An Expansively-framed Unplugged Sequence Intended to Bear Computational Fruit of the Loom

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ABSTRACT

We report on a late-breaking project that centralizes the Maker practice of loom-based weaving as a locus for unplugged computational thinking. While unplugged activities are appealing for making computation accessible, they also come with the risk of developing inert knowledge. To address and mitigate that risk, we introduce a new framework that we are developing called "Expansively-framed Unplugged" (EfU) computing education. We report on some initial testing and refinement of a learning sequence that starts with weaving on a loom and ends with optimizing code in Scratch. The testing was done with a school librarian who is will be implementing a coding program with students at a middle school library using this EfU sequence.

CCS CONCEPTS

• **Social and professional topics → Computational thinking**; **K-12 education**; *Computer science education*; Model curricula;

KEYWORDS

Computational Thinking, Expansive Framing, Looms, Weaving, Unplugged

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1 INTRODUCTION

Unplugged computing education, or computing education that does not require a digital computer, has grown in popularity. For instance, unplugged computing has been demonstrated in beads [5] and in tabletop board games [2]. An entire computer science curriculum has been developed that is unplugged by design [1]. An example activity from that curriculum has students making rules connecting islands on a map to represent finite-state automata. While activities like these are appealing in that computing is presented as being more accessible and in new, non-digital contexts, knowledge developed through unplugged activities runs the risk of remaining inert because knowing is fundamentally situated.

In this paper, we propose a Making-inspired learning sequence to support the development and refinement of computational thinking. The sequence is intentionally unplugged in its early activities and draws upon the Making associated with yarn looming. To work past the risk of learners' developing knowledge that is situated only in looming practices, we also propose a longer sequence of activities to mobilize looming knowledge. This design follows a learning activity framework we are developing for computing education that we describe as "expansively-framed unplugged" or *EfU*. Our framework builds upon the recently introduced theory of "expansive framing" for transfer [6]. We illustrate this sequence in action through case study data of a school librarian new to computing working through the learning sequence.

2 THEORETICAL AND DESIGN FRAMEWORK

As stated above, we position our work as building on the movement toward unplugged computing education. The underlying assumption of unplugged computing is that computational thinking can be engendered in activities and materials that are different from those that are directly associated with digital computers. This is a point made by Wing [7] early in her advocacy for computational thinking. For computational thinking to be possible without a coding language involved, there is the presumption of underlying concepts, practices, and perspectives that are intimately involved in use of a programming environment and participating in programming culture [4]. Unplugged computing has generally treated the development of computational thinking to be a laudable goal in its own right without requiring the introduction of formal coding.

However, that may be insufficient. The risk is that computational thinking does not get mobilized through unplugged activities alone, and an educational design approach that might address this would encourage some form of "transfer". Transfer is a controversial term in education research, in part because it has been so difficult to produce within traditional experimental approaches that have been used [3]. For our work, we have relied on Engle's re-conceptualization of transfer as the product of expansive framing that sought to address that difficulty [6].

Expansive framing takes seriously the situatedness of knowing and learning but also introduces the sociolinguistic construct of framing as a way of understanding how tasks, ideas, and ways of interacting are made relevant to a given situation. Ideas from one framing of an interaction are made useful and elicited in another interaction as they are framed expansively through some potential mechanisms, including establishing connections between settings or promoting student authorship [6]. What we hope to establish are activity pairings, bridges between settings, and ways of promoting student authorship that expand the framing of an unplugged learning activity to a digital coding environment – hence the designation of our approach as EfU computing education.

3 DATA SOURCES AND METHODOLOGY

Research Context

The larger project context for this paper is a multi-year design-based research project involving public and school libraries. Specifically, the project aims to increase the capacity of librarians who serve teen patrons in their ability to organize and facilitate library-based Maker programs. In the geographic region studied, which serves small cities and rural communities, fiber arts, needlework, and fabric-based crafting are very prominent practices, especially for women in the community. This is evidenced by the large number of crafting and fabric stores per capita, the prominence of communal activities such as quilting, and local county competitions for such work.

Case Study Design

We pursued and present a case study that was intended to help us understand and improve our EfU approach. This designed learning sequence was quite new for us. We wanted to help position a school librarian, who found that looming was popular as a Maker activity for students in her library, to be able to mobilize it for a coding context. Thus, we asked the librarian, whom we refer to as Antoinette, to participate in three 1-1 professional development meetings to use looming

Figure 1: A loomed pattern made in yarn.

to help her learn some basics of coding. She, in turn, would then implement a library-based program with her students to do the same. Our goal was to iteratively refine the initial sketches of a designed sequence with observations of and direct feedback from Antoinette.

Antoinette had worked with our team for the previous two years. She had been a part-time librarian at a middle school, had just completed her school library media certification prior to working with us, and had just been promoted to full-time librarian at a different middle school. Her prior coding experience was a training session on how to use CODE.org with students, giving her some familiarity with a block-based coding interface. Other than that, she had not been involved in writing code. She appreciated the importance of coding and computer science education for her students, but had not considered it part of her responsibility as a librarian. (That is beginning to change, see librariesreadytocode.org).

