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The Markings of a New Pencil: Introducing Programming-as-Writing in the Middle School Classroom

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Abstract

Using the setting of a writing workshop to facilitate a deliberate process to learn computer programming, this exploratory study investigates where there is a natural overlap between programming and writing through the storytelling motif, and to what extent existing language arts coursework and pedagogy can be leveraged to introduce this new form of digital composition to middle-school children. Whereas previous studies linking children's programming with storytelling did so within the informal afterschool clubs, this study focuses on integrating computer science into the classroom, aligning curricula to core-content English language arts instruction.

Keywords: writing workshop, computer programming, digital storytelling, digital composition, middle school language arts

"For me," Seymour Papert (1980) famously declared in his book *Mindstorms: Children, Computers, and Powerful Ideas*, "'computer as pencil' evokes the kind of uses I imagine children of the future making of computers" (210). Papert's reference to the pencil is quite deliberate here. While hardly as intricate as a laptop computer, the pencil—as Petroski's (1992) short history demonstrates—was a remarkable technological innovation when it first emerged in the mid-17th century. Less cumbersome and dirty than a piece of charcoal and far more precise than even the finest tipped brush, the wood-encased graphite could quickly produce writing on a much wider range of materials and made the writing process far less arduous. When the eraser was added in the mid-19th century, the pencil also made the writing process far more revisionary in nature as the products of its markings could now be returned to and altered over and over again. To what extent has the computer, as the new-and-improved pencil, made similar gains in terms of enhancing the process, products, and perception of writing? Now thirty years later, Papert's vision of a computer for every child in every school seems not only visionary, but also prophetic. While still not as ubiquitous as the yellow No. 2 pencil, computers are nonetheless widespread in schools as technological tools to heighten and broaden communication.

As much excitement as computers in schools generates, it is easy to overlook that computers have been in schools for three decades without necessarily making a large change in the way children actually write—at least within the classroom (Collins and Halverson 2009). A large-scale, nationally representative study sponsored by the Kaiser Family Foundation (Rideout, Foehr, and Roberts 2010) indicates that while children may have the digital devices themselves, they do not necessarily know how to optimally use them creatively nor critically, resulting in a dominant paradigm that keeps many children only on the receiving end of corporate media. While children spend considerable time "reading" their computers through the ever-present stream of words and images, there is far too little "writing" with these digital devices, creating anew imaginatively, critically, and collaboratively. Over the past decade, there has been a promising shift among educators to focus on digital media not simply in terms of the physical products themselves but also in terms of a composite digital literacy (Alvermann 2002; Lankshear and Knobel 2003; Hobbs 2010) giving users the capacity to access, analyze, and engage with such technology both critically and creatively. One such strain of media literacy has been in the area of computer programming. Long considered to be the erudite pastime of "techies" alone, programming is increasingly recognized by educators

as a potential pathway by which to get all youth more engaged in the workings of the web-based media that surround them (Boutin 2010; Wing 2006). By introducing children to the underlying language upon which countless applications run, programming helps demystify the process by which media are created and ultimately gives children the opportunity to not only read digital media but to write such media as well.

This study is rooted in this notion that schools are responsible for developing children's literacies across the curricula as opposed to segmenting reading and writing into an exclusive skill set far removed from the usage of digital media. Building upon previous research on teaching programming in terms of storytelling (Bruckman and DeBonte 1997; Burke and Kafai 2010; Kelleher and Pausch 2008), the study considers programming in terms of writing within the traditional core subject of English language arts (ELA). Using the classroom setting of a writing workshop as a means to facilitate a deliberate process by which one can learn programming, this exploratory research investigates (a) where there is a natural overlap between programming and writing through the storytelling motif, and (b) to what extent existing language arts coursework and pedagogy can be leveraged to introduce this new form of digital composition to children. With a total of ten participating middle school students (ages 12-14), I conducted a seven-week long writing workshop that focused on generating one's own digital stories using the introductory programming language Scratch (http://scratch.mit.edu). This article describes how the students drafted, revised, and published their own unique digital stories in Scratch and in the process learned about this connection between programming and writing as overlapping forms of composition. As Hagood (2011) points out, "the future of media literacy development must include both the development of traditional skills of reading and writing combined with the new literacies practices involving speaking, viewing, listening, and designing" (12). This study represents one small step in such a direction, asking a two-part research question: First, how do the programming activities that children employ with Scratch potentially link to the traditional writing skills they have encountered in their English language arts coursework? Second, how can educators explicitly link programming and narrativecomposition and move beyond the oft-used "writing" metaphor to actually connect children's coded compositions in Scratch with the traditional narrative and writing skills they encounter in the classroom?

Background

Examining the nature of writing in her seminal book *Education and Learning to Think*, Resnick (1987) adeptly points out that the writing venture is not simply a product but also very much a process, and that the key to effective writing is to hold such duality in balance, emphasizing and evaluating the final artifact itself but never losing sight of the crucial steps by which it was generated. The extent to which K-12 writing instruction has struck this balance between product and process is limited at best. For the majority of the 20th century, schools largely considered student writing only in terms of the finished product (Resnick 1987; Tompkins 2000). Students were assigned the paper itself and there was the subsequent expectation that the writing would be submitted in a timely fashion, but there was scant consideration (nor class time granted) for the considerable "in-between" part—namely the writing process itself. The pedagogical move toward maintaining writing portfolios beginning in the late 1980s (Baker and Linn 1992; Wolf 1989) challenged this conception of writing as solely a product, emphasizing it as a perpetual process. Such "perpetuality" however presented new challenges for writing instruction as the portfolio movement often shifted the balance too far in the other direction, overemphasizing process to the extent that students could have well over a dozen sketches and drafts at course end but ultimately would lack a single coherent and polished piece of writing (Stecher 2006). Writing instruction may very well be perceived as a "balancing act" (Tompkins 2000) and not an easy act, as evinced by research documenting a persistent and seemingly intractable sense of writing anxiety among pre-adolescent and adolescent students (Daly and Miller 1975; Martinez, Kock and Cass 2011).

