

Unfold.studio: Supporting critical literacies of text and code

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Abstract. This article explores how textual literacy and computational literacy can support each other and combine to create literacies with new critical possibilities. The primary research questions were: what kind of medium and pedagogy might support textual-computational multiliteracy; what practices might emerge in such a literacy space; and what are their critical possibilities? These questions emerged through three iterations of participatory design-based research (Bang & Vossoughi, 2016). The initial studies developed a web application for interactive storytelling and a conceptual framework for analyzing critical discourse models, interactive dialogue simulations which represent, analyze, and critique formations such as gender and race. The third study used a grounded theory approach to analyze the emergence and structure of critical discourse models written over two weeks in a high school sociology class. The results are a web application and pedagogical strategies for interactive storytelling and documentation of how textual and computational affordances supported critical literacy practices. Previous work has insufficiently spanned the fields of learning sciences and literacies, respectively emphasizing the mechanisms and the content of literacy practices (Vossoughi & Gutiérrez, 2016). In focusing a design-based approach on critical awareness of identity, power, and privilege, this research develops tools, pedagogies, and theory for supporting critical computational literacy. As computer science becomes a mainstream school subject, we have an opportunity to define how it will be practiced. This article offers a vision of a literacy-based approach which could contribute to liberatory education.

Keywords: literacies, computational literacy, critical literacy, multiliteracy, computer science education, participatory design research

Introduction

Literacy is about much more than learning to read and write. The practices which emerge within networks of people and texts often have prosaic goals such as conveying messages, documenting

agreements, and establishing authority, but they can profoundly reshape participants' cognition, identity practices, and social relationships. Ong (1982) argues that privileged access to reading and writing led to the emergence of new social roles high in the status hierarchy, and that widespread literacy in a society "restructures consciousness" (p. 77) by synchronizing frames of reference such as dates, facts, and perspectives on the world. In addition to supporting practices which define social roles and relationships, Scribner & Cole (1978) found that reading and writing were associated with changes in individual cognition such as improved abstract communication, memory, and language analysis skills (p. 27-29). It is not necessary to argue for a direct causal link between reading and writing and cognitive change; rather they may be seen as tools which have the potential to spur a different developmental path for the individual and for the society (Vygotsky, 1980).

Computational literacy (diSessa, 2001) is structurally similar to textual literacy, and includes practices ranging from programming to interacting with computational artifacts such as Facebook or mobile phones. As text and code offer different affordances, they support the development of different cognitive and social structures. The designers and technologists who invented personal computing were inspired not just by technological possibilities, but also by the possibility of new ways of living (Markoff, 2005). Engelbart (1962) pursued augmented cognition through *bootstrapping*, a reciprocal process by which technological advances allow new forms of cooperation and collaboration, which enable further technological advances. Sensory affordances such as virtual reality and ubiquitous mobile computing present not just new information channels but "material exteriority," (Hansen, 2000) extensions and transformations of the body which redefine the subjectivities we may inhabit (Haraway, 1991; Lanier, 2010). Nelson's development of hypertext was motivated by the possibility of new social, political, and economic arrangements. (Nelson, 1974) In contrast to the view of computers as primarily information-processing machines, personal computing and the internet have always functioned as technologies of literacy, making possible networks of humans and computers whose practices transform cognition, identity practices, and social relations.

Educators who understand learning as situated in contexts of people, spaces, tools, ideas, and purposes (Collins & Greeno, 2011) recognize the importance of cultivating literacy spaces (Gee, 2004b) and bringing students into communities of practice which engage with media in discipline-specific ways. They also recognize the potential of new media to support the development of new cognitive and social structures (Pea, 1985). In this research, the authors position themselves as such educators, and draw on two traditions of pedagogy considering literacy and new media. The first are learning scientists interested in how computers can support thinking and learning. The second are scholars of critical multiliteracies interested in how the same literacy practices which can be so empowering also enact oppressive subjectivities and power hierarchies, and they are interested in strategies for resisting and subverting them. The spread of computation into all aspects of our lives, and

the growing awareness that "Silicon Valley is not your friend," (Cohen, 2017) makes it urgent that we integrate these two traditions into a critical computational literacy.

Seymour Papert, an early proponent of computers as a medium for thinking, emphasized their unique interactional possibilities. Microworlds, simulations which allow the learner to discover the rules of the world through exploration or play, can be a powerful way of constructing knowledge with which one has a personal relationship (Papert, 1980, p. 135). Programming an agent which models one's own thinking and intuitions can develop metacognitive awareness in a manner similar to the practice of rereading one's diary. diSessa (2001) explores how computation may join text as an "infrastructural" (p. 5) medium supporting cognition distributed and embodied in the medium of computers, as well as the social practices of teaching and learning which might support it. The project of investigating the mechanisms by which computation can support thinking and learning, as well as a design-based methodology of implementing new media to learn how they might work (Papert's Logo and diSessa's Boxer), continues in more recent computational media (Sipitakiat, Blikstein., & Cavallo, 2004; Resnick et al, 2009).

A second tradition of literacy pedagogy is focused on multiliteracies (New London Group, 1996), a term which draws attention to "the multiplicity of communication channels and media, and the increasing saliency of cultural and linguistic diversity" (p. 63). Multiliteracies stands in a figure-ground relationship with the learning sciences approach to literacies, emphasizing sociocultural issues of identity, voice, positionality, and power. Bringing attention to the ways dominant literacies also marginalize and disempower demands taking a critical stance. Freire's (1968) political activism teaching the poor to read was grounded in a recognition that text-mediated thought was responsible for constituting them as passive subjects incapable of action. Learning to read the wor(l)d means participating in social meaning-making instead of taking meaning as given, realizing that the present world is constituted in certain ways and could have been different, and working toward more just and inclusive futures. In addition to contesting the hegemony of dominant literacies, multiliteracies works to re-value marginalized literacies as legitimate meaning-making processes in and out of school (Paris, 2011; Morrell, 2015).

These two traditions have not been sufficiently in dialogue with one another, respectively emphasizing the mechanisms and the content of literacy practices (Bang, Medin, & Atran, 2007; Vossoughi & Gutiérrez, 2016). As educators and practitioners within both textual and computational literacy spaces, the authors are interested in studying the material and critical possibilities of textual-computational multiliteracy. This research adopts the methodology of participatory design research (Design-Based Research Collective, 2003; Anderson & Shattuck, 2012; Bang & Vossoughi, 2016), working iteratively with adolescents to design and build a web application that supports critical practices drawing on both writing and programming, and collaborating with participants to interpret the results. The starting point is the existing medium of interactive storytelling, which has affordances of

both writing and programming and a history of critical resistance to the sexism, racism, and heteronormativity common in mainstream video games (Anthropy, 2012). The research questions guiding these studies are:

- 1. What kind of medium and pedagogy might support textual-computational multiliteracy?**
- 2. What practices might emerge in such a textual-computational multiliteracy space?**
- 3. How might such practices support critical awareness and resistance to racism, sexism, and other oppressive ideologies?**

This article is structured as three iterations of design-based research. The next section develops the conceptual framework grounding these research questions and discusses prior work in interactive storytelling. From there, each iteration reports on a workshop with middle- or high-school students refining a web application for interactive storytelling. The first workshop focused on discovering possible uses for interactive storytelling. The second workshop focused on developing curriculum and pedagogical strategies to support textual-computational multiliteracy practices using interactive storytelling. The third workshop focused on how interactive storytelling might help students develop critical literacy practices.

Throughout the workshops, data sources are ethnographic fieldnotes, surveys and written reflections completed by students, and the interactive stories students wrote. An ethnomethodological lens is used (Koschmann, Stahl, & Zemel, 2004), seeking to make visible the multiliteracy reading and writing practices which enact a literacy space. The third study relies on open coding to analyze student writing, initially with a grounded theory approach (Charmaz, 1996). A case study of one interactive story uses discourse analysis (Fairclough, 1992; Wortham, 2001; Gee, 2004a;) to analyze how students' interactive stories enact critical change. The article concludes by summarizing the web application, summarizing the new concept of critical discourse models, and exploring how it might be of value to practitioners and academics.

