Group 1996; Gee 2010). One of the most common uses of multimedia in schools is through student production of PowerPoint presentations, frequently in a way that adds little educational value and may actually subtract it (see discussion in Warschauer, Knobel, and Stone 2004). Though Scratch can be taught as badly as PowerPoint often is and though where to include Scratch programming in the school curriculum is often not immediately obvious, the study suggests that for some learners it has some powerful affordances and thus might be considered for broader use in school and after school programs. Additionally, we advocate that programs such as Scratch be integrated into arts or language arts classes, in addition to science, technology, engineering, and mathematics courses, because the use of such programs can enable learners to produce personally meaningful work through nonlinear and self-directed explorations (Peppler 2010).

The study also informs our understanding of what kinds of technological tools might be beneficial for learners from a wide array of language and literacy backgrounds. In current multimodal software applications for education, the laudatory framework of Universal Design for Learning (UDL) (CAST 2010) is often misapplied, with an emphasis on making only *current* academic content as accessible as possible (which often involves simplifying language or replacing texts with images). However, UDL also entails empowering learners to develop the knowledge and skills necessary to access *future* content (Rose and Meyer 2002), and that requires a more sophisticated and multifaceted approach. For example, Scratch is fun, but it is hard fun. It is accessible, but it is challenging. It has many entry points that leverage students' ability to draw or tell stories, but it requires engagement with increasingly complex texts for students to exploit the software for creative programming. It allows emergent readers and writers to get started with what they have at hand, but it incentivizes learners to tackle hard problems and language and in doing so to produce work that carries clout among peers and builds connections to professional media communities. Designers of other media for education will do well to draw on these successful elements of Scratch.

We can also consider the possible implications of this study for the creative uses of technology in special education. Brandy showed us that at least some children with cognitive or learning disabilities can succeed at digital media production despite severe limitations in reading ability and lack of programming experience. Digital media production can potentially provide a valuable pathway toward development of reading skills. Further research with students of different ages, with different types of disabilities, and using diverse tools is required to extend and deepen the lessons Brandy has taught us and to help us better understand the educational potential of creative media production for other youth with special needs.

Finally, Brandy's case has something to teach us about the social construction of disability. After school centers such as the Computer Clubhouse are designed to be as inclusive as possible and provide supportive educational opportunities to youth

who have been marginalized. However, in Brandy's case even those who had the best of intentions overlooked many of her strengths and achievements. Only through extraordinary persistence was she able to break through misconceptions and barriers. A few key events from this narrative stand out as lessons for communities wanting to encourage all their members, regardless of their (dis)abilities, to reach their fullest potential. First, leaders of this project had to step back and look at the data on occasion to see who was participating and in what ways. The data we examined indicated that Brandy was an extraordinarily active and productive user of Scratch, a fact that had not been immediately obvious to Clubhouse leaders and mentors from their day-to-day perusal of events, review that was perhaps unduly influenced by their preconceptions. A second key event occurred when an outside committee was able to see the value in Brandy's work in ways that had not been evident to the Clubhouse mentors and leaders. Outside evaluation helped shift the community's perceptions of her ability. External assessment has been proven to be of value in other educational contexts (see, e.g., Reeves 2004), but it is usually used only in schools in narrow high-stakes ways (i.e., for standardized multiple choice tests). Broader uses of external assessment, for both formative and summative purposes and for measuring a wide variety of student products, potentially has great value, as seen in this example. Finally, Brandy's eventual recognition by the community and the invitation to present her work publicly at the university and participate in the college tour was of great importance to her. This recognition was key to her identity development as a self-confident multiliterate contributor to the community and not just a girl nicknamed "Special Ed."

Conclusion

The educational value of after school environments for at-risk learners has been well documented (Nicolopolou and Cole 1993; Gutiérrez, Baquedano-López, and Asato 2001; Hull and Schultz 2001), as has the role of digital media for promoting valuable new learning opportunities, both in school (e.g., Warschauer 2006, 2010) and out of school (e.g., Gee 2003; Black 2008; Ito et al. 2009.) However, within this body of research on out-of-school and digitally supported learning, little attention has been paid to the situation of children with learning or cognitive disabilities, who are too often poorly served by the existing school system (see, e.g., McDermott and Varenne 1995).

This case study offers an in-depth examination of one child's learning experiences with digital media. Overcoming both her own disabilities and the low expectations of the adult staff, Brandy developed skills in both programming and reading, becoming a valued member of the learning community in the process. Her successes in programming and in building bridges between multimedia and print literacies suggest potentially new pathways to promote meaningful experiences for youths with special needs in and out of school.

Note

1. Throughout the quotations and extracts presented in this article, the abbreviation "OC" (or "O.C."), for observer commentary, indicates that a bracketed comment appears in the original field note or document. Interpolations that do not include this abbreviation were added by the authors of the article.

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