To what extent have computers in schools addressed this much-needed balance between writing as both product and process and addressed youth's negative perception of the practice? In terms of background, research on computers and writing in school falls into three distinct periods: (1) the typed page through computers' first appearance in schools during the 1980s as word processors; (2) multimedia writing through digital storytelling initiatives of the 1990s which combined words

with images, music, and sound; and (3) programming-as-writing, a new and unique form of digital composition emerging over this century in which words, images and sounds are not only arranged as text but coded sequentially as a unified narrative. An overview of each is outlined in this section.

Word Processing: The Typed Page

When computer-assisted instruction first emerged on the K-12 landscape in the early 1980s, many educators and researchers identified word processing as the ideal use of the microcomputer (Daiute 1985; Edelsky 1984; Green 1984). Students no longer had to be weighed down by aesthetic concerns associated with the final "product" of writing, such as bad handwriting, which too often received more attention from educators than sentence structure and word choice (Cochran-Smith 1991). The potential to produce a "clean" piece of writing of uniform black lettering on white paper meant that teachers could more closely examine the thoughts denoted by the words as opposed to the legibility of the words themselves. Perhaps even more significant than this removal of surface level aesthetics was the computer's potential to make the revision process more efficient. Students could revise their papers without having to go through the laborious process of rewriting and recopying the entire piece; freed from the physical constructs of pen and paper, students could better grasp writing as a veritable "process" and not just the production of a single and permanent end-result (Graves 1983). Yet while some teachers utilized computers' word processing capabilities to highlight writing as a dynamic and continuous process, other educators simply perceived computers as elaborate typewriters and introduced their students to the machines as such (Sheingold, Hawkins, and Char 1984; Hawkins and Sheingold 1986). In these instances, such a perception ensured computers did not really change the composition process but only tacked on another step as students still drafted their papers by hand and only utilized the word processor to "type up" the final drafts for an aesthetically cleaner and uniform look.

Multimedia: Digital Storytelling

As computers grew increasingly sophisticated in the 1990s, their potential to amplify the writing process grew more readily apparent. With the emergence of new software applications and the explosive growth of the Internet in the early 1990s (Watson 2006), computers gained the capacity to store and display a growing variety of visual and audio features, and students' writing with computers likewise became populated with these images and sounds (Kress 1998). Interestingly, the aesthetic element of writing which word processing aimed to neutralize through uniform black-on-white compositions was now being amplified by computers. Instead of simply describing their summer vacation with words alone, children could now incorporate accompanying photos from the vacation itself to highlight their descriptions. Instead of just writing a report on their favorite musical artist, children could create a presentation incorporating snippets of the music itself, punctuating the singer's musical development over the years. Out of this combination of words, images, and audio (as well as from a broadening conception of "text") came the practice of digital storytelling (Robin 2008). With its earliest incarnation in the late 1980s (Lambert 2002), digital storytelling has since emerged as a growing medium by which to expand the concept of writing and literacy and introduce children to the applications of storytelling, writing, and technology through a mix of words, images and sounds. As with computer word processing (Goldberg, Russell, and Cook 2003), research (Sefton-Green and Buckingham 1996; Vincent 2003) demonstrated children's enthusiasm for writing increased with the introduction of multimedia applications. Children were excited about the opportunity to incorporate media from their own life and/or personal tastes into their writing, just as they were stimulated by the prospect of eventually publishing their compositions online and sharing them with each other. In this sense, digital storytelling offered new opportunities to make the composition process more of a personal process and a participatory one.

Programming-as-Writing: The Coded Narrative

One of the more recent forms of digital storytelling is particularly unique in that such storytelling is based in computer programming. Like new media studies, programming-as-writing relies upon words, images, and sounds to create multi-modal digital stories. Whereas new media studies focused on accompanying words with images, video,

and audio to enhance the text, programming-as-writing treats the words as the driving component producing these multimedia features. Instead of co-existing with digital graphics and sound effects on the screen, words act as the underlying language through which to animate these graphics and coordinate their movement to sound effects and music. Programming-as-writing thus represents a unique shift in not only the digital story format but also when it comes to writing with computers in general. The words (re: code) that drive forth the story itself remain hidden, acting as the "workers" behind the scene, producing the aesthetic but never on stage themselves as part of the aesthetic. The veiled aesthetic of code speaks to the distinction between coding and writing and why programming tends to be viewed solely through the lenses of science and mathematics as opposed to those of humanities and art. It also offers some explanation as to why previous research studies on programming-as-writing (Bruckman and DeBonte1997; Kelleher and Pausch 2008) have focused exclusively on the programming aspect of such activities instead of also exploring how such composition can also facilitate children's writing abilities. Such studies using programming in terms of writing have not been particularly interested in the writing component except insofar as it offers a means to introduce children to fundamental programming concepts. While coding is certainly a valuable skill, using narrative composition simply as a way to draw children into programming neglects to take into account the full and rich ways such storytelling can also be used to develop children's sense of writing as a means to frame, organize, and sequence ideas. It ultimately does not have to be an either/or scenario: digital storytelling within the context of programming can and should have the double benefit of supporting both the learning of programming and the learning of writing in meaningful ways. Educator Sandy Hayes (2005) points out, "Remember students don't have to produce standardized writing to meet writing standards" (7). Programming-as-writing represents one such potential "unstandardized" format of writing that deserves further exploration in schools—and not only within English language arts classes (as subsequently outlined below, but within any coursework (be it Social Studies, Science, or Math) in which narrative figures prominently as a means to ground learning in the communication of human experience.