Conceptual framework

This article considers literacy to be a particular form of situated learning (Collins & Greeno, 2011) in which a network of actors (Latour, 2005) collaborate to do semiotic work. Actors may include people, texts, computers, objects, ideas: anything which engages in meaning-making, or which represents, interprets, or mediates meaning, or which is marked as meaningful within a literacy space. The abstract terms *actors* rather than *authors, media, and symbols* are used so the definition can include conventional communities reading and writing texts as well as scenarios where it is harder to distinguish between the authors and the media. In computational literacy spaces, computers function as semiotic media but may also introduce new ideas, engage in interpretation and author their own identities. Chatbots, online avatars, and news feeds have complex relationships with the people who

designed them, who control them, and whom they purport to represent. The question of agency is urgent, but not easy to answer.

Gee's (1990) term *literacy space* is adopted as a near synonym for *literacy community* or *figured world* (Holland et al, 2001), following his rationale that it is unproductive to try to define the membership boundaries of a literacy community. Would-be participants may be excluded, while others may become implicated in a literacy space without their consent. Describing literacy spatially also emphasizes the embodied nature of participation. A literacy space is similar to a *Discourse* (Gee, 1990) or an *ideology*, though the latter two tend to be larger networks with longer histories, so that participants are less able to transform meanings within them. For example, Reyes (2017) documents how students within a school literacy space in the United States were able to contest local stereotypes about what it means to be Asian and author new identities for themselves, but they had to work within more widespread ideologies about Asianness, Whiteness, and legitimacy.

What kinds of interactions qualify as semiotic work? First, transforming old meanings into new ones. Holland et al (2001) describe a process of "symbolic bootstrapping" (p. 38) or "heuristic development" (p. 40) by which actors take up external tools (or ideas or symbols), use them, internalize them as part of their developmental histories, and thereby render their environments useful or meaningful in new ways. The pattern for this process is Vygotsky's account of how people acquire language and build concepts (Vygotsky, 1980). For Holland et al, Bakhtin's (1981) heteroglossia--the recursive composition of meaning from prior meanings--runs parallel to the Vygotskian process of tool and concept construction. One point Vygotsky, Bakhtin, and Holland et al each emphasize is that the generation of new meanings is grounded in and constrained by the existing materials, which always already have a history. Each participant acts out of a history of participation which encodes the meanings of other actors, and so continued participation sustains the historical meanings of the system.

The meanings of selves within literacy spaces develop via the same process. This article uses the term *identity* to denote a model of selfhood one authors and occupies in a literacy space, which exists at the interface "between intimate discourses, inner speaking, and bodily practices formed in the past and the discourses and practices to which people are exposed, willingly or not, in the present." (Holland et al, 1998, p. 32) Drawing again on Bakhtin's dialogic self, Holland et al describe identity as the negotiated meeting place of unconstrained inner speech and an external subject position made available by social meanings. The subject position specifies the terms by which one is addressable and by which one will answer. "What we call identities remain dependent upon social relations and material conditions. If these relations and material conditions change, they must be 'answered,' and old 'answers' about who one is may be undone" (Holland et al, 1998, p. 189).

Given this model, what options are available to people who find themselves within oppressive literacy spaces, where the existing language and cultural materials offer only marginalized subject positions? One might refuse to participate, retreating into the space of inner speech where for Bakhtin

(if not for Vygotsky), one is free to fashion a self. Otherwise, one might try to "use the master's tools to dismantle the master's house" (Lorde, 2003), or insist on the inclusion of other materials, for example by legitimizing the use of vernacular language (Anzaldúa, 1987). This article refers to *critical literacy practices* as those with the potential to enact transformation both within the literacy space (by changing the actors or the sense-making processes) and also beyond the literacy space (Gee, 2004; Fairclough, 2004).

The two semiotic tools with which this article is most concerned, text and computation, function differently as actors in literacy spaces. Although in practice our literacies are multi- and trans- (New London Group, 1996; Thomas et al, 2007), there is value in distinguishing how reading a text differs from playing computation (Aarseth, 1997). While text has been theorized in many ways, one essential mechanism of text is representation. In Rosenblatt's (1968) account of reading as a unique, historically-grounded transaction between a reader and a text, each is transformed. The reader's identity is changed through her response to the text, which then reciprocally transforms the text's possible meanings (Barthes, 1981). This fits well into a cultural-historical account of literacy spaces. Many writers have put their faith in the representational possibility of their work, hoping that what their texts present will transform their readers.

Freirian critical literacy depends on the representational function of text: once people become aware of the parallels between reading the word and reading the world, they may realize that neither has a fixed meaning, but rather the meanings of each are continually produced within a literacy space, and that the possible meanings co-develop with one's identity. Of course, as mentioned earlier, it is much easier to re-author one's identity and the meanings of a text within a small discussion group than it is within the context of ideologies that span centuries and continents.

One way we can interact with computation is as a model or simulation. Interacting with computational models has been recognized as a central practice in science (NGSS, 2013) and computer science (K-12 CS Framework, 2017). Interacting with a model can be agent-based, emphasizing how one actor in the system can affect others, or systemic, emphasizing emergent properties (Weintrop et al, 2016). Papert (1980) used the term *microworlds* to describe computational models or simulations in which one can immerse oneself and learn how the world works through play or exploration. This can lead to authentic, embodied knowledge, more like getting to know someone than learning a fact. For example, Netlogo (Wilensky, 1999) is an environment for modeling dynamic systems. Participating in a NetLogo simulation can help students understand and predict the behavior of systems from both an agent-based and a system-level perspective (Wilensky & Stroup, 1999). This article uses *microworld* as a synonym for *model* or *simulation*, a particular class of *games*.¹

1 There is much more to say about the nature of games, which is not taken up in this article. In the early 2000s, there was a fierce debate between narratologists and ludologists about whether games ought to be analyzed using the machinery of literary criticism. The competing framings of games ran roughly parallel to the representative texts and microworlds presented here.

Microworlds can be interpreted as literacy spaces. Immersion in a microworld involves the same recursive process of making sense of the other actors by using them as tools, internalizing them, and thereby being transformed. Papert's emphasis on the embodied quality of the resulting knowledge is explained well by the necessity of self-authoring the identity one inhabits in a literacy space. Therefore, if representational text participates in a literacy space as an actor, computational models can participate as nested literacy spaces. The idea of a nested literacy space as an actor within a larger literacy space is not new: Bakhtin's (1981) multivocal understanding of texts and Minsky's (1988) understanding of minds composed of many agents may each be understood as literacy spaces functioning as actors within larger literacy spaces. However, the distinct affordances of microworlds (particularly the precision with which one can author them) may offer unique critical possibilities. Interacting with a microworld can mean interacting with an ideology itself rather than with its effects.

Interactive storytelling

The goals of this research are to develop media and pedagogy capable of supporting textual-computational multiliteracy, to study the practices that might emerge, and to assess their critical possibilities. The starting point is interactive storytelling (often called interactive fiction), a medium which draws on text and code to create single-player or multiplayer text-based games and stories. Interactive storytelling had a widespread following from the late 1980's through the 1990's, bounded chronologically by the emergence of personal computers and early access to the Internet and its displacement by graphical games made possible by improvements in processors and displays (Labrande, 2011). Over the last several decades, interactive storytelling has retained a small but active community, often articulating feminist and queer critical responses to the ideologies dominant in the literacy space of mainstream video games (Anthropy, 2012).

Theorists of interactive storytelling have asked what it is and how it works (Glassner, 2004; Montfort, 2011; Murray, 2017). Ryan (2001) describes reading print text as constructing a world of meanings around oneself through a transactional reading process. The reader potentially experiences *immersion*, a sense of being embodied in and surrounded by that world. In contrast, when playing a microworld, it does the work of simulation and its world is perceived as outside of oneself. There may be an experiential tradeoff in interactive storytelling: the more the text handles the simulation (functioning as a microworld), the more one can interact with dynamics that are too hard to simulate or which one could not have imagined. The more the reader is left to do the simulation (as with a representational text), the more she can experience intimacy and empathy through immersive embodiment. When we consider a work of interactive storytelling as an actor in a literacy space, both modes of meaning-making will likely be at work simultaneously.

