Teacher Perspectives on a Narrative-Centered Learning Environment to Promote Computationally-Rich Science Learning through Digital Storytelling

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Abstract: Elementary school teachers are increasingly looking to incorporate computational thinking (CT) into their practice. Unlike middle and high school where CT is often integrated into a single subject, elementary school teachers have the unique opportunity to integrate CT across multiple content areas. However, there is little research on the in-platform supports elementary teachers need to accomplish this integration successfully. To investigate this integration, we are iteratively developing a narrative-centered learning environment to facilitate learning outcomes in physical science via the creation of digital narratives that elicit CT. The learning environment enables students to use their science understanding to propose a solution to a problem through story creation using custom narrative-centered programming blocks that set a story's scene, selects characters, and controls the story's unfolding dialogue and actions. We have engaged with four upper elementary teachers to gather their perspectives on the usability of the learning environment and input on future design iterations. In this paper, we report results from a focus group study with the teachers that examines their perceptions on whether and how the learning environment facilitates story creation and if the learning environment provides learning supports for integrated science, language arts, and CT. Initial results suggest that teachers found the environment to be engaging and supportive of students' creativity.

Introduction

Computational thinking (CT) is now recognized as an integral 21st century skill that is widely applicable to problem solving across disciplines (Grover & Pea, 2018; Shute & Asbell-Clarke, 2017; Yadav et al., 2016). Thus, the importance of embedding opportunities for CT learning within K-12 education has become a focus for both scholars and practitioners (Hsu et al., 2018; Mishra et al., 2013; NRC, 2011). While at the middle and high school levels, students now have increasing opportunities to learn CT through designated computer science and STEM courses, K-5 educators often do not have the tools to support their students' learning CT (Code.org Advocacy Group, 2018; Manilla et al., 2014). Furthermore, many argue that an interdisciplinary approach to CT teaching and learning is more effective than having students learn CT in isolation from other subject matter (Sandford & Naidu, 2016; Voogt et al., 2015).

Given that K-5 teachers teach a variety of subjects to their students each day, they are uniquely positioned to integrate CT across multiple content areas (e.g., science, ELA, math) for more robust learning experiences. However, there is a dearth of research that has focused on learning technologies and the types of in-platform support that teachers need to seamlessly integrate CT into disciplinary content learning (Angeli et al., 2016; Kale et al., 2018; Pila et al., 2019). To fill this research gap, our team is iteratively developing a narrative-centered digital learning environment to explore computationally-rich science learning for upper elementary students. Digital narrative creation offers students the ability to creatively explore scientific phenomena (Henriksen, 2014; Henriksen et al., 2016), while also reflecting many computational thinking concepts in the writing and story creation process (Lee et al., 2014; Parsazadeh et al., 2020).

Study Design and Context

The aim of this study was to gather feedback from upper elementary teachers about the design of our learning environment and its usability for classroom and distance learning settings. We examine teachers' perspectives on the learning environment's facilitation of story creation using custom narrative blocks as well as the efficacy of its integration in science, English language arts, and computational thinking. To this end, we designed a focus group study framed by the following research questions:

1. How do teachers perceive that the learning environment facilitates story creation with narrative blocks?
2. How usable do teachers perceive the learning environment to be? What supports or additional features do teachers feel are needed in the learning environment?
3. How does the learning environment content integration differ from teachers' instructional practices in science? English language arts? Computational thinking?

The 60-minute focus group session was held virtually via the Zoom platform with consenting participants. Focus group participants were notified that the session would be recorded and given the opportunity to opt out of audio and video recordings. Audio recordings were transcribed and analyzed using thematic qualitative coding. The researcher team performed thematic coding of the transcript content and then discussed the results to reach a consensus. The following sections describe the study participants, focus group protocol, and methods employed by the study as well as findings from the study.

Participants

To explore the usability of the learning environment, the research team conducted a focus group in the fall of 2020. Four 4th grade teachers were recruited to participate in the study, including 3 females and 1 male. Three of the teachers planned to cover physical science in their classrooms this year. All participants teach at elementary schools in Northern California.

Researchers provided participants with a prior experience survey consisting of 3-point Likert items, ranging from "None" to "A Lot". Three teachers reported having "Some" level of experience using coding activities in their classroom. Only one teacher reported having "A Lot" of experience using digital narratives, while the remainder reported having no experience with digital narratives. Among all of the participants, researchers collected data via the online Zoom video conference platform using its main and breakout room video conference functionality.

Methods

The focus group protocol consisted of three parts: 1) an introduction to the study and learning environment; 2) teacher experimentation with the learning environment; and 3) post-experimentation focus group interview. To begin, all researchers and participants engaged in an icebreaker activity to establish rapport. Once the initial activity was completed, researchers provided participants with an introduction to the overarching goals of the project and learning environment, and participants were randomly assigned to one of two Zoom breakout rooms where they were asked to engage in think-aloud interaction with the learning environment. During this think-aloud interaction, participants were given a story starter (e.g., a group of scientists stranded on a remote island) and asked to plan and develop a digital narrative that posed a solution to the open-ended problem presented in the scenario. Each breakout room included a researcher to answer participants' questions and address any technical issues that might arise. At the end of the think-aloud breakout sessions, researchers asked participants' permission to collect screenshots of the computational artifacts produced during their session.

