Circuits, Bags and Agency: Conceptualizing Children's Tinkering Projects as Mangles

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Abstract: This poster contributes to the understanding of making and tinkering as teaching and learning activities for children. We use the concept of mangle (Pickering, 1995) to describe and understand how children work with circuitry components to create projects that interest them in a shared space. Using qualitative methods, we analyze three projects created by three children as well as the process through which they were created and discuss how tinkering with familiar materials may contribute to learning while tinkering.

In the context of K-12 education, making is a way to fuel STEM (Science, Technology, Engineering, and Mathematics) learning and innovation in children (Honey & Kanter, 2013). Bevan (2017) describes how making is used as an umbrella term to describe activities as different as assembly (making something following instructions), creative construction (making unique modifications to a pre-existing project idea), and tinkering (a playful and improvisational type of making). Each of these types of making is a rich learning experience, but how children engage in learning while making, constructing and tinkering is poorly understood. Here, we focus particularly on tinkering as a maker activity that is playful, iterative, spur-of-the-moment and yet a powerful means for engaging and exciting children around STEM learning and examine a small set of children's tinkering projects with the goal of illustrating emergent problem-solving. We elaborate on the real-time, process-oriented, and iterative nature of tinkering using the metaphor of mangle (Pickering, 1995). We argue that the metaphor of mangle is a useful way to conceptualize the interplay of children's actions and meaning-making with materials and designs in the particular social and cultural setting of a tinkering workshops.

Theoretical framework

Scientists have long suggested that science and scientific activity is a series of actions set in complex natural, material and social contexts that require emergent problem-solving and performance before cognition (Pickering, 1995). Real-world scientific problem solving science and scientific problem solving is a performance involving both humans and non-human entities exercising *agency*. Mangle is a metaphor for the performance of meaning-making in which human intentions and agency, and material agency are set in evolving actions, sociocultural practices and norms around these. Through a dance of endless iterations of resistance and accommodation that ends in a temporary *status-quo,* the performance of science and iterative meaning-making, mangle makes visible the *real-time* understanding of actions (ibid. pg 3). We think of meaning-making while tinkering as a performance that begins with human actions "in a field of material agency"(Pickering, 1995, p. 21) which humans struggle to capture. Our goal is to highlight the performance, the dialectic of resistance and accommodation and the dance of agency during the process of tinkering. We describe children's actions and the ways in which materials respond to these actions result in children making sense of their actions, and affordances and constraints of materials and designs.

Methodology

We set up a circuitry related tinkering workshop at a local public library makerspace that offered regular hour-long sessions based on various aspects of making, tinkering, and crafts for school-age children and adults. Our workshop was planned around building circuits using sewable and regular circuitry supplies for use in projects. We collected videos (whole group as well as short videos captured by children) and photographs during the sessions and field notes during and after the sessions.

Findings

We present details of two projects and then elaborate the relevance of the mangle as a conceptual tool.

Projects

A parent-child duo participating at the workshop created a snap-button circuit a unique design in which each half of a snap button was sewed into conductive thread connecting one end of the battery to the corresponding end of a sewable LED. When the buttons were snapped together current flow to the LED was cut off making the button function as a switch. Two siblings replaced the conductive thread with Copper tape and attached the circuit to the opening of a tote bag. This way, when they unsnapped the button to take things out of the bag the LEDs would light up.

Mangles

To the workshop participants, sewing related to repair and not circuitry. Having used regular cotton thread to sew buttons on his shirt, children felt disadvantaged while handling conductive thread. They used the conductive thread in the same way as cotton thread and the thread broke easily when tugged, unraveled frequently and had to be wound several times through a hole in the sewable LED for it to light up. Further, a long piece of thread was difficult for them to manage while taking care to prevent ends from touching. Sewing through multiple layers of the fabric caused the thread to break. These struggles to use the conductive thread like regular thread taught them a few important attributes of a circuit. Using these materials for new purposes gave rise to a series of resistances and accommodations. These revealed to them some new affordances (conductive materials need to be used in specific ways to achieve the desired outcome or that conductive thread is useful because without it one would need to use electrical wires for all projects that needed circuitry) and constraints (the conductive thread needed to be thought of as a wire and not as a thread and parts of a circuit cannot touch). The tinkering projects and the process of their creation that we described above illustrate what it means for children to participate in meaningful knowledge construction and science as performance.

Conclusion and implications

The projects centered around problems – identifying problems, looking for solutions, trying these solutions, making changes to them, trying them again, and finally choosing one. The nature of the designs as well problem-solving were emergent, just like the mangle. The unusual design choices that children made, the unconventional materials they used, and the potential uses that they identified for the projects on the other hand demonstrates epistemic agency (Scardamalia & Bereiter, 1991). They not only created knowledge for themselves, but took responsibility for shaping the knowledge and practices that made it possible. Both these observations have the potential to shape our understanding of children's tinkering as a practice and how and why it can be encouraged.

References

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