Two recent works of interactive storytelling illustrate the dynamics of immersion and interactivity. In *80 Days* (2014), the player inhabits the role of *Passepartout*, valet to a wealthy

Englishman who is attempting to circumnavigate a counterfactual 19th century world. In choosing how the story should unfold, the player may have very different experiences depending on how she engages dialogically with other characters, and the ways in which she decides to explore beyond the bubble formed by her employer's casually racist, sexist, and elitist attitudes. For example, Passrepartout and his employer frequently take a hotel room in cities they visit and the player is presented with the choice of playing it safe by staying in, or exploring the city by night. Occasionally the choice to go out and explore yields information that is strategically advantageous, but more often the player (in the avatar of Passrepartout) finds herself hearing a fisherman's story of losing his wife, having to decide whether to lie to protect a thief from harsh punishment, or allow oneself to be seduced. In the interplay between interactivity (making strategic choices) and immersion (becoming invested in the lives of other characters), *80 Days* functions as a microworld in which the player can discover how richly expansive or foreclosed the world (and one's self-authored identity) can be, depending on the extent to which one chooses vulnerability and openness in the face of the unknown.

Nicky Case's *Coming Out Simulator* (2014), an autobiographical "half-true story about half-truths," powerfully demonstrates the capability of interactive storytelling to model how linguistic processes produce our social reality and shape how we can act within them. The game replays the evening during the author's teenage years when he told his parents (or, perhaps, they found out) that he is bisexual. The interface mimics that of a mobile phone, superimposing text message speech bubbles over simple animations and presenting the player with dialogue options. In the prologue, the game emphasizes that all the characters remember and respond to everything the player does. As the protagonist struggles to come out to his parents, they are equally committed to preserving their image of him by silencing his attempt at self-redefinition. The story is ultimately about negotiating what it means to be male and to be a good son within a cultural context. It is played through speech acts through which the player struggles to author an identity using language whose categories and meanings are largely under the parents' control.

We perform these discursive negotiations on a daily basis, but because they are fleeting and invisible, they can be difficult to perceive or understand. In contrast to our lived experience or linear narrative, in which we can only follow one path through a space of possibilities, the *Coming Out Simulator* "includes dialogue that I, my parents, and my ex-boyfriend actually said. As well as all the things we could have, should have, and never would have said. It doesn't matter which is which." The game takes no more than twenty minutes to play through and it explicitly invites multiple replays through which a player may map out the space of interactional possibilities. In doing so, the player engages in an epistemic game (Collins & Ferguson, 1993) of modeling how characters position themselves and each other and analyzing the how the game's reality is shaped by the characters' speech choices. Both *80 Days* and the *Coming Out Simulator* illustrate the critical potential of interactive storytelling as a medium which engages with textual-computational multiliteracy. Studying language,

identity, and culture within a computational environment could make it possible to simulate, replay, and share these otherwise-elusive phenomena. Reading and writing microworlds in the context of questions usually addressed by literature might imbue an otherwise abstract and impersonal field with profound personal significance.

Ink

Inkle, the studio which created *80 Days*, released an open-source language specification and implementation of their internal scripting language called Ink in early 2016. The authors adopted Ink as the language in which interactive storytelling is written in the web application developed over the course of this research project. Appendix I shows a short story written in Ink, demonstrating several of its key structures. The narrative is divided into knots, typically containing anywhere from a phrase to several paragraphs of prose. Typically, a knot ends with several options to be presented to the player, whose consequences are redirects to other knots. More advanced usage of Ink is computationally complete, allowing authors the definition and usage of variables, functions, and more complex control structures. While some software for writing interactive fiction is capable of interpreting open-ended player input (Montfort, 2007), Ink only supports writing stories which present players with discrete choices.

Workshop I: Co-developing the medium and literacy practices

To begin exploring the critical possibilities of textual-computational multiliteracy, the authors developed a web-based environment for reading and writing interactive stories using the Ink language. The initial prototype allowed users to browse the library of published stories; after selecting a story users could toggle between edit mode and play mode in much the same manner as Scratch (Resnick et al, 2009). The goal of the first workshop was an open-ended co-development of the medium and the literacy practices it might support.

The tool was introduced in a weeklong workshop with twelve students at an all-girls middle school. The group met for three hours each morning (15 hours in all) in a loosely-structured format modeled on writer's workshop (Dorn & Soffos, 2001): students spent most of their time working on their own interactive stories with occasional short craft lessons targeting writing skills such as incorporating dialogue, developing character, using sensory detail, and structuring plot, as well as computational skills such as as expressing stories as sequences and branches, using loops and conditionals, and using trees and directed graphs to plan their stories. Craft lessons were presented in practical terms while also drawing on theoretical essays applying these concepts to interactive storytelling in particular. For example, Sherwin (2011) addresses how to use recursive structures to write rich character dialogue that does not feel repetitive.

The final 30 minutes of each day were devoted to discussing what worked and what did not work in the lessons, and to critique the software tool, proposing refinements for the following day. Each night the authors made changes to the software tool, guided by the students' feedback. The authors collected ethnographic fieldnotes, logged interactions with the authoring environment, analyzed the stories students wrote, and asked students to engage in reflective writing at the end of each session.

Results

In response to student feedback, three iterations of the software tool were released over the course of the week. The students delighted in suggesting improvements and reporting bugs and checking that the changes had been made. The most frequently-requested features were support for additional typefaces, font styles, font sizes, and colors. Students also requested support for visual elements such as background colors and incorporating animated GIFs into their stories, user accounts with the ability to mark stories as private, and site navigation elements such as the ability to search, star favorite stories, and add short descriptions to stories for ease of browsing. Students came across several situations in which they needed to toggle between a prose-like interface and a code-like interface. For example, a monospaced font was preferred for editing, so that the syntactical punctuation was aligned from row to row, but a variable-width font was preferred for playing stories. The text box had a fixed width and text was wrapped to improve readability, but when there were syntax errors (located by reference to line number) it became necessary to preserve line numbering. Because the initial text-editor did not provide spell checking, some students copy/pasted back and forth from Microsoft Word; Word added hidden characters which caused syntax errors. Several students attempted to use accented Spanish characters and emoji in their stories. At the time, Ink did not support unicode, so these characters caused the application to crash.

Table 1. Students' aspirations for interactive storytelling after the first workshop

Explore worlds	"being lost and using sensory details and choosing certain paths" genres of quest, mystery, suspense, escape
Character, perspectives, dialogue	"going deeper into characters" "pretend like you are talking to someone in imessages on your mac" "I wanted to make a story from my puppy's point of view and mine when we first got him. I wanted to write on how [I] think he felt when first entered his new home. I also wanted to describe how I felt to see him at my house and what I did to make him feel welcomed."
Evoke social reality	"I want to write one about meeting your [Internet best friend]" "stories of people and a world of different types of people"

Connect with audience	"I love this interactive storytelling. I love it because when I'm on the website creating an interactive story I feel like a writer and I feel like with this website not only can you share the story that you have been working on but you give the viewers the opportunity to make the story their story by choosing what path they want to take." It's cool that the user chooses how the story will go... be more detailed so that the user will clearly imagine what's happening."
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Over the course of the week, students explored the nature of interactive storytelling as a medium, positioning it with respect to stories, games, and computer programs, and playing and critiquing several published examples. These conversations generated a great deal of aspirational discussion about what could be created with interactive storytelling. Drawing on fieldnotes and students' written reflections, Table 1 groups these aspirations into categories. These categories became the basis of the curriculum developed in the second study. Finally, the authors collected examples of emergent writing and programming practices, shown in Table 2.

Table 2. Emergent literacy practices in Workshop 1.