A Middle School Language Arts Elective Course

For seven weeks in the Fall of 2010, I set up eleven writing workshop sessions using the introductory programming language Scratch with a group of middle school students. Set within an urban public middle school located in West Philadelphia, the workshop consisted of ten male students (ages 12-14) who were representative of the school's racially diverse population of African-American, Caucasian, and Latino children. All ten participants chose to be in the course which met twice a week over a period of two months as part of an elective option at the school entitled "Choice". Eleven projects were collected in total (one participant created two stories) by the end of the program.

The Tool: Scratch

Since its public launch in 2007, Scratch has helped to introduce basic programming concepts to children (primarily ages 8-16) while also allowing them to create and to share their own digital media. Designed to be intuitive in its operation, Scratch allows users to manipulate media through a process of "drag-and-drop" command blocks of code, then stacking these blocks together to form coding scripts (Resnick et al. 2009). These scripts are then activated by various inputs, be it a keystroke or the click of a mouse, bringing to life the various Scratch character "sprites" and backgrounds (see the ocean-life scene in figure 1). Simply knowing how to use a mouse is enough to get started, though the program's wide variety of textual coding bricks ensures that users can create projects of significant complexity as they progress.

Much of users' growing proficiency with Scratch comes through the projects they encounter on the accompanying Scratch website (http://www.scratch.mit.edu). Dubbed "the YouTube of interactive media," the Scratch website currently has more than 800,000 registered users worldwide and more than two million projects uploaded to date, 15 percent of which are categorized as "digital story" or "story" through users' self-generated tags (Burke, Monroy-Hernandez, and Kafai 2011).

Choice Elective and Alignment with State Academic Standards.

Designing the course around a scaled-down version of Calkins' (1986) well-known writing workshop model, every Choice session opened with a

Figure 1. Screenshot of the "Shark Attack?" Scratch interface and the coding bricks (inset) determining the yellow fish's behavior in the scene.

brief "mini-lesson" emphasizing a particular element of effective composition (such as characterization, foreshadowing, setting a scene) which would likewise be tied to learning a particular coding procedure in Scratch (e.g., using the broadcast feature to establish dialogue, importing external images, using loops to standardize behavior). Following Calkins' directives for supporting mini-lessons with examples, every lesson was supported by one to three sample digital stories selected from the Scratch website, which exemplified a particular storytelling element or genre of storytelling (e.g., mystery, action/adventure) featured within the lesson. This not only grounded the lessons in practical application but offered an excellent segue to examining the actual coding scripts of the projects. All lesson plans were aligned to Pennsylvania state standards for reading, writing, listening, and speaking for grade 8 and supported by the school's junior-high literacy instructor who offered feedback rubrics and pre-writing activities from her own classes which were likewise based off of Calkins' text.

The workshop consisted of five stages over seven weeks. While the stages are individually distinct, they did overlap from week to week depending on individual student progress:

Pre-writing/planning (weeks 1-2). All participants generated 3-4 "seed ideas" (Calkins, 1986) and entered these into their Writer's Notebook, which they then reviewed with me for feedback.

Drafting (weeks 2-3). Once students had shared their seed ideas, they proceeded to sketch out these ideas using storyboards. With a pencil, the children drew out their individual shots with the knowledge that these screen-by-screen renderings would act as a "roadmap" for their compositions.

Revising (weeks 3-6). Once their storyboards had officially been approved (sessions 3 and 4), the students began to compose their actual digital stories. All participants utilized both a "bottom-up" and "top-down" aproach to composing their stories, both creating entirely new projects in Scratch as well as sampling others' finished projects and repurposing the code for their own projects. The majority of participants leaned more to "bottom up" composition, particularly over weeks 3-4 of the Choice class.

Editing (week 6). This was the briefest stage in which students made final revisions based on comments they had received online as well as during weeks 6-7 of class. Many of the edits were simply "fine-tuning" language in terms of correcting spelling and grammar in characters' dialogue or trouble-shooting the programmed behavior of a coded sprite.

Publishing (weeks 6-7). All students posted to the Scratch website again over the final two weeks of the workshop. On the last day, students presented their final projects to their classmates in terms of plot and characterization as well as in terms of the underlying code.

Data Collection and Analysis

Over the 7 weeks of the workshop, I used a variety of data collection techniques to address my research questions. These include field observation, video recording, artifact analysis, and interviews. Field notes were collected during every session and transcribed within a 24-hour period. Based on observations within the room as the participants interacted with each other and Scratch, field notes started as shorthand observations made with a pen and notepad before subsequently being typed into narrative form. All workshop sessions were video recorded in their entirety with select sections—in particular gallery walks and student presentations—transcribed for the sake of better capturing a moment-by-moment understanding of how students used the software in the workshop. All Scratch projects were periodically collected over the duration of the program (a minimum of three times per project) and subsequently examined in terms of their staged storylines and underlying coding scripts. Last, at the program's end, all students participated in 5-10 minute interviews gauging their experience. These interviews were video recorded and subsequently transcribed in their entirety.