The second author led the professional development meetings with Antoinette where Antoinette completed and provided feedback on the learning sequence. The second author collected field notes and photographs.

4 THE LEARNING ACTIVITY SEQUENCE

The learning activity sequence began with the learner having previously weaving with a Schacht Flip Loom. In prior work, we found students would socialize while looming and repeating the patterns that were initiated as long as they could observe basic operation from someone else who had already learned how to operate it. Antoinette had prior experience working with the loom as she supervised and helped initiate its use in her library. For the designed learning sequence, the learner examined the pattern that was already made on the loom, such as the one shown in Figure 1.

The learner then colored on paper a complete grid sequence emulating the weaving. This would then be translated using a notation to emulate the the up and down string sequence in the loom for each passing of the loom's shuttle (Figure 2). As the loom configuration changes as the loom is

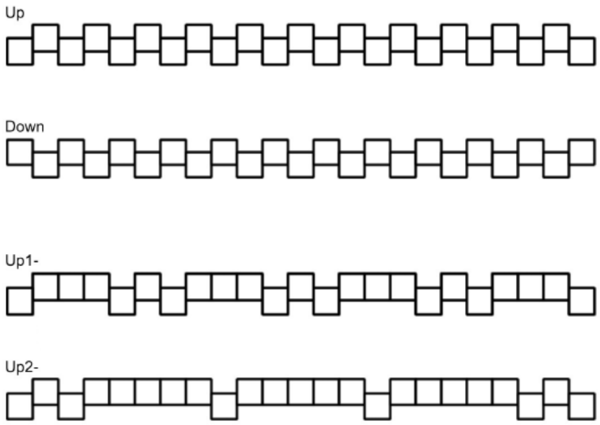

Figure 2: A schematization of the woven pattern.

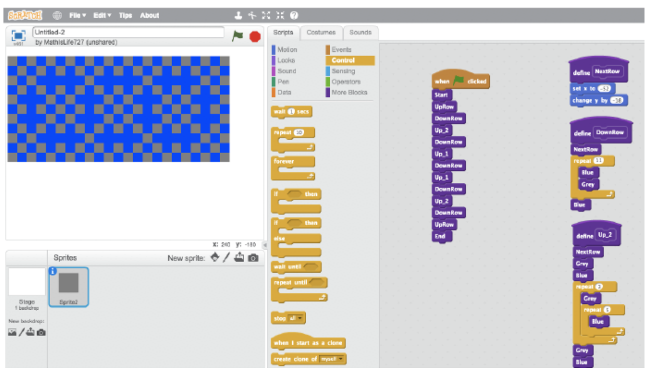

Figure 3: A Scratch instantiation of the woven pattern.

used, the goal was to preserve on paper an inscription of the pattern that could be inspected and abstracted for coding purposes. The larger goal was for the learner to recognize repeating patterns, which they would later encode using repeat loops in Scratch.

Using a Scratch template, the learner then instantiated the code using coding blocks. First, the learner produced the same pattern line by line using the vertical Scratch code block sequence. Following this, the challenge the learner was given was to refine their program so as to use as few code blocks as possible. As the learner iteratively tested the code (Figure 3), the learner would see what pattern was rendered from the code and could then compare it to the loomed material sample or to the color patterned inscription that was previously created to depict the loomed material.

The EfU connections are made through the artifact creation, in the loom, on paper, and in the digital environment. There are also explicit context connections made in that the same pattern is being represented across the three media. Furthermore, the anticipated need for information and knowledge in each preceding medium is made prominent, as hypothesized by Engle et al. [6].

5 ANTOINETTE'S PARTICIPATION IN THE SEQUENCE

Overall, Antoinette found the sequence very approachable and in the three sessions with Antoinette, we also recognized several potential improvements. In the first session, she recognized that there was a pattern repeated in the sample weaving that was made from the physical loom. As such, she only found it necessary to color the first iteration of the loom pattern on the provided paper grid. However, due to the tautness of the weave, she made some coloring errors and had to restart. Her recommendation was that students first write the color sequence using pencil and then color it after so as to accommodate inevitable mistakes that result from "reading" yarn. Between the three options (weaving, paper, and code), paper was seen as the most forgiving and familiar material for students and thus the desirable one to make errors that could be intuitively repaired. After giving that suggestion, Antoinette felt confident that this would be an appealing activity for students who gravitated toward the craft making options she provided at her library.

In the second session, Antoinette quickly moved through the learning sequence and recognized where different blocks in Scratch corresponded to her representations of the yarn. Moving from writing the iterations of code in Scratch to the repeat loops was easy, albeit she had to make some corrections for some arithmetic errors when when creating repeat loops for the repetition of rows. Once her repeat code was run, she was able to easily replicate the intended pattern. However, when she ran the code, she expressed concern that what was being depicted on the Scratch stage was of different size than the sample weaving she was trying to replicate. For instance, if the edge or a particular section of the yarn weaving was blue, she was not certain if what she had made in Scratch needed to be blue as well. Here, we were seeing that some aspects of the expansive framing would need to be renegotiated. What learners should attend to was the pattern and their ability to replicate the pattern. The framing of the activity was adjusted to help direct student attention to the repeating pattern at this point rather than exact fidelity to the physical weaving. What appears to be a challenge in our use of EfU is that as correspondences are made between multiple contexts (weaving, paper, and coding), the criteria for success was not clear. In the absence of a defined criterion, full visual fidelity became the default.