Writing practices	freewriting ("I just like to write it out") dialogical interaction ("I was relating A LOT to my imaginary friends") sensory detail ("I also practiced writing in ways that made the reader visualize what was happening") peer revision ("Feedback, that was something that we were working on in our group") revising ("I've been re-writing a story I wrote a long time ago into 1st person.")
Programming practices	testing ("I love to test out parts of my story when I do it") tinkering ("try doing things") commenting ("I wrote notes for myself using comments") referencing other programs debugging refactoring using documentation
Writing/ Programming practices	prewriting/pseudocode ("I sometimes spend time thinking about what will happen before writing it.") working incrementally ("I wrote up certain parts of my story to outline how i was doing to continue it and i brainstormed twists.") modeling experiences ("I thought about how I really like it when books have unexpected twists in them. I often like it when its about identity, so i created the twist

	<p>where one of the generic other prisoners turned out to be the girls brother.")</p> <p>writing/designing for audience ("I have been thinking about questions in my story if people ever thought of them.")</p> <p>being an audience and responding to others' stories</p>
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Analysis

The first workshop provided rich evidence of emergent textual-computational multiliteracy practices, as well as some tensions between writing and programming. In some cases, the interface could be re-designed to accommodate both writing and programming, but in other cases, particularly the system's inability to accept non-English characters, problems persisted into later workshops. The aspirations listed in Table 1 clearly show students imagining interactive stories as immersive experiences, as microworlds, and as actors within a literacy space. "being lost," "going deeper," and descriptions of "a world of different types of people" all describe immersion. The desire to use interactive stories as microworlds is evident in the genres of quest, mystery, and escape (where the world will appear different depending on what the player knows and has already done), and particularly in the desire to simulate dialogical encounters. Even though the affordances for social reading were minimal in these initial versions of the application, students expressed strong aspirations to read each others' stories and to write for an audience. Other aspirations point toward transliteracy practices. Students imagined creating stories in which it is possible to move from one character's perspective to another, observing how reality depends on point of view. Others were eager to simulate the infinite possibilities contained in a conversation: one's reactions and disclosures profoundly shape how the conversation might unfold.

The practices recorded in Table 2 show students engaging with interactive storytelling as both writers and programmers. The student who wrote, "I was relating to A LOT of my Imaginary friends" was able to engage the text immersively to summon other perspectives and imagined experience. Similarly, the student who "wrote notes for myself using comments" and "referred to my other program for reference" used the medium as code to store and then recall computational ideas. The practices which overlap writing and programming provide vivid examples of self-authoring within a literacy space. For example, when one student wrote, "I thought about how I really like it when books have unexpected twists in them. I often like it when its about identity, so i created the twist where one of the generic other prisoners turned out to be the girls brother," she explicated a complex process of drawing on her own experience as a reader to imagine her audience, and then composing her story to have a particular effect on her imagined audience. This latter example illustrates how the literacy practices of text and code not only coexisted, but also served as resources for one another. Using the story as a microworld enacting a reading process, the student was able to model the moment when the reader chooses an option, the story advances, and the reader is shocked by the plot twist. Helping students learn that reading is an active, interpretive process (Rosenblatt, 1968) rather than one of passive uptake

is a central goal of English/Language Arts and Freirian critical pedagogy, made particularly challenging because the student usually cannot observe the practices adopted by the expert reader.

Workshop II: Developing pedagogy

The results of the first workshop brought into focus the pedagogical possibilities of interactive storytelling. A second workshop, using an improved version of the web application, tested a curriculum based around writing and programming practices. The goal was to assess the extent to which students used these practices in their interactive stories. This workshop (10 hours total) was embedded within a two-week summer program designed to build community amongst students receiving scholarships to the same private all-girls middle school as the first study. The participants were 16 incoming 6th-graders, all bilingual speakers of Spanish and English. The authors also had the opportunity to plan and co-teach the workshop with an incoming 8th grade student, a college sophomore majoring in creative writing (both alumnae of the same program), and the students' future Humanities teacher.

The workshop was again structured as a writer's workshop, though much of the first week was devoted to introducing the narrative and computational elements of interactive storytelling through three small projects. The first was a quest in the manner of classic role-playing games in which players explore a world. Students were asked to bring in and share three important objects, and then to plan out a geography in which the objects could be found (For example, some students chose to situate their objects along a journey from their birthplaces to their present homes). We modeled this world using directed graphs showing each site and the connections between sites, and then practiced building an interactive story allowing the player to move from site to site, picking up the objects as they were found.

The second project was a perspective story, in which students were asked to consider a real-life incident where each participant had a distinctly different experience. (One student chose a fight with her brother.) We asked students to model this incident as a sequence of time steps, and then created a lattice with a separate node for each participant at each time step. When moving from one time step to the next, a player could choose the perspective from which to unfold the story. This involved writing out the whole story differently for each participant.

Finally, students were asked to consider a conversation that felt full of possibility, in which something important was said or went unsaid. Students graphed the course of the actual conversation, as well as the possible ways it could have gone. This was the most complex story to model, as the story no longer traversed geographic or chronological space, but a space of possibilities. Students were encouraged to make connections between parts of the story that possibly included loops, and demonstrated how to use conditionals to change the possibilities inherent in part of the story based on what had come before based on how the past experiences would change characters. As in the first

study, the various workshop leaders took fieldnotes and students were asked to engage in reflective writing at several points in the workshop. Students' open-ended stories were analyzed in terms of the writing and programming practices used.

Results

Over the two-week period, students wrote an average of 3.4 stories (SD=1.2); stories averaged 9.1 knots (SD=5.9) in length. (Each knot in a story ranges from a single sentence to a full paragraph, depending on the structure of the story.) The distribution was skewed right (most stories were short), as students used numerous short stories as prototypes to test out particular dynamics in the service of larger stories. Table 3 shows the practices we identified in coding students' stories, and the percentage of stories which show significant evidence of their adoption.

Table 3. Practices found in students' stories after the second workshop

Writing practices (% of stories using practice)		Programming practices (% of stories using practice)	
Story built around dialogue	39%	Story uses branches for nonlinear structure	81%
Story based on personal experience	37%	Story uses cyclical or recursive structure	19%
Story navigates physical space	31%	Story uses lists to iterate content	13%
Plot based on a quest	28%	Story uses variables	7%
Story simulates perspective	15%	Story models a rule-based system (e.g. a role-playing game)	6%
Story simulates self-presentation	11%		

While fieldnotes were not formally coded, several clear themes emerged from the workshop. The first was the importance of personal connections and community. The college student in particular engaged the workshop participants with a powerful writerly presence. In speech and writing, she allowed herself to be vulnerable and direct in her perceptions, unafraid to follow thoughts even when they approached topics that felt potentially taboo. One author noted, "I was struck by the difference between her real story and my skeleton of a story. Juli's had an authenticity, a sensory immediacy that was so vivid it was almost uncomfortable." The authors repeatedly noted students authoring their identities by writing about real issues (and sharing their stories) after Juli opened space to do so.

A second prominent theme was a focus on talk about language. After writing the second story (told through different perspectives), many of the students drew on their bilingualism to model how social reality changes when speaking English and when speaking Spanish. Many students wove their own experiences into these stories. Some stories addressed multilingual family contexts in which the player can position herself by drawing on a spectrum of linguistic practices. Others explored public

spaces in which the player experiences discrimination when choosing to use Spanish. And yet others incorporated English and Spanish into the player's inner speech. While they worked, the classroom sustained a lively and thoughtful conversation exploring these questions. The authors' fieldnotes repeatedly describe students arranging their desks so that each could face her laptop screen and her partner while reading and writing--a corporeal enactment of the literacy space. Unfortunately, some of these fascinating and important aspirations were limited by the software, which still could not handle non-English characters. Over and over, fieldnotes record students' attempts to use Spanish in their stories, and the resulting syntax errors. In the same way that simulation made literacy structures visible in the first workshop, this technological artifact painfully reified the writing environment as an English-only space.

Analysis

In the second workshop, students' use of writing practices was fairly widespread and, qualitatively reasonably complex. Most of the stories were recognizably representing meaningful ideas and experiences. On the other hand, few stories functioned as microworlds. Computational strategies beyond basic story branching were used in only a small fraction of stories. Based on fieldnotes and student reflections, students found the computational concepts interesting and generative. One student wrote, "I have understood this language pretty well. The language seemed very difficult to me at the beginning of this week but by the end I feel like I can write a million more stories with this language." There is insufficient data to say whether the basic branching structure was sufficient for the stories students wanted to write during the workshop, or whether they tried and failed to write stories using more complex computational structures.