In terms of data analysis, the goal was to triangulate data sources (Denzin 1978) in order to provide a more accurate account of the workshop activities, and to consider the vantage point of multiple data sources in conjunction with each other. For such triangulation, my data sources came from three distinct vantage points: my own direct observations (via field notes taken on-site and through video footage); the personal perspectives of the participants themselves (via video-taped post-interviews); and the actual digital stories themselves (via artifact analysis of the Scratch projects).

Field note observations were the starting point of my data-analysis. I initially reviewed the collected notes in their entirety, identifying particularly salient themes that ran across the multiple workshops. Themes included the role of the sample stories in providing ideas, the role of in-person and online collaboration in developing these ideas, and the role of storytelling as a means to better understand code, among other usage trends. Following this initial review, I went through all the notes again, coding them now thematically (Strauss and Corbin 1998) based on this initial set of trends to more systematically capture a sense of how the class, as a whole, performed and reacted to the workshop model. I followed this same two-step thematic coding process both with the transcribed post-interviews as well as the transcriptions of select video-recorded interactions within the class, using many of the same themes noted within the field notes and adding others that especially related to participant perception, including students' personal feelings about their completed digital stories and the Scratch workshop, in general.

In terms of the actual projects, I analyzed all of the final projects (as well as various earlier iterations) both in terms of their constituent storytelling elements and the coding sequences each employed. Based upon Rumelhart's (1975) seminal concept of a "story grammar" as the essential structures shaping any narrative, the storytelling elements by which I evaluated the effectiveness of each digital story included plot, characterization, setting, dialogue, point of view, style, and overall theme—narrative features that figure prominently in any language arts curricula from elementary school up through high school. As far as evaluating each project in terms of the coding sequences they utilized, I analyzed each project's programming blocks using Scrape technology, a tool developed by RiverSound Media (http://happyanalyzing.com) that tallies the number, the range, and the frequency of the various Scratch blocks being used to provide an overall "snapshot" of the underlying programming schemes operating each project.

Findings: The 3 Ps

Over the course of the workshop, students learned both the fundamentals of programming and storytelling, and this is charted in table 1 in terms of the products (digital stories) they created, the processes (debugging and revising) they utilized, and their overall perceptions of the workshop.

Product

Nine out of the 10 participants generated a complete digital story, entailing multiple characters, settings, and plot stages. One such story is Andre's "Trouble at the Playground" (see figure 1 for captions). Based on a real-life experience about an encounter with an older group of boys at the school's basketball court, 8th grader Andre initially had composed the story as a graphic novel in his 7th grade literacy class, substituting anamorphic animals for himself, his friends, and the children they encountered. A tall boy for his age, Andre selected a giraffe for himself, while his four smaller

Table 1. Data results for both coding and storytelling

Writing Workshop Focus	Scratch Programming	Writing
Product *What did they learn?*	Basic programming concepts *(e.g., loops, event creation, and handling, parallel execution)*	Essential story elements *(e.g., denouement, rising action, conflict, resolution, and characterization)*
Process *How did they learn?*	Design, troubleshooting, debugging	Drafting, revising, editing
Perception *Attitudes toward programming and writing and their relationship*	Understanding coding as a form of sequential composition	Understanding the utilitarian nature of the writing framework

friends including a set of twins were represented by a pair of identical deer, a squirrel, and a bird. Fittingly, Andre represented the anonymous (and seemingly menacing) children as a trio of lions (see Appendix for screen-by-screen rendering of Andre's story).

Andre's selection of animals drew laughs from some of his audience during the presentation over the last day. Already familiar with the real-life situation, they enjoyed seeing the visual representations of their peers, particularly the deer for the twins and the wide-eyed squirrel for one boy who was known for his excessive "chattering" (talking) in school. Publishing the project online at the Scratch website, Andre also had the satisfaction of finding an audience for his work beyond the classroom, receiving a complimentary comment one day after he posted. Like his peers in the classroom, Andre relied heavily on his drafted storyboard to sequence the events, develop tension in the scene, and arrive at a satisfying resolution. During the actual composition process, Andre spent more time tinkering with the finer details such as dialogue and precise timing of characters' arrivals and departures from the various scenes.

Not all stories transferred as well from participants' brainstormed ideas into the Scratch medium. Stories that were primarily visual-based, like Andre's "At the Playground" (see figure 2), transferred quite well. Given his storyline already existed as a graphic novel, Andre essentially had his storyboards in place (see figure 3).

Seventh grader Ishmael had a much more difficult time, however. Like Andre's, Ishmael's story was to be a personal one—his reaction to the death of his two pet birds. Yet upon learning this highly sensitive story was to be displayed in front of his peers and potentially uploaded to the Scratch website, Ishmael balked. "You mean, I got to share this in front of all those guys?" he exclaimed to me privately during week five, "No way!" Losing steam, Ishmael ended up abandoning his narrative and instead opted to make a video game based on Pong in which his birds replaced the bouncing ball, which neglected the storytelling motif altogether.

Yet Ishmael's project "Bird Pong," like all other projects submitted, did successfully exemplify a wide range of basic yet fundamental programming concepts. As a "by-product" to the digital stories themselves, all participants employed basic coding principles. Though Scrape analysis, table 2 highlights some of the programming concepts students used in the creation of their stories as well as the frequency of use. The seven programming concepts are not exclusive to the Scratch software, but are characteristic of any programming language (from Java to C++), offering students a baseline understanding of coding literacy. As evident in the table, some coding features such as coordination and synchronization and loops figure prominently in the storytelling format, while others such as Boolean Logic, Conditional Statements and Variables were utilized far less. Characteristic of game-play in which is no fixed outcome, these programming concepts figured less prominently in the straight-linear narratives that the students composed in which there was a fixed ending.

