Interactive fiction: Weaving together literacies of text and code

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Abstract
We propose structural parallels between textual literacy and computational literacy, and explore interactive fiction as a medium at their intersection. We designed and built a web application allowing students to read and write interactive fiction and a curriculum weaving the two literacies together. A study evaluating the curriculum found modest adoption of literacy practices from each domain. Our qualitative observations suggest a mechanism for how each literacy can support the other: incorporating computation into English/Language Arts makes it possible for students to model linguistic processes which are otherwise ephemeral. In the other direction, situating Computer Science concepts in students' identities and experiences can make them personally meaningful and address inequities in STEM education. A third study, underway, will quantify the extent to which one literacy supports growth in the other.

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Computational literacy; computer science education; sociocultural learning theory; sociolinguistics

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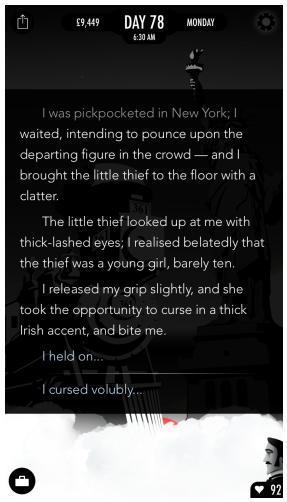

Figure 1: Inkle's *80 Days*

Figure 2: Nicky Case's *Coming Out Simulator*

Introduction

We propose structural parallels between the literacy communities that form in progressive secondary English/Language Arts classrooms and those which might come to exist in Computer Science classrooms. Based on these parallels, we explore opportunities for mutual cooperation between the development of textual literacy and the development of computational literacy. Pedagogy from English/Language Arts, particularly that which emphasizes personal meaning-making through engagement with text, might also be effective in teaching Computer Science. In the other direction, Computer Science could support students' learning in English/Language Arts by making visible the subtle transactions that comprise participation in a literacy community. These questions have substantial implications for equity in learning opportunities: students could draw on one literacy in which they are competent to develop the other. Computational literacy could provide an additional route toward textual literacy for students such as English language learners. In the other direction, textual literacy could support the development of computational literacy for students who are oppressed by stereotypes excluding them from STEM fields. We used a sequence of three design-based experiments [5] to test these hypotheses.

Study 1 explored the pedagogical feasibility of using interactive fiction to concurrently approach Computer Science and English/Langauge arts as literacies, and sought qualitative evidence of students recruiting one literacy to support development in the other.

Study 2 evaluated the extent to which students working with an interactive fiction curriculum adopted literacy practices from textual and computational literacy.

Study 3, underway, measures the support one literacy provides the other by assessing growth in each literacy when the curriculum is used by three groups: students already strong in tetxual literacy, students already strong in computational literacy, and a control group.

Background

The structure of literacy

Our hypotheses are grounded in a recognition of structural similarities between the practices of writers and computer scientists. diSessa [7] offers a three-part definition of literacy as engagement with an external medium (text or code), cognition afforded by the medium, and social interaction grounded in the niches and genres of a literacy community. Textual literacy–learning to read and write, the accompanying cognitive changes [12], and literacy-based social roles [11]–is a central concern of progressive English/Language Arts pedagogy [6]. Computer Science has important cognitive [18] and social [16] aspects, and recent curricular frameworks explicitly model the discipline as a literacy [1]. In exploring how these literacies might support one another, we draw on Papert's [13] observation that constructionist learning environments, in which students can see the shared product of their work and the tools they are using, are particularly effective for constructing new understandings.

Interactive fiction

The theorized structural similarities between textual and computational literacy, suggest the two literacies might interact, particularly in formal educational settings where parallel pedagogical strategies could emerge. In k-12 schools in the United States, textual literacy is a central cross-disciplinary concern, while Computer Science is just beginning to be a widespread academic subject. We saw one possibility in interactive fiction, a form of computational storytelling at the boundary of text and code, belonging in both English class and in Computer Science. The experience of reading and

```
=== waking ===
My eyes flickered open
into warm sunlight. I
found myself on a beach.
* A dream, I thought.
    -> dream
* I willed away the
  memories.
-> denial
=== dream ===
But what dream had ever
felt so real? I was
sure I could feel a
crust of salt in my hair.
* It was too much.
    -> denial
* It all came flooding
  back to me.
    -> onward
=== denial ===
I resolved not to think
of the past. Yet the
words of the prophecy
haunted me.
* That was just a story.
    -> denial
* No matter. What's done
  is done, even if it
  happened in a dream.
-> onward
=== onward ===
... to be continued ...
  -> END
```

Figure 3: The Ink language

writing interactive fiction is fundamentally similar to that of prose; at the same time, interactive fiction has affordances for four of the seven concepts Brennan & Resnick [4] identify as core concepts in computational thinking: sequences, loops, conditionals, and data. (The other three core concepts, events, parallelism and operators, are not inherently present in the structure of narrative.)

Several recent interactive fiction games demonstrate the medium's potential. In *80 Days* (Figure 1), the player/reader 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/reader may have different experiences depending on the extent to which she decides to explore beyond the bubble formed by her employer's casually racist, sexist, and elitist attitudes. When staying overnight in a city, the player is presented with the choice of playing it safe by staying in, or exploring the city by night. If the player goes out at night, Passrepartout might end up hearing a fisherman's story of losing his wife, having to decide whether to lie to protect a thief from harsh punishment, or allowing himself to be seduced. In these ways, *80 Days* functions as a microworld [13] in which the player can discover how richly expansive or foreclosed the world (and one's identity) can be.