For the third session with Antoinette, she did one more pattern in Scratch, based on another of the example weavings. Instead of coding each row step by step, she immediately moved to finding repeating sections and using the repeat blocks, showing that she felt comfortable with the concept of loops in Scratch. When she had finished coding what she had written on her paper, she looked at the visual image of the pattern created by her program, and decided there were errors in the edges, because the pattern was distorted there. This turned out to be a constraint of the physical weaving, as there is a certain pattern the edges have to follow in order to catch the end strings while moving to the next row of the weaving. Antoinette pointed out that this constraint is difficult to remember while coding the pattern, leading to some later revisions of the sequence. However, she felt comfortable with the overall sequence and confident in her ability to facilitate a Maker program using the sequence.

Design Realizations and Improvements

From this testing with Antoinette, we realized the following to improve this EfU sequence:

First, while repetition is represented in the weaving and amenable to code-based replication, repetition in action runs the risk of becoming tedious. Antoinette detected the repeating patterns and only found it necessary to color the paper-based grid for a few lines as she recognized the repeating patterns and did not think it was worth her time to complete the entire grid.

Second, while the existence of the pattern was easily recognized, getting the pattern properly translated to paper was more challenging. Paper appeared as the most familiar medium, and creating a step in the activity to allow for erasing and correcting was the recommended course of action.

Finally, criteria for establishing equivalence across the three media (weaving, paper, and code) needed to be established. The match between what was rendered by the code and what was produced from weaving as designed did not account for the edges nor the precise color sequence as it was notated by Antoinette on paper.

In the coming weeks, at the time of writing this late-breaking work, we expect to see how the students respond to this sequence as we observe Antoinette facilitate it with them. As the longer term goal is to empower librarians to facilitate and lead their own Maker and computing programs, waiting to see how this is taken up by the librarian and how students respond to the librarian's facilitation was the appropriate testing process for our research goal.

6 DISCUSSION AND CONCLUSION

While there are some parallels that can be leveraged between unplugged activities and ones that involve digital computing environments, there is still work to be done to support expansive framing of those unplugged activities. We saw some areas for improvement that involved setting new expectations for how the sequence would progress (e.g., be aware of the recognition of repetition and anticipate error). We also realized that part of the work of designing for expansive framing involves setting criteria that can be communicated for when understandings from one setting should be used in other contexts.

While more work and reporting will be done in the future, this begins to raise question about where and how concepts, practices, and dispositions related to computation reside. Fluency in one context, such as weaving, can be a support but there are still considerations that need to be made for other contexts that must be communicated in some way during the learning activity and moderated by a facilitator. Our work is in its very early stages, but has sought to explore whether the EfU approach can bear "computational fruit." Currently, we are appreciating, as is the case with all educational design work, that the potential does seem to be present but iterative and direct engagement with those who will be involved in the learning setting is critical for eventual success. In the future, we will report on the full enactment of this sequence with students with Antoinette at the helm.

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REFERENCES

[1] Tim Bell, Jason Alexander, Isaac Freeman, and Mick Grimley. 2009. Computer Science Unplugged: School students doing real computing without computers. *Journal of Applied Computing and Information Technology* 13, 1 (2009), 20–29.

[2] Matthew Berland and Victor R. Lee. 2011. Collaborative strategic board games as a site for distributed computational thinking. *International Journal of Game-Based Learning* 1, 2 (2011), 65–81. https://doi.org/10.4018/ijgbl.2011040105

[3] John Bransford, Ann L. Brown, and Rodney R. Cocking. 1999. *How people learn : Brain, mind, experience, and school.* National Academy Press, Washington, D.C. xxiii, 319 pages.

[4] Karen Brennan and Mitchel Resnick. 2012. *New frameworks for studying and assessing the development of computational thinking.* Vol. 1. Vancouver, Canada, 1–25.

[5] Michael Eisenberg. 2010. Bead Games, or, Getting Started in Computational Thinking Without a Computer. *International Journal of Computers for Mathematical Learning* 15, 2 (2010), 161–166. https://doi.org/10.1007/s10758-010-9167-5

[6] Randi A. Engle, Diane P. Lam, Xenia S. Meyer, and Sarah E. Nix. 2012. How Does Expansive Framing Promote Transfer? Several Proposed Explanations and a Research Agenda for Investigating Them. *Educational Psychologist* 47, 3 (2012), 215–231. https://doi.org/10.1080/00461520.2012.695678

[7] Jeannette M. Wing. 2006. Computational thinking. *Commun. ACM* 49, 3 (2006), 33–35.