To conclude the focus group, participants and researchers rejoined the main Zoom meeting and participants were asked to share their perspectives regarding the learning environment activities by responding to open-ended interview questions. This portion of the focus group session lasted approximately 25 minutes and the interview questions were aimed at eliciting the participants' perspectives regarding the learning environment's ability to facilitate story creation, its usability, and the efficacy of its content integration. The researchers held a debriefing session after the focus group to discuss and record observations.

Following the meeting, the Zoom session recordings, including breakout rooms, were transcribed and analyzed by the researchers. The transcripts were divided among the researchers who performed a round of qualitative thematic analysis. Once coding was completed, the researchers discussed the results to reach consensus on the thematic elements of the results. These results are presented in the following sections corresponding to the overarching themes.

Results

Facilitating Story Creation with Narrative Blocks

An overarching goal of the project is the iterative creation of a learning environment that facilitated students' abilities to develop science-based digital narratives through a custom narrative-centered block-based programming interface. Thematic analysis revealed that the learning environment's custom narrative blocks aided teachers' development of their digital stories. During experimentation with the learning environment, teachers made reference to the custom narrative blocks as they encountered them in the exploration of the environment, and this seemed to spur the creation of their narratives. An example of this is shown in the think-aloud of a teacher who noticed the set scene block and began inquiring with their breakout partner about where the narrative should be set:

> *"So, location. So, do we want to be at the beach or waterfall?"*

Similarly, teachers were easily able to discern that characters could be added using the character focused blocks and enthusiastically began incorporating dialog blocks for their characters' interactions. For example:

> *"So now we have all of our people and then Hailey says, 'They arrive at the waterfall, right?' Because they're just walking at the waterfall and they arrive at the waterfall and what is Hailey saying."*

Teachers appeared to perceive the custom narrative blocks as intuitive, and researchers observed that both groups of teachers spent the majority of their breakout exploration time on the character dialog of their digital stories. Despite expressing some frustration with the tedious nature of typing their characters' dialog, the teachers enthusiastically engaged in creating their science-based narratives, even incorporating problem-solving:

> *"So, we have a shelter and a water source, but we need a power source. A question for the audience might be, how do we get our power source?"*

Despite this engagement in creating their stories, one point of contention seemed to arise from teachers' expectations of how their characters should look. A teacher in one group fixated on a male character offered in the learning environment that was dressed as a nurse despite incorporating the character into their story in another way. It should be noted that in this early stage of the learning environment development, the characters provided were not customizable.

Finally, during the post-interview teachers, expressed that timing would be a key element to using the learning environment in the classroom. All the teachers perceived the activities as enjoyable and useful to their students but suggested that they would need to spend some instructional time on ELA concepts before jumping into the learning environment for digital story creation. One teacher expressed the need to “lay out [a] lot of groundwork” and another expressed that:

> *“I think you'd have them work in teams and plan out the story? And they'd have to get some ideas, I think. So, you'd have to brainstorm, like she said and I'd see this being at least [a] week too and using a lot of language arts time before they dive into it. What a story should look like even.”*

Usability of the Learning Environment

Analysis of the qualitative data provided insight into the usability of the learning environment and an associated online worksheet provided to participants to help them plan their stories. Overall, the learning environment operated according to its design. There were no issues observed with accessing the custom narrative blocks or with the dragging and attachment features of the block-based programming interface. While teachers had some initial difficulty with navigating the interface or complete the planning worksheet, once researchers gave minimal instructions, participants found the learning environment to be engaging and easy to use.

Teachers were able to intuitively and cooperatively use the block-based programming interface and planning worksheet. The participants worked together to plan out their story and use the learning environment to implement their story. The planning worksheet included a ‘dialog’ and ‘ask the audience a question’ organization to scaffold the teachers’ thinking during the story creation process from a beginning stage, through to the middle, and end. The categories in the block-based programming interface and naming of the custom narrative blocks helped teachers to identify the story creation components they needed to develop their planned story.

> *“All right. Stage direction left, right, middle, Hailey exits, Hailey enters. Oh, Hailey enters stage left. Oh, I got it. I got it. I got it. Hailey enters stage left. Dialog, Hailey’s going to say ‘Oh my geezy, is everyone okay?’”*

Dragging blocks onto the main work area was also seamless and the teachers were able to easily attach blocks with other blocks on the work area. Half of the teachers reached the point of using the learning environment’s narrative visualization system, and when directed to, successfully observed the translation of their story into visual form.