The most important outcome of the second workshop was the emergence of powerful, subtle, and authentic dialogue-based stories which served as limited microworlds of literacy spaces, simulating both heteroglossic possibility and exclusionary language ideologies (Rosa & Burdick, 2016). They provided nowhere near the level of interactivity as something like a physics simulation, but they nevertheless allow the player to interact with a simulation of how rich and at home in one's skin it can feel to be among the multilingual space of one's family, and also the process by which linguistic practices can be made meaningful in ways that produce disempowering social roles and categories. Fieldnotes and students' post-workshop reflections document the importance to participants of constructing, revising, playing, and discussing these interactive stories. They functioned as what Vossoughi (2014) calls social analytic artifacts, "tools that deepen the collective analysis of social problems." (p. 353)

Specifically, these interactive stories functioned as *critical discourse models*, microworlds simulating discourse within a literacy space. A player who has no prior experience with a particular meaning-making experience--for example, the way a careless microaggression can shatter a person's

sense of self and safety--can play and replay a critical discourse model, observing the effects of her actions and unexpected emergent dynamics. Critical discourse models may offer experiences which cannot be enacted with immersive representational texts, and introducing them as actors within a literacy space may offer new possibilities for critical literacies pedagogy.

Workshop III: Toward critical multiliteracies

The result of the first two workshops was a medium capable of supporting textual-computational practices literacy practices through interactive storytelling, and a hypothesis that these practices could be particularly effective in supporting critical awareness. The goal of the third workshop was to test this hypothesis by analyzing the development of students' critical textual-computational multiliteracy practices, specifically students' use of critical discourse models to transform the classroom literacy space and potentially also the material, embodied power relations beyond the literacy space. Fairclough (2004) refers to the *performativity* of texts as their "causal effects [of texts] on nonsemiotic elements of the material, social, and mental worlds and the conditions of possibility for the performativity of texts" (p. 225).

This workshop was set in a high school in the western United States drawing students whose socioeconomic status ranges from very high to very low. The workshop took place over two weeks (15 hours total) in students' English and Sociology classes, linked together in a special academic track focused on social justice. 23 high-school seniors participated; two additional students did not return consent forms and were excluded from analysis. The authors co-designed the workshop with several of the students during meetings and email exchanges prior to the workshop, and co-led the workshop with two of the students' teachers.

The structure of the workshop was again modeled on writer's workshop (Dorn & Soffos, 2001), with most of the time devoted to students working on, sharing, and revising their interactive stories. The previously-developed curricular sequence was used, though the third story introducing nonlinear dialogue was modified to focus on critical understandings of discourse. Drawing on concepts from linguistic anthropology (Agha, 2005; Rosa & Burdick, 2016), four ideas were introduced:

- Models of personhood: In any social world, people inhabit models of personhood which define what kind of person they will be seen as and what they can do.
- Performativity: Identities are dynamic, not static. We perform our identities, bounded by models of personhood, but possibly also redefining models of personhood.
- Register: A recognizable way of speaking. (necessarily stereotypical)
- Enregisterment: An assumed link between a register (way of speaking) and a model of personhood.

This terminology was selected for its concreteness and the ease with which students would be able to identify examples from their own lives. Students were then asked to write dialogue stories starting from several prompts: create an oppressive social world where the possibilities of speech are limited for the main character; create a world where the main character is assigned a model of personhood based on how s/he speaks; or to create a world where the main character subverts a model of personhood s/he is assigned. As they discussed these prompts, many students offered examples from their own lives. Students were encouraged to draw on these experiences in their writing, but were also cautioned to proceed with integrity (not sarcasm or mockery), and to work with registers and models of personhood with which they were familiar. Subsequent sessions were predominantly devoted to writing, sharing, and revising the interactive stories which emerged from these character sketches.

Methods

The stories students wrote during the workshop were analyzed through multiple iterations of qualitative coding. Initially, the authors distanced themselves from the conceptual framework which had emerged over prior workshops, and relied on open coding via a grounded theory approach (Charmaz, 1996). Over multiple passes of coding, writing integrative memos (Emerson, Fretz, & Shaw, 2011, p. 143), and refining the coding scheme, categories emerged which were largely congruent with the initial conceptual framework, but which articulated the ways participants used affordances of the medium to create meaning in particular ways.

This expanded framework is organized into four layers. First, **affordances** are properties of the medium which authors put to use. Computational affordances of interactive storytelling include branches and merges which control the flow of the story, variables and conditions which maintain state and enforce rules based on what happened earlier, and other building blocks of programming (the full list of codes is included as Appendix II.) Literary affordances include properties of text which can be put to use such as narration, dialogue, and sensory details. Finally, I identified webapp affordances, or properties of the platform. For example, numerous authors took advantage of indexicality, or references to meanings external to the text such as people, places, and events. Stories in a literacy space can always function indexically, but the web application enhanced the effectiveness of indexicality by allowing stories to be published and read privately or socially by peers.

The second layer, **techniques**, are ways of using affordances to create meaning within the literacy space. The two primary categories of techniques are interactivity and immersion. Interactive techniques include providing or denying agency to the player, allowing omnipotent control of the world (for example, allowing the player to choose the reactions of others or whether it rains), and inserting parenthetical remarks on the player's choices. Immersive techniques include allowing the player to construct an in-world identity and structuring choices so that the player becomes morally implicated in the story's events or is presumed to have given consent.

The third layer, **figured meanings**, describe the effects created through the use of techniques. These may include reshaping the meanings of actors within the literacy space or reshaping the sense-making processes. Following the earlier definition of identity as the interface between internal self-authoring and externally-imposed subjectivities, changes to figured meanings may expand or contract the kinds of identities possible within the literacy space. One common way interactive stories reshaped sense-making processes was by adhering to existing genres or developing new genres. Genres include literary genres such as horror, science fiction, and role-playing games, as well as what Bahktin (1981) calls speech genres, or the "sphere in which language is used [and] develops its own relatively stable types." Participants recruited diverse speech genres, including quizzes, text messaging conversations, and Facebook posts. Story topics, such as family, friends, dating, and school, function similarly to speech genres in that they create expectations for the kinds of meanings that will be expressed.

Finally, the fourth layer, **critical possibilities**, are ways in which stories enact or hold open the possibility of critical engagement for a reader. These include engagement with gender, race, social class, social roles, and other categories which establish power relationships between people and constrain their possible identities. For example, in one story a woman prepares to marry a man about whom she feels ambivalent. Gender is repeatedly marked throughout the story and gender-related power dynamics shape the story's world, but the story does not explicitly address gender or allow the player to make choices that directly affect gender dynamics. Contrast this with another story, in which a high school girl goes to a party and is touched inappropriately by a boy she knows. The player is faced with a decision of whether or not to challenge this and make a public scene; the rest of the story is concerned with how the rest of the party might unfold following either decision.

Development of critical discourse models

Table 4. Relative co-occurrence of codes (columns) in stories with codes (rows)

Code (count)	FLOW	Affordances STATE	DIALOGUE	Techniques IMMER- SION	INTER- ACTIVITY	Figured meanings LIFE	LITERARY GENRE	SOCIAL MEDIA	CRITICAL
FLOW (17)	100%	29%	65%	47%	71%	41%	47%	12%	53%
STATE (12)	42%	100%	58%	17%	42%	25%	67%	25%	33%
DIALOGUE (22)	50%	32%	100%	59%	68%	45%	32%	27%	55%
IMMERSION (15)	53%	13%	87%	100%	73%	73%	13%	33%	53%
INTERACTIVITY (21)	57%	24%	71%	52%	100%	48%	43%	14%	52%
LIFE (13)	54%	23%	77%	85%	77%	100%	0%	46%	62%
LITERARY GENRE (15)	53%	53%	47%	13%	60%	0%	100%	0%	20%
SOCIAL MEDIA (9)	22%	33%	67%	56%	33%	67%	0%	100%	33%
CRITICAL (13)	69%	31%	92%	62%	85%	62%	23%	23%	100%

In order to analyze the development of participants' stories, relative co-occurrence was calculated of frequently-appearing codes. The results, shown in Table 4, validate the construct of critical discourse models as an effective structure for exploring critical ideas in real-life contexts. Of the stories with critical engagement (CRITICAL), 62% dealt with familiar settings such as family, friends, dating, and school (LIFE), 62% used immersive techniques (IMMERSION), 85% used interactive techniques (INTERACTIVITY), 69% used computational affordances to control story flow (FLOW), and 92% relied on dialogue (DIALOGUE). These are precisely the properties hypothesized to be effective for exploring critical ideas.