Process

PA English Language Arts aligned mini-lessons. The coded commonalities among projects are not surprising given that all students followed the same process in the classroom. All 10 participants had a strong sense of the stages of writing—from brainstorming and pre-writing through drafting and revising, and finally formally presenting and publishing. This was the expectation—having met with Mrs. Steinberg the month prior to the workshop, she assured me the

Figure 2. Translation of Andre's graphic novel into Scratch

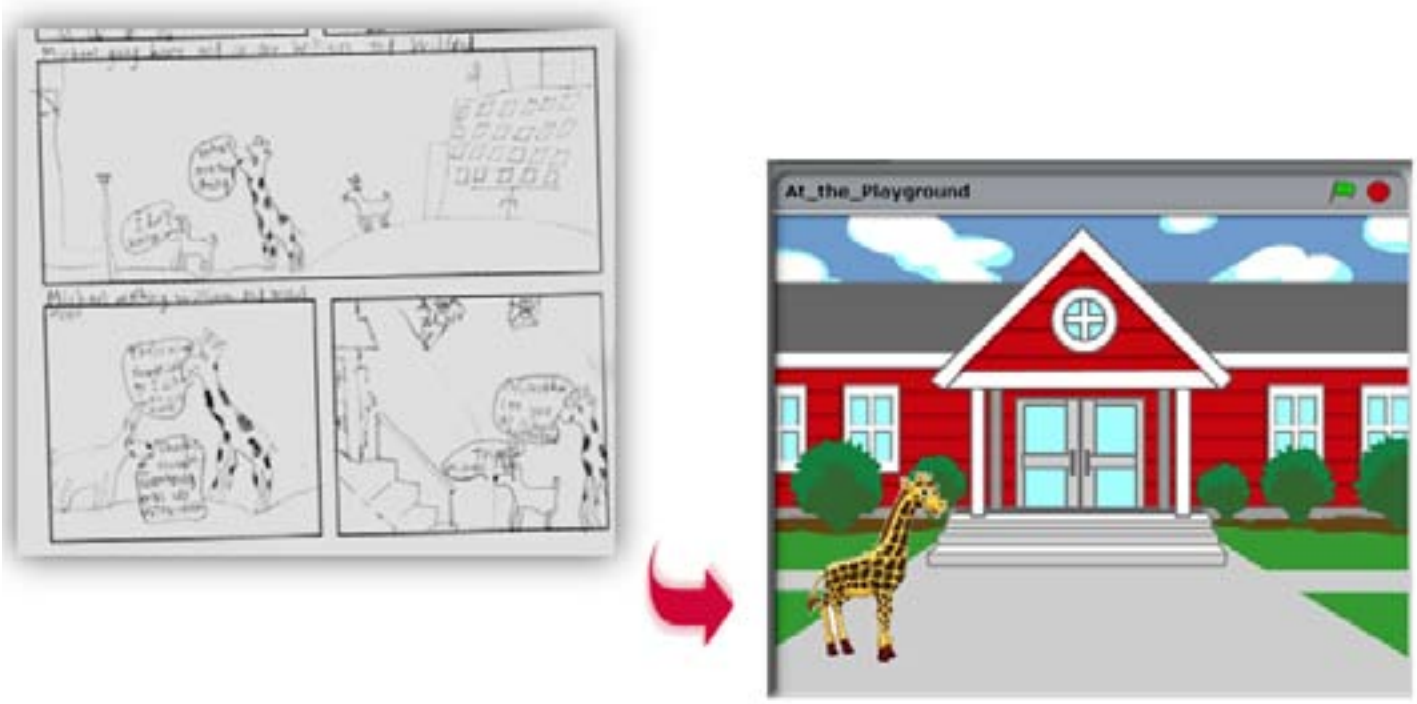


Table 2. Types of programming concepts utilized and in what frequency

Programming Concepts	% of Projects Utilizing the Concept	Frequency per Project
Coordination and Synchronization	100%	8.8
Threads (Parallel Execution)	100%	1.6
Loops	90%	2.5
Event-Handling	100%	1.5
Boolean Logic	20%	1.6
Conditional Statements	30%	1.7
Variables	10%	.3

students went through these stages of composition whether they were composing a poem, a graphic novel, or an expository essay. However, even more than their familiarity with the stages of writing, the middle-school students' familiarity with the elements of writing—particularly the elements of creative fiction—were reinforced through students' composition in a new, somewhat foreign medium. Couching the use of Scratch in terms of common language arts concepts such as rising action and static versus dynamic characterization proved remarkably effective in acquainting (or in some cases, reacquainting) the students to the Scratch programming language. Simply being able to describe basic elements of programming in writing terminology increased students' familiarity with the coding process. Programming "sprites" or "objects" could be described in terms of the characters of "protagonist" or "antagonist"; the programmer's "design" became synonymous with a writer's "draft," while the "de-bugging" process was explained in terms of "revising" and coding "parameters" were determined by clearly identifying each character's underlying "motivation" within the wider narrative.

