Anchoring Computational Thinking in Upper Elementary Physical Science through Problem-Centered Storytelling and Play

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Abstract: In an effort to infuse computational thinking practices in upper elementary science, and to promote positive student dispositions toward STEM, this project investigates a new narrative-centered maker environment involving: 1) problem-based learning research and modeling of physical science concepts, 2) application of learned concepts to original digital stories created using block-based programming, and 3) further communication of science understanding through play with fabricated story sets and characters reflective of narratives.

Project Rationale

The Next Generation Science Standards in the United States recommend computational thinking (CT) practices as essential to develop for learners across all grade levels (NGSS Lead States, 2013). As the elementary grades are a crucial time for developing dispositions toward STEM, it is important to introduce CT practices seen as foundational to these young learners (Chen et al., 2017). CT involves solving problems using techniques like analysis, abstraction, and modeling (Shute, Sun, & Asbell-Clarke, 2017). Problem-solving practice is further informed by learning models such as problem-based learning (PBL) that recommend group resolution of open-ended or ill-defined problems through cycles of problem definition, research, and resolution (Hmelo-Silver, 2004). Needed are problem-centered contexts to engage young learners in computational practices.

This project infuses CT practices into upper elementary physical science through a PBL environment anchored in two compelling elementary learning strategies—storytelling and play. Storytelling enables learners to communicate their understanding of science phenomena, while combining literacy and science activities has been shown to improve outcomes in both areas (Avraamidou & Osborne, 2009; Barber, Catz, & Arya, 2006). Play is common in the elementary grades and makerspaces in which students experiment with (typically) physical materials with tolerance for retesting (Kurti, Kurti, & Fleming, 2014; Pellegrini, 2009). Combining digital storytelling with physical elements has a precedent in informal learning such as using circuits in puppet show lighting (Chu et al., 2015) and programming robotic characters (Ryokai, Lee, & Breitbart, 2009).

Narrative-Centered Maker Environment

After studying physical science concepts, student pairs explore seeded problems (e.g., shipwrecked explorers must create an SOS signal to achieve rescue). Our learning environment scaffolds students through cycles of PBL, listing what they know about a problem (e.g., light bulbs available in one of the explorer's backpacks), what they need to know (e.g., ways to illuminate a light bulb), and offering embedded simulations that model core concepts (e.g., circuit design) (Figure 1, Phase I). After researching the problem, students are prompted to outline a related story with interactive decision points and branches that will allow the audience to influence the story outcome, and with explanations of physical science concepts (Phase II). Outlines are submitted to teachers for feedback before students proceed with block-based programming of their stories. During programming, students drag narrative-based blocks to a canvas to create characters, direct actions (e.g., character speaks), and write conditions for branches. An animated-style story can be previewed on the computer during development. Students download completed stories to an Arduino board and receive a schematic to connect provided electronics to direct physical story elements (e.g., speakers play dialogue, switch selects story branches, LED "rescue light" illuminates) (Phase III). Printed characters, scenery, and props allow students to play with their story and demonstrate it to peers.

Conclusion

Combining block-based programming and digital storytelling provides significant promise for engaging upper elementary students in CT. In this poster, we present the rationale and structure behind a narrative-centered maker environment in which students research and communicate resolutions to physical science problems in story form.

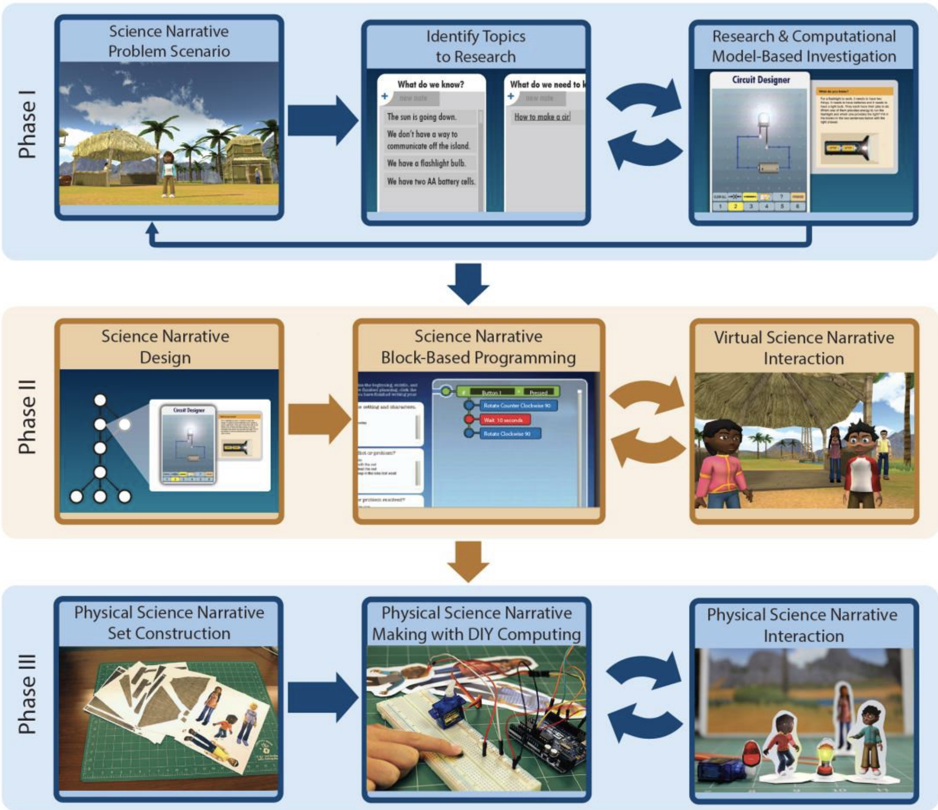

Figure 1. Narrative-centered maker environment.

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