There was a clear distinction between the use of computational affordances for controlling the flow of story execution (FLOW) and the use of variables to maintain state (STATE). FLOW affordances tended to occur in stories using both immersive (47%) and interactive (71%) techniques, while STATE affordances were seldom used in immersive stories (17%) and more often used in interactive stories (42%). While FLOW stories engaged with LIFE (41%) and LITERARY GENRE (47%) figured meanings, STATE stories focused predominantly on LITERARY GENRE. (The sets of stories coded with LIFE and LITERARY GENRE were disjoint.) Finally, 53% of FLOW stories featured critical engagement (CRITICAL), compared with only 31% of STATE stories. Broadly, these results suggest that FLOW affordances were often important components of critical discourse models, while STATE affordances were more often games or puzzles set in fictional worlds, whose figured meanings had lower stakes.

One particularly interesting set of stories were set in the speech genres of text messaging and social media. These stories effectively made use of affordances and techniques which are also important in text messaging and social media, such as acronyms, iconic textual effects, emoji, and pacing--either the staccato of brief exchanges or ellipses denoting significant pauses. The affordances shared by texting, social media, and the interactive storytelling medium have become infrastructural (diSessa, 2000) to identity in many youth cultures. Holland et al (2001) emphasize that identities are authored within literacy spaces dependent on material conditions; as these conditions change identities must be articulated anew. The prevalence of social media as a space of youth identity practices may make interactive storytelling particularly valuable for authoring identities and critical analysis of the literacy spaces in which they are authored.

Enacting critical change

A case study of one student's experience in the workshop shows the potential critical discourse models have to enact change in and beyond the literacy space. In an introductory survey, Leanne describes herself as female, and biracial, mostly a speaker of standard English, as well as African American Vernacular English at some family gatherings. Her pre-survey responses suggest a rich history of

textual literacy practices, and very little history with computation. Leanne experiences gender-based discrimination frequently and racial discrimination daily. Leanne was an active, but not extremely vocal, participant in the workshop. Some days she sat by herself and worked, other days she sat with a small group of peers. She participated regularly in the quiet conversation taking place while students read and wrote. In a survey halfway through the workshop, Leanne described having trouble deciding what to write about: "I grasp that I can pull from my own experiences, but I have trouble picking just one. I know that when I do, it could end up being pretty profound, but I haven't been able to zero in on one concept yet." In the first week, she wrote a fan fiction-style story set in the world of *Dune*, which her English class had been reading. She also reported having some trouble with the programming aspects of interactive fiction: "I think I get the gist of it, but an error occurred on the story I did write. I don't know how I can fix these errors; the explanation given when I click on my story is still confusing to me."

At the beginning of the second week, an incident took place which motivated Leanne to write her final story. During a discussion on register, Mr. Leo, one of the co-teachers shared an anecdote in which he had imitated the speaking style of several African American freshmen girls he did not know well. He described how he had intended the interaction as a joke and a way to connect, but they were extremely offended. He explained that they would not have had the same reaction if they had been in his class, because they would have known him as someone who likes to tell jokes and understood his intentions. No student responded to this anecdote at the time, but Leanne addressed it in her final reflection:

I was intrigued by the discussion on personhood and register, and the idea of having no way out of the stereotypes you are assigned. Mr. Leo gave an example of register discussing some insensitive things he said to a couple of African American freshmen girls, saying the same offense wouldn't happen in this class. I disagreed, since I was very offended by his words and conclusion, but didn't say anything in order to not make people (especially [author] who I didn't know very well) "uncomfortable." I regretted not saying anything, and I think that regret evolved into my piece.

The story Leanne wrote in response to this incident, "Angela: The bystander's story," is paraphrased in Figure 1, and its full source code is included in Appendix I. The indices in Figure 1 refer to knots in the story; when line numbers are cited, they correspond to the numbering in Appendix I. The story functions as a critical discourse model, allowing the player to engage the story through both as an immersive text and as a microworld. The story enacts critical transformation both within its world and, by voicing an otherwise-unspoken contestation of Mr. Leo's anecdote, within the broader literacy community of the workshop.

The story is written in second-person, which highlights the player's role as a character in the story. The first choice the player is presented with (knot 1) is not an action in the story but a choice of

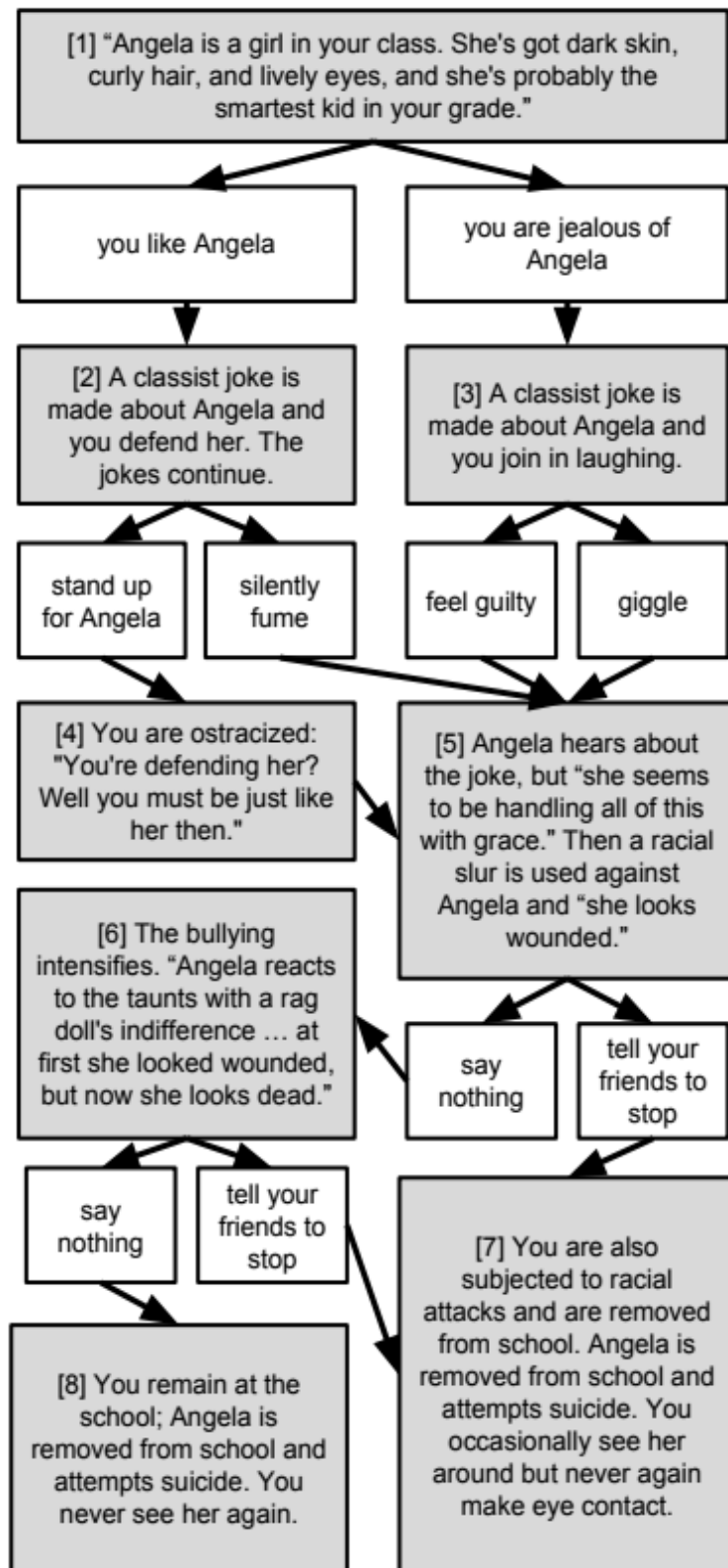


Figure 1. Flow diagram of Leanne's story

identity: whether to like Angela or whether to be jealous of her. This is the beginning of a process by which the player self-authors an identity within the story, and thereby makes herself a witness and complicit in the action. Regardless of the player's choice, the plot continues with another girl making a joke about how Angela is so poor that she probably has to wear second-hand clothing to school. The player is offered at least one opportunity to defend Angela against the attacks. However, the player's protests are ultimately ineffectual. Standing up for Angela only gets the player ostracized too.