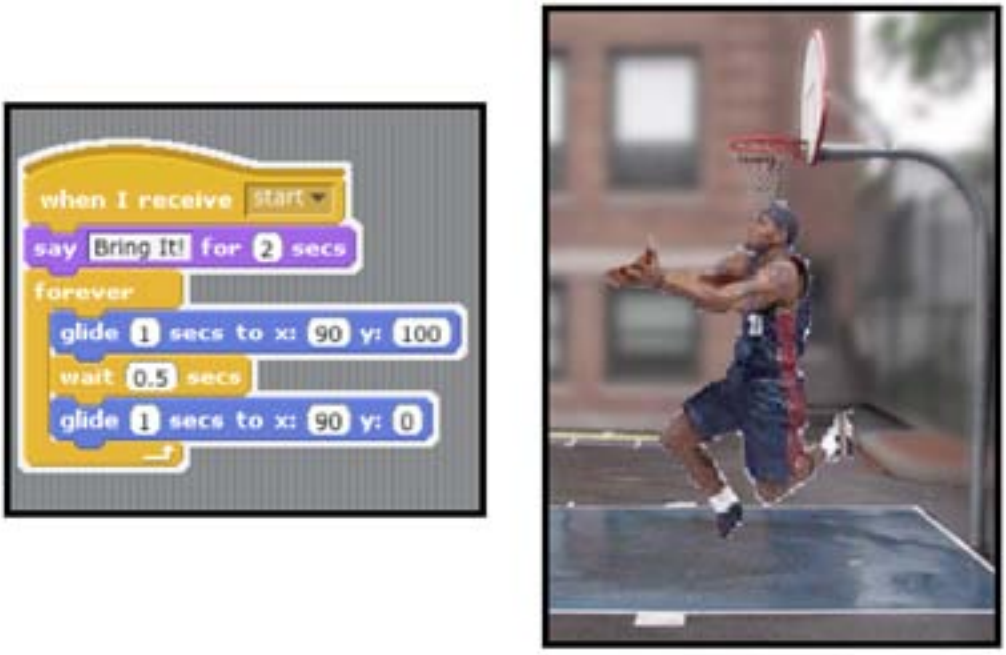
"Oh yeah, I understand 'round' versus 'flat' characters," eighth grader Marcus remarked with some surprise when I explained during session 3 how flat "stock" characters' programmed behavior could be "looped" while the protagonist's more dynamic (and thus "round") behavior would be far less repetitive. Accordingly, children learned to program Scratch sprites based on a particular character's motivations. In this sense, literary elements such characterization and setting served not only as a means to introduce programming terminology, but also reinforced the utilitarian nature of these tropes in framing and arranging ideas. In the case of seventh grader Barry's "One-Man Hamlet-Scam" project, the lead character (a robot reciting "To be or not to be" before shuttling off the stage prematurely) has a diverse, linear-based coding sequence, timed out in intervals. Meanwhile, the two unseen hecklers (represented as black dots) have programmed behavior that is far less varied and entirely looped, typical of characterization that is both flat and static in nature. Likewise, Marcus' "Fantasy Basketball" project had a dynamic protagonist, NBA player Tim Hardaway, while the antagonist's (NBA nemesis Lebron James) behavior was looped to have the character simply jump up and down continuously in an attempt to block Hardaway's shot (see figure 3). These instances of successful overlap between coding and language arts concepts were well facilitated by the structure of the lesson plans which identified both the technical and imaginative process of composition and which tied easily to PA eighth grade ELA standards, which were general enough to ensure such composition need not be with pencil-and-paper but could be enacted digitally through coding.

Brainstorming and outlining. Students began to map out their digital stories in Scratch over sessions 3 and 4 of the workshop. Generally, students relied on three different sources to generate ideas for their potential digital stories (none of which were mutually exclusive):

> Writer's notebook: distributed by Mrs. Steinberg to every 7th and 8th grader at the start of the academic year, the thin black-and-white speckled pad is the mandated starting point for any student composition (regardless of the medium). According to Mrs. Steinberg, students need to generate at least three potential ideas before they opt for any single one—a requirement which was maintained for the Choice class as well.
>
> Sprite cache: an assortment of various character images, ranging from people to animals to alphabet letters which are stored within the Scratch software and can be imported with the click of the mouse.
>
> Popular culture: while the term "popular culture" encompasses a virtually innumerable array of source-material, here it refers to those images that students individually searched out over the Internet, saved on their desktops, and imported into Scratch as image files (JPEGs typically). While all participants initially experimented with importing images, four more experienced Scratch users—8th graders Carlos and Marcus and 7th graders Darrell and Amadu—relied more heavily on imported imagery, be it from popular sports video games or from well-known anime books and comic series.

Drafting, feedback, and revising. As an outline, the storyboards served as the students' raw "roadmap" and was the first piece they submitted

Figure 3: Marcus' "static" antagonist Lebron James and its repetitive ("looped") coding sequence



(during session 5) to receive formal feedback by way of written comments. While three of the storyboard submissions were fairly perfunctory, including only an absolute minimal amount of detail, the remaining seven were well organized and utilized the side-space alongside the caption box to explain *the who?* (character/sprites), *the what*? (actions/scripts), and *the where?* (settings/stages) of each progressing scene.

Following my notes on the storyboard submissions, feedback over the next three sessions was more informal, including comments and suggestions on individual student projects as the group worked independently on them. The entire class participated in ten-minute "gallery walk" midway through the workshop, leaving their laptops open to their in-the-works projects and then walking the room to sample each others' stories and ask questions about them. To a certain degree, the projects students had prepared for the gallery walk served as their initial drafts; however, no participant had actually completed his digital stry at this point, which made giving constructive feedback more difficult. Students largely commented on the appearance of other's characters (e.g., "cool costume", "nice look") but had a difficult time providing more substantial feedback about elements like plot development and characterization. "So what's supposed to happen here?" eighth grader Todd asked of his friend, Greg's project during the gallery walk, unable to offer much more given that he was entirely uncertain where the narrative was actually heading.