Nicky Case's *Coming Out Simulator* (Figure 2), an autobiographical "half-true story about half-truths," powerfully demonstrates the capability of interactive fiction to model how linguistic processes produce our social reality and shape how we can act within them [10]. 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 animation 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 game 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 which position oneself with respect to pre-existing "figures of personhood," [2] or (in the parents' case) by preventing action by insisting on categories which fix one's identity.

Both *80 Days* and *Coming Out Simulator* illustrate the potential of interactive fiction as a medium which engages with both textual and computational literacy. Studying language, identity, and culture within a computational environment could make it possible to simulate, replay, and share these otherwise-elusive phenomena. Studying computational thinking in the context of questions usually addressed by literature might imbue an otherwise abstract and impersonal field with profound personal significance.

Inkle, the studio which created *80 Days*, released an open-source version of their internal scripting language called Ink in early 2016. Ink is designed to feel like writing prose while incorporating control structures, variables, and functions. Figure 3 shows a short story written in Ink.

Methods

In **Study 1**, we developed a web-based environment for reading and writing interactive fiction using the Ink language. We introduced this tool in a weeklong workshop (3 hours per day) with twelve students at an all-girls middle school. The loosely-structured format was modeled on writer's workshop [8]; students spent most of their time working on their own stories with occasional short craft

Quest
Bring in three objects which tell an important story about you. Then build an explorable world in which the player can find these objects.
Perspective
Think of an event in which each participant had a different experience. Write this story in several anecdotes, allowing the player to change perspective between each.
Conversation
Think of a conversation where something important was said or went unsaid. Write this conversation in all the possible ways it could have gone.

Table 1: Outline of our interactive fiction curriculum

lessons targeting writing skills such as incorporating dialogue, and developing character, as well as computational thinking skills such as as conditional branching and using directed graphs to plan stories. We took fieldnotes, logged interactions with the authoring environment, analyzed students' stories, and asked students to write daily reflections.

In **Study 2**, we developed a curriculum (Table 1) based around writing and programming discourses [9] and evaluated its efficacy in eliciting writing and programming practices in students' stories. This study was embedded within a two-week summer program designed to build community amongst students receiving scholarships to a private all-girls middle school. We worked with 16 incoming 6th-graders, all bilingual speakers of Spanish and English. We used a writer's workshop format, though we devoted much of the first week to introducing the narrative and computational elements of interactive fiction through three small projects. We analyzed fieldnotes, students' reflections, and students' stories.

In **Study 3**, we use our interactive fiction curriculum to compare growth in each literacy between students who have expertise in the other literacy and a control group. We used our curriculum in three different classrooms for a two-week workshop. Our measures include self-reported skill level in each literacy, analysis of students' stories, and a post-test in which students suggest revisions to an existing story [17]. We hope to use fieldnotes and artifact analysis to argue for a mechanism by which textual and computational literacies support each others' development.

Results

In **Study 1** we collected discourses students reported in their daily reflections and grouped them into those we recognize as writing, programming, and shared (Table 2). After

Writing discourses	
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"
Programming discourses	
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"
Overlapping discourses	
Planning	"I someimes 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 experience	"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."
Considering audience	"I have been thinking about questions in my story if people ever thought of them."
Revision	"I've been re-writing a story I wrote a long time ago into 1st person."

Table 2: Discourses identified in students' reflections (**Study 1**)

Writing practices	
Story built around dialogue	39%
Story based on personal experience	37%
Story navigates physical space	31%
Plot based on a quest	28%
Story simulates perspective	15%
Story simulates self-presentation	11%
Programming practices	
Story branches into options	81%
Story includes cyclical structure	19%
Story uses lists to cycle content	13%
Story uses variables	7%
Story models a system	6%

Table 3: Practices identified in students' stories (**Study 2**)

working with the interactive fiction curriculum in **Study 2**, students wrote an average of 3.4 stories (SD=1.2). We analyzed these stories for specific practices we associated with writing and programming (Table 3).

Analysis

The discourses described in Table 2 show students engaging with interactive fiction as both text/narrative and code/algorithm. 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. Here, the discourses of writing and programming serve as resources for one another. Because the story is interactive, the student is able to concretely 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 [3, 15] rather than one of passive uptake is a central goal of English/Language Arts, made particularly challenging because the student cannot observe the practices adopted by the expert reader. In this case, the interactive fiction here serves as an observable simulation [13, 14] of the metacognitive reading process.

Sophisticated writing practices were widespread in students' stories. Students also made frequent use of computational thinking by writing stories that branched into different options, though few went beyond basic usage. Nevertheless, students found the computational thinking concepts interesting and generative. One student wrote, "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."

Conclusions

This paper proposes parallels between textual and computational literacy. **Studies 1 and 2** demonstrate the pedagogical utility of interactive fiction as a medium engaging both literacies. **Study 3** tests the hypothesis that each literacy can support development in the other. Bridging two literacies has the potential to support educational equity: students could draw on one literacy in which they are competent to develop the other. Computational literacy could provide an additional route toward textual literacy for students such as English language learners. In the other direction, textual literacy could support the development of computational literacy for students who are oppressed by stereotypes excluding them from STEM fields.

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