Regardless of the player's earlier choices, she ends up in the pivotal sequence at knot 5. Angela's refusal to be provoked by the mean joke causes the girl to escalate her attacks, which finally overwhelm Angela's composure. The player is faced with two options recapitulating the earlier structure, to either remain in shocked silence or to defend Angela. If the player does nothing, the attacks escalate (knot 6). Angela still does not respond to the attacks, but now instead of "handling all of this with grace" (52), she reacts "with a rag doll's indifference" (68). The player is offered one final chance to stand up for Angela as she goes from looking "wounded" to "dead" (69). If the player stands up for Angela at either opportunity, she reaches one of two possible story endings. For the first time,

the player is positioned racially--as a "White N*gger" (77). The story concludes with the player's removal from school. Alternatively, if the player chooses not to defend Angela, the player's life goes on--the player dissociates from Angela and disappears from the narrative altogether. It becomes clear that the racial attacks were always about power: "The girl who started it all is on top of the world, the queen bee; the school is hers now. Angela is so far below her in the social hierarchy that she never has to feel jealous again" (88). In both outcomes, the player watches as Angela is dehumanized: she no longer makes eye contact with the player, is described as "IT" (76) and is described as the other students' "plaything" (93). In both endings, the narrator relates that Angela attempts suicide.

In neither outcome is the player able to meaningfully protect Angela; the only choice is whether to be stripped of one's whiteness and subject oneself to the same attacks, or to remain silent. The story offers no way out, makes available no sense of blamelessness or solidarity. Both immersion and interactivity are at work: the high stakes and appearance of choice invite replay and exploration of the action space in an attempt to find a solution. The parts of the story where the player's action is narrated rather than selected, and particularly the vivid imagery showing Angela's facade cracking, eyes dimming, and progressive dehumanization, implicate the player in the story. A player might be both inside and outside the story, and the effect could be a transformation of the player's identity within the literacy space as well as within the world of the story. In refusing to grant the player agency, the story possibly enacts critical change in its literacy space, for example by arguing against the easy answers of an anti-bullying curriculum claiming that bullying can be stopped by a simple act of moral courage.

The story functioned as a critical discourse model within the workshop. As Leanne wrote in her closing reflection, writing it was an opportunity to think about the dynamics by which someone can be trapped and silenced in models of personhood and a way for her to speak back against her teacher's assumptions. While this did not lead to a confrontation with Mr. Leo or a reckoning with his joke, Leanne's story did contribute to change within the broader literary space. In the final days of the workshop, the authors noted students increasingly frequently sitting in pairs or triads, reading and discussing stories. One question on the closing survey asked participants to write an open-ended reflection on new ideas they considered in the workshop. 44% discussed ideas related to criticality or empathy, often using forceful language to describe their interaction with interactive stories. For example, one participant wrote, "I enjoyed learning about how interactive fiction can drive people to explore/understand limits and effectively force people to empathize."

Conclusion

The three iterations of participatory design research reported in this article yielded fruitful answers to the initial research questions. The first study explored the potential uses of interactive storytelling and developed the web application. The second study further iterated the affordances of the web application to support textual and computational literacies and developed pedagogical strategies for supporting

multiliteracy practices. The third study validated critical discourse models as tools for critical engagement and documented the role of textual and computational affordances. In each workshop, the participants were involved in planning the workshop, framing the questions, and interpreting the results. Their participation was essential to the validity of the findings and also to ensuring that the research process could play an equitable role in the literacy spaces which were the focus of study.

This research makes three primary contributions. First, the iterative participatory design process yielded a refined web application capable of supporting textual-computational multiliteracy in a writer's workshop environment. The application has been publicly released and has already been used for several months in an introductory computer science course, as well as in several professional development workshops focused on computer science and critical literacies. Framing interactive storytelling as an introductory approach to programming may help teachers of computer science to view their subject as a literacy, as a resource for their students' existing multi- and transliteracy practices, and as an opportunity to support their students' critical perspectives. The expansion of Unfold Studio as an online literacy space, and its efficacy as an introduction to programming, will be a topic of future research.

Second, this research finds theoretical common ground between learning scientists and scholars of critical literacy, and demonstrates the importance of continued dialogue between these communities. Over the last two decades, the computer science education community has devoted increasing attention to educational equity (Margolis & Fisher, 2003; Margolis et al, 2010; Kafai & Burke, 2013), focusing on unequal participation in computing and factors causing it. This work is important but incomplete. Too often, efforts toward more equitable participation do no critical interrogation of the practices with which they seek to increase participation. There are direct parallels to the decades of work by scholars and practitioners of English/Language Arts grappling with how and when to teach dominant American English. Computing too has a culture of power (Delpit, 1988) and a tendency to view other sense-making practices through a deficit lens (Moll et al, 1992). What might culturally sustaining pedagogy (Paris, 2012), with its insistence on criticality, look like in computer science?

Finally, this research yields the concept of critical discourse models, which may be particularly effective in supporting critical awareness in the multi- and transliteracies prevalent in youth culture today. Critical discourse models may also be useful in contexts where people have different amounts of experience thinking about these concepts. These are often particularly difficult settings in which to discuss power and privilege. Those coming from habitual and seldom-questioned privilege may feel they need a nonjudgmental space to consider new self-understandings, and feel threatened by critical positions. However, for people who experience marginalization on a daily basis, the insistence on a safe space which excludes uncomfortable truths is often experienced as another act of erasure by dominant literacy practices. The multivocality of interactive storytelling is a particularly useful affordance in such a space. Interactive storytelling allows for discourse with multiple layers addressed to multiple

audiences at once. The ability to empathize while repeatedly replaying a critical discourse model allows it to function as a microworld without exhausting the patience of a human interlocutor.