More directed feedback came from me as an instructor during the next session when all students posted their draft projects at the Scratch website. With storyboards in hand, I reviewed each project based upon what had been uploaded to the website thus far and what the remaining captions on the storyboard indicated should happen next. I used the "Comments" feature on the website to post brief observations and small items of encouragements as well as occasional questions. Given the character-limit of the Comments box as well as the decidedly "non-academic" nature of the website, I opted to keep the comments succinct and casual. The goal was not to exhaust the students with a "to do" list but rather to engage them with the potential of sharing their work with wider audiences online.

Perception

While 70 percent of participants in the post-workshop survey reported the instructor's comments were useful to the composition of their digital stories, students excitement around external comments only outwardly sparked when such comments were truly "external"—namely, from other Scratch users at the

website. "See he doesn't like Lebron James either!" 8th grader Marcus exclaimed aloud upon logging into to the website after his first draft had posted and viewing Scratch user "SLA-support" remark "this is very, very cool—Lebron should lose." Typing back "I don't like Lebron James," Marcus subsequently "friended" this commentator online. Five other student likewise wrote back to those who had commented on their project online, whose feedback ranged from one-word posts such as "funny" to queries about the basic nature of the story, "I don't get how to make this start?" This excitement from online comments however was far surpassed by participants' eagerness to share their finished narratives with their classroom peers during the last day of the workshop. In general there was steady enthusiasm for the workshop over the seven weeks. Based on the post-workshop survey, 70 percent of respondents agreed or strongly agreed that the storyboard helped them create their stories; 70 percent agreed or strongly agreed that they learned more about computing during the workshop, while 80 percent indicated they learned more about storytelling during the workshop; 70 percent agreed or strongly agreed that they felt more skilled at computing based on their experiences during the workshop; 90 percent agreed orstrongly agreed that they had enjoyed the writing workshop experience; and 70 percent agreed or strongly agreed that anyone can be a good writer in Scratch if he or she works hard at it.

In post-workshop interviews, much of the one-on-one feedback from students focused on storytelling, with multiple middle-school students stressing the importance of the storyboards in ensuring they had a particular idea in mind for their Scratch project. "Scratch can do almost anything," explained 8th grader Daryl in his post-interview, "It has hundreds of controls, hundreds of images and you can even take ones of the Internet…And so, all you need to do is have a focus." Likewise, the majority of students (80 percent in the post-workshop survey) felt that storytelling offered a good entryway into learning Scratch's coding sequences and appreciated the opportunity to compose stories in a digital medium. In the post-workshop interview, 7th grader Barry compared the process of transforming his narrative outline into a digital format as akin to making a movie. "And I think," he concluded, "that alot of people nowadays prefer to go and see the movie version of the book than actually read the book." Meanwhile, 8th grader Marcus made a similar point in explaining how his digital story differed from the story he wrote on paper. "It's like—it's just visual," he mused. "It's easier to comprehend, and it is more fun to actually see what is going on instead of just reading about it.

Discussion

Reflecting upon his team's creation of the programming language Logo in *The Children's Machine*, Papert (1993) writes that Logo was to be more than just a means to introduce children to computer programming but essentially serve as "an entirely new language" with which children could make computers "write" (171). While the experiences of these ten children in using Scratch during writing workshop hardly delved into the intricacies of code to this extent, it is clear that the workshop setting alongside the school's existing language arts standards is not only an effective framework for facilitating middle school children's digital composition, but also underscored the wider connection between coding and writing as interrelated processes of composition. Digital storytelling in Scratch—particularly in terms of the workshop's focus on characterization and plot analysis—offers a new medium through which children can exercise the composition skills they learned within traditional literacy classrooms while also offering the mutual benefit of introducing coding at earlier ages. The ongoing debate over media literacy (Hobbs, 2009) is still very much with us as educators, but recent studies by classroom practitioners (Clarke and Besnoy, 2010; Sewell, 2010) clearly demonstrate it does not have to be an "either/ or" scenario; educators can leverage students' traditional conception of writing onto new media platforms to both acquaint them with more sophisticated technologies as well as reinforce the writing process as a utilitarian framework that produces more than simply textual characters but essentially represents "thinking on the page" (Scarmedelia, Bereiter, and Goldman, 1982, 52).

This said, echoing McLuhan's (1965) maxim, one must always be mindful of the medium. As evident in the case of Ishmael's story about his deceased birds, more internal and reflective stories may be less suited to Scratch. In Ishmael's case, the written word would likely afford his personal story a more intimate—and perhaps more appropriate—format for expression. The highly visual nature of the Scratch software and its ready-made authentic audience online may be a motivating boon for some forms of student composition