Teachers had some difficulties with navigating the interface and completing the planning worksheet. Participants did not fully grasp the interactive theatre aspect of the learning environment and thus were not sure how to receive ‘theatre audience’ question response. “Are we given the audience’s response [to the question] too?” “Okay. Do we have to add dialogue now? [After the question options 1 & 2] Is that what that means there?” Participants also could not successfully edit the blocks in the question space of the planning worksheet. The participants tried multiple times to click the question box and enter text, but the online worksheet did not support text entry at that location. Two teachers had initial confusion about what to do when they initial opened the learning environment. As a result, they sought researcher direction and support. “What is this? What are we supposed to do here?” Half of the teachers had some difficulty navigating the block-based programming interface due to not understanding how to close/exit the block categories. “I don’t [know] what I’ll do here. Where are we? How do we get out of here?” A third teacher guessed but was unsure if they had to pull the blocks over from the left-hand side of the category. “So, we have to go to ‘scene’, okay. What’s our set location? We pull that block over, am I right?” “Okay.” “I don’t know what I’m doing. I don’t want to do… [something wrong].” Another teacher expected the learning environment was platform agnostic and unsuccessfully tried to access it on his iPad. “I’m on my iPad and it says, the one thing is not available on a mobile. So, I’ll have to go back to my other computer again.” “That’s [the environment is] what I think I don’t have access to.” However, in all cases, given a small amount of feedback from the researchers and/or additional time, the teachers were able to move through each source of difficulty without further assistance.

Content Integration Efficacy

One of the main objectives of this study was to gauge our participants’ perceptions of how well the narrative-centered learning environment supported the integration of science, ELA, and CT. Our findings indicated that the participants were able to make explicit disciplinary connections to ELA as well as science and CT although to a somewhat lesser degree. Several of the participants indicated that they would specifically dedicate ELA instructional time for the activities, in particular, allowing students a few days to draft and build their stories. One teacher's comment reflected this sentiment, "I'd see this being at least two weeks too and using a lot of language arts time before they dive into it, what a story should look like even." In particular, one teacher indicated that he felt the learning environment would be well-suited as a tool for generating the creative writing genre of playwriting and dialogue between characters.

> *"I think if we were writing a play or a storyline, a script, a screenplay, they would work with that if you're trying to teach them to do that...This gives stage directions and all that. So that lends itself through them coming up with the ideas because they don't have to have all that background. It's kind of built in for them."*

The teachers were also able to make science content connections as exhibited during their breakout sessions through the planning and development of their narratives. In particular, several of them remarked how the built-in components of the narrative environment such as waterfalls and wind could be sources of energy leveraged to get off the island. However, in the post interview they expressed a concern that students would need group brainstorming sessions to make these explicit science connections: "I don't want to give them dialogue but maybe, 'What kind of people would be on that ship?'...Kind of do those brainstorming out loud with a little bit of note-taking and then go like, 'What now? Well, how could we get off the island?'"

Finally, the investigation probed the participants to discern if they noticed potential opportunities for CT integration. Although teachers in our study never explicitly named CT concepts as a part of the learning experience, their practices exhibited CT elements that with proper nurturing through professional development and training could be integrated into their pedagogy with the platform. For example, the teachers exhibited the use of CT to define the problem scenario that was needed to plan a solution: "I think maybe if we start with the problem and how we're going to solve the problem, then we'll be able to know what types of...if there's any other tools that we need." They also recognized that graphic organizers could help students decompose and abstract the necessary story elements and scientific components that would be needed to compose their narratives. During the interview, teachers shared ideas to consider for the learning environment that aligned with CT. For example, one teacher noted, "I think you'd have them work in teams and plan out the story," indicating he saw the environment fostered opportunities for collaboration. Another teacher discussed the learning environment's value for creating artifacts:

> *"At the end when we saw what we created, that's why I feel like my kids would really like it. Because I see what the end could look like and if they can see what the end would look like, I think they would go crazy wild because it's great."*

Our observations also indicated that the participants saw the narrative visualization system and the block-based programming interface as means for fostering CT, including debugging, tinkering, and evaluation, as we witnessed them engaged in these processes.

Conclusions and Recommendations

Results of our analysis suggest that the narrative-centered learning environment, while still in an early stage of development, does facilitate creative digital storytelling with custom narrative blocks and offers promise for providing an engaging environment for students to learn science, ELA, and CT. However, teachers' initial confusion with getting started with the block-based programming interface and difficulties with its accompanying instructional materials (e.g., narrative planning worksheet) suggest that additional navigational and instructional supports may be beneficial. Our findings also suggest that the learning activities associated with the learning environment did support the application of CT practices such as collaboration and evaluation, but that CT and science concepts were less explicit in the learning environment than those associated with storytelling. Therefore, additional consideration should be given to providing a more balanced integration of the conceptual knowledge we aim to support with this platform. To this end, we are integrating a science problem explorer in the environment to support students' science conceptual understanding, particularly for the concepts they may choose to incorporate into their digital narratives. Given the researchers observations that teachers were employing CT practices while engaging with the environment, we recommend that CT be made more explicit in how teachers and students engage with the environment's activities.

Thus, we will include additional strategies for engaging in self-reflection on CT within future professional development for teachers who use the learning environment.

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