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Appendix I: A bystander's story

```

-> start
====start====
Angela is a girl in your class. She's got dark skin, curly hair, and lively
eyes, and she's probably the smartest kid in your grade. You all go to the
5 most prestigious private school in your area, and you've known each other
since you were kindergartners. Angela isn't the most popular, per say, but she's
kind and outgoing.
*You're really jealous of her.
10 -> jealous
*You're not the best of friends, but you like her well enough.
-> like

====jealous====
15 Another girl in your class lives in Angela's neighborhood. One day, she tells
you that she hates Angela. "She's such a loser," she says. "And I know her
secret: She's on scholarship! She's so poor, she has to beg the school to let
her come. How pitiful is that?" In your jealous state you agree with the girl
and laugh about Angela. The two of you find a friend of yours and you tell her
20 the same juicy story. Your friend snickers even louder than you did: "Angela is
so poor, I bet she had to get her uniform from the lost and found! What a lost
cause!"
*You start to feel guilty about what you said, but you don't say anything.
-> yet
25 *The three of you giggle together.
-> yet

====like====
Another girl in your class lives in Angela's neighborhood. One day, she tells
30 you that she hates Angela. "She's such a loser," she says. "And I know her
secret: She's on scholarship! She's so poor, she has to beg the school to let
her come. How pitiful is that?" You point out to the girl, "Aren't you on
scholarship too?" The girl, caught, skulks away. Later, though, she comes to
your lunch table and tells your friend, who snickers and continues the mean
35 joke: "Angela is so poor, I bet she had to get her uniform from the lost and
found! What a lost cause!"
*You stand up for Angela and tell them both off.
-> bullyU
*You don't say anything, but you silently fume.
40 -> yet

====bullyU====
"You're defending her? Well you must be just like her then," says the girl. In
the coming months you are shunned by your class, called "loser" and "b*tch"
45 and other hurtful words right alongside Angela. You are shoved in the hallway,
excluded from every lunch table, just like her. Now when you speak your mind,
no one listens.
->yet

50 ====yet====
The rumor gets back to Angela within the week. You keep an eye on her, wondering
if she is affected, but she seems to be handling all of this with grace. Angela
continues to be a strong student, and is kind to the people around her. The
girl who began the rumor becomes aggravated. One day you hear her shout at
55 Angela, "You filthy n*gger!" Angela stares at her, stunned, her unaffected smile
completely gone. She looks wounded. You know that a horrible line has been
crossed.
*You are shocked into silence.

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-> bullyA
60 *You tell the girl, "That's too far. Stop it."
-> bullyMe

===bullyA===
65 The new game spreads like wildfire. Angela is shoved on the staircase, excluded from everything. The word "N*gger" echoes through the halls and is written in Sharpie on her backpack. It scares you how awful your classmates are being to Angela. You never thought she was a bad person; what has she done to deserve this? More and more, Angela reacts to the taunts with a rag doll's indifference. Her empty eyes haunt you. At first she looked wounded, but now she looks dead.
70 *You've had enough. You tell your friends to stop.
-> bullyMe
*If you say anything, you know they'll come after you too, so you say nothing.
-> fear

75 ===bullyMe===
"You're defending the n*gger? You must be just like her, just like IT!" The cry becomes "White N*gger! White N*gger!" You are shunned alongside Angela, who is too broken now to notice you. Your parents pull you out of school. Months later, they receive an email from the principal, which informs you that Angela
80 attempted suicide. Her family sent her to the local public school to get away from the bullying. You see her at the grocery store sometimes, but she never meets your eyes.
-> DONE

85 ===fear===
The months pass. Nothing gets better for Angela. Every passing period you hear cruel laughter from your friends, hisses and jeers, all directed at Angela and all due to the color of her skin. The girl who started it all is on top of the world, the queen bee; the school is hers now. Angela is so far below her in the
90 social hierarchy that she never has to feel jealous again. One day, Angela doesn't come to school. She's not there the day after that, or the next, or the next. The class whispers, what happened to her? They have lost their favorite plaything. A week later, your principal calls an assembly and tells you that Angela attempted suicide. Her parents moved her to the local public
95 school. You never see her again.
-> DONE

Appendix II: Qualitative coding

AFFORDANCES:

COMPUTATIONAL:

FLOW:

KEEPEGE: Uses both * and + to define options, so that some edges are available only once, while others are available for reuse.

LOOP: The story flow contains at least one loop (you can get back to somewhere you were before).

MERGE: The story flow has divergent paths leading to the same node. (Multiedges, where there are several different ways to go directly from A to B, do not count. Consider coding these as SKIN. Also contrast MERGE with LOOP: MERGE is a divergence in a fundamentally linear structure; once there's a LOOP you can no longer talk of constant progress toward the end of the story)

LIST: Lists are used.

WEAVE: Weaves are used.

STATE:

COND: Uses conditionals to determine the course of the story. Includes guard statements indicating when an option should be available.

VAR: Defines new variables.

BOOL: Uses boolean operators (||, &&, ~)

MATH: Uses arithmetic (+, -, *, /)

FUNC: Defines new functions

HTML: Injects HTML or CSS.

RANDOM: Uses randomness.

LITERARY:

SENSORY_DETAIL: The use of sensory detail, descriptions of sights, sounds, smells, etc.

AMBIGUITY: When clarity is restrained to the point that it's unclear what is happening. Use **INDEXICALITY** instead when appropriate.

IRONY: Uses some form of irony. (Dramatic irony includes the narrative voice directly addressing the reader/player)

DIALOGUE: Not coded when dialogue occurs incidentally, for example as an occasional exclamation or a short internally-voiced reaction. Also not coded when speech is described

but not represented.

NARRATION: The story includes a narrating voice.

WEBAPP:

INDEXICALITY: When meaning points directly to something or someone that actually happened within the literacy space, and that knowledge is necessary to understand what is happening. Sometimes this is explicit, as when the story is a commentary on something that happened; other times it is implicit, as with coy references to taboo topics like sex or drugs.

TECHNIQUES:

INTERACTIVITY:

OMNIPOTENT: The player is presented with choices which affect the story's reality beyond her role as an actor. For example, instead of choosing whether or not to bring a raincoat, the player chooses whether or not it rains.

AGENCY: The player is able to effect change.

NOCONTROL: The player cannot affect the outcome of the story in a way that matters: perhaps it comes as a surprise, or perhaps the story creates some sense of urgency to affect the outcome.

STACCATO: The use of sustained brief transactions, like the way people send each other text messages.

CUTOFF: Some options lead to an abrupt end to the story, implicitly suggesting an uninteresting choice. This is often used to allow the player to choose (or not) to make a break with convention or expected routine. If the player chooses not to, then the story ends, suggesting there is nothing to tell about that possibility. Do not use this when it appears a branch of the story is unfinished (**FRAG**); only when it intentionally ends for effect.

CHOOSE_SELF: The player is presented with the option on who to be in the story.

TALKBACK: The story addresses the player directly, perhaps commenting on a choice.

IMMERSION:

EMOTIONALBID: The player makes some kind of emotional bid to other players. For example, expressing fear and being comforted (or mocked).

SKIN: The player can personalize (re-skin) the story through inconsequential options that all go to the same place and have no further effect on the story.

AFFECT: The player controls how she presents herself to the world. It might seem that this is a form of interactivity, but I classify it as immersion because it encourages the player to feel in the world, to construct identity within the world.

IMPLICATED: The player is encouraged or forced to make a choice that implicates her in what happens in the rest of the story. She may become a witness, or be presumed to have consented, etc.

EVAL: The player is given the opportunity to express an opinion or evaluate something.

FIGURED_MARKED_MEANING:

TOPIC:

DUNE: The story is set in the Dune universe.

LIFE:

FAMILY: Deals with relationships with parents, divorce, etc.

DATING: Deals with dating or sexual attraction.

FRIENDS: Deals with friendship or social relationships.

JOB: Deals with jobs or professional relationships.

SCHOOL: Deals with the social world of school.

DRUGS: Deals with drugs or other social risk-taking.

LITERARY_GENRE:

RPG: The story is structured as a role-playing game.

SURVIVAL: The story is structured as an effort to survive. It may or may not be possible to survive. These are sometimes reminiscent of choose-your-own-adventure stories.

PUZZLE: The game is really a puzzle.

SCIFI: The story is set in a fictional universe.

HORROR: The story uses conventions of the horror genre, including extreme violence.

SPEECH_GENRE:

SOCIALMEDIA: Set in or deals with the world of social media

TXT: Set in or deals with individual or group text messaging

QUIZ: Structured as an online quiz

SLANG: The story is written in nonstandard English.

EMOJI: The story uses emoji.

HASHTAG: The story uses hashtags.

INSPEECH: The story uses in-group speech or a private language.

FORMALITY: Different levels of formality are used in some way.

CRITICALITY:

RACE_MARKED: Race is marked in the story.

CLASS_MARKED: Social class is marked in the story.

GENDER_MARKED: Gender is marked in the story.

LANGUAGE_MARKED: Linguistic identity is marked in the story.

ROLE_MARKED: Social roles are marked in the story.

RACE_ADDRESSED: There is interactive engagement with race in the story, active or passive.

CLASS_ADDRESSED: There is interactive engagement with social class in the story, active or

passive.

GENDER_ADDRESSED: There is interactive engagement with gender in the story, active or passive.

LANGUAGE_ADDRESSED: There is interactive engagement with linguistic identity in the story, active or passive.

ROLE_ADDRESSED: There is interactive engagement with social roles in the story, active or passive.

OTHER:

FRAG: The story is an unfinished fragment.

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