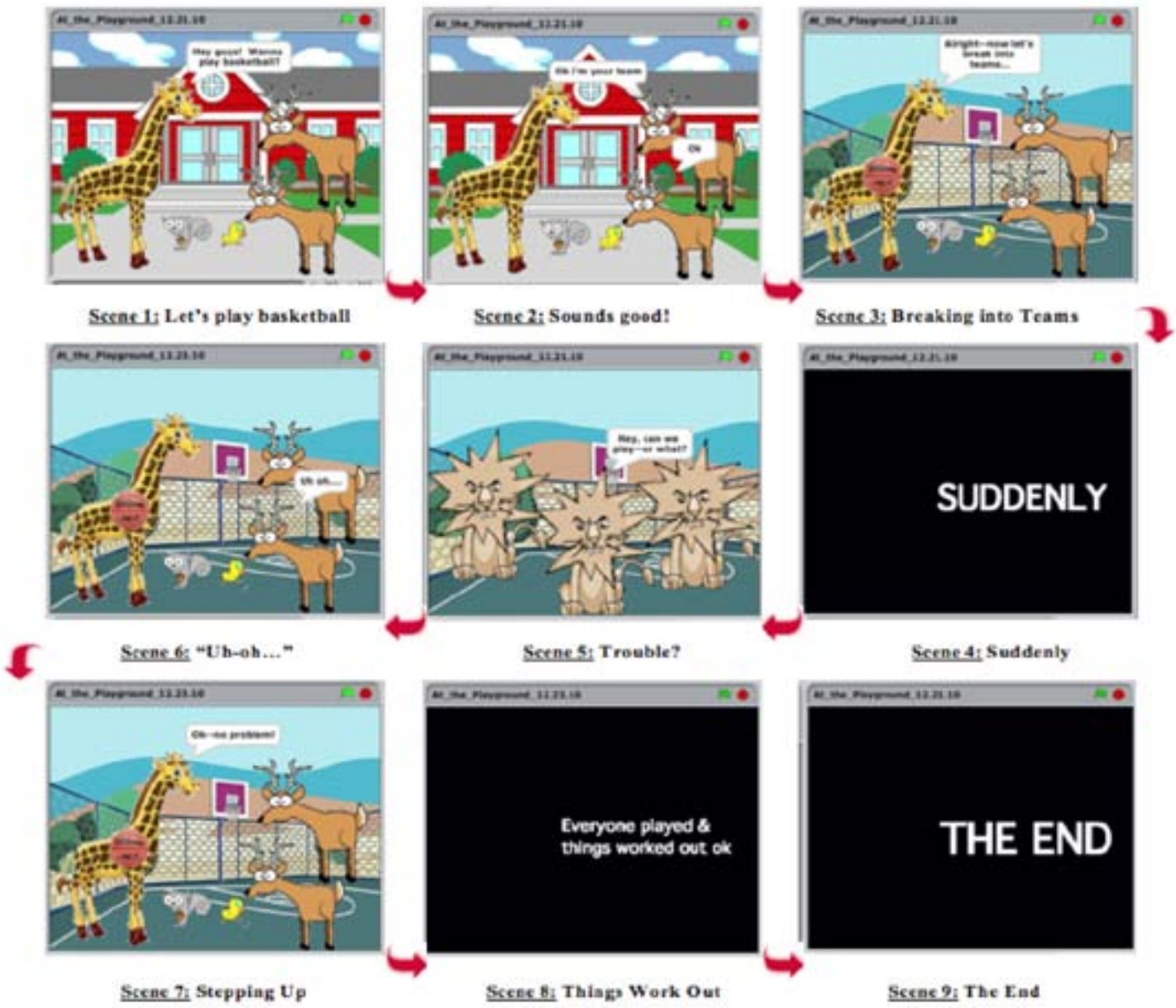
but in other cases, such a medium can clearly be a constraint. What also bears close consideration as far as future workshops are concerned and refining the initial model presented here is the fact that my own study benefited tremendously from (a) my own prior familiarity with the Scratch software and (b) my students' prior experience with the writing workshop model and the stages of composition. Such prior knowledge made it considerably easier for me to plan and pace the workshop accordingly, while the middle school participants clearly had an easier time following the sequence of the seven weeks and intuiting this overlap between writing and code. While the ease to which these workshops aligned to state academic literacy standards (in this case, Pennsylvania) suggests such workshops can and will meet federal mandates for classroom instruction, educators who enact such Scratch writing workshops clearly need the time to prepare and adjust lessons accordingly, as well as teach a population of students familiar enough with the stages of writing to comfortably follow them in terms of Scratch storytelling.

Resources available at the recently developed ScratchEd website for educators (http://scratched.media.mit.edu) act as a starting point for educators as do the National Research Council's (2010) recent curricular and pedagogical frameworks for computational thinking in the classroom. Computational thinking, which emphasizes the practical and *creative* functionality of algorithms, offers a potential new lens for accentuating the connection between coding and writing, both of which attempt to articulate a precise input in order to facilitate a particular output. Freeing programming strictly from the domain of the "hard sciences" and writing strictly from the realm of the "arts", computational thinking may very well represent the most cogent and persuasive initiative to make K-12 computing more interdisciplinary and integrated into core curricula subjects. Building upon Black's (2008) research surrounding the adolescent participatory culture surrounding online fan fiction sites, future writing workshops can also become increasingly collaborative in nature by more fully incorporating the Scratch website into the individual sessions. A series of recent "Collaborative Challenges" issued by the Scratch website encourages such online cooperation and research (Kafai et al. 2011) documenting these online collaborations points to the paramount importance of popular culture books and movies as the common tropes which align Scratch users together, despite frequently having not met in person.

Ultimately—as is the overwhelming case with most educational reforms and adjustments—the majority of the burden falls on the classroom teacher as the veritable "front line" in advancing children's capacity to engage with computers critically and creatively. While few would argue that language-based literacy is less important in the new millennium, it is also clear that the traditional conception of literacy as simply reading and writing text alone is insufficient for the kinds of communicative practices that already characterize 21st Century communication. The New London Group (1996) suggests that the primary mission of education is to "ensure that all students benefit from learning in ways that allow them to participate fully in public, community, and economic life" (60). This call has been subsequently been echoed through a growing body of scholarship (Baker, 2010; Coiro, Knobel, and Lankshear, 2008; Domine, 2009) focusing on what it means to be "literate" in 21st century schools. Educators therefore need new pedagogical and curricular platforms to teach their students how to engage with the variety of visual and textual media that mark contemporary life, or, as Zingrone (2004) succinctly put it, "a one-medium user is the new illiterate" (237).

Appendix

Screenshots of Andre's "At the Playground" digital story



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