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Tinkering in Parallel: Pathways for Professional Learning in Education

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Abstract: This study explores professional learning that occurred during a summer program in which educators engaged with a series of tinkering activities facilitated online. Analysis revealed two primary themes: (1) generative starting points with multiple pathways for exploration, and (2) resolution of sticking points through social connections. An analytic frame of parallel process, adapted from counseling psychology, highlights the way these themes simultaneously speak to learning through tinkering and to professional development.

This study explores the learning experiences of a group of STEM educators who completed an informal online professional development program in summer 2020 that featured a series of tinkering activities.

Background

Educators must develop a skillset that is well grounded in learning theory and empirically supported pedagogical techniques, yet also flexible enough to respond to students' needs (Athanases et al., 2020). Learning to facilitate tinkering activities is a prime example of this challenge, since these activities are open-ended and invite creative exploration rather than fixed lesson plans (Vossoughi & Bevan, 2014). The ways educators have adapted to pandemic challenges underscore the need to conceptualize learning in terms of repertoires of practice that are flexible, responsive, and grounded in supportive pedagogical relationships (Gutiérrez & Rogoff, 2003).

Research design

Data come from 23 interviews with 12 educators who engaged with a series of tinkering activities facilitated online by the Exploratorium: Exploring Spinning, Chain Reaction, Cranky Contraptions, and Video Sensing. Activity prompts were introduced by email, and participants were encouraged to document their process and connect with others on social media. Interviews were semi-structured and were designed to elicit narrative accounts of participants' tinkering experiences. Analysis began with open coding to identify high-level topics that were salient across narratives; subsequent analysis elaborated upon each code in turn. Here we focus on two crosscutting themes that emerged in the second phase of analysis: (1) generative starting points with multiple pathways for exploration, and (2) resolution of sticking points through social connections.

Findings

Generative starting points with multiple pathways for exploration

In all 23 interviews, educators described the need to find a personally meaningful starting point to begin engaging with each activity. Generative starting points were associated with a sense of emotional resonance and playfulness; emotions that frequently came up in participants' narratives included excitement, inspiration, and curiosity. Because starting points were linked with personal sense making, many participants favored prompts that were open-ended enough to leave space for creative exploration while also providing a clear sense of direction. We believe these tinkering activities engendered fruitful learning in part because they were amenable to a variety of starting points and multiple pathways for exploration. We identified five types of starting point that generated engagement; Table 1 provides a description of each type, including observed frequency.

Resolution of sticking points through social connections

In 17 of the 23 interviews, educators described encountering sticking points in their exploration. These moments were characterized by intense frustration and interruption in the flow of engagement with an activity. Sticking points typically arose when participants encountered limitations, either in the material resources available to them at home, or in their individual knowledge about a particular tool or resource. In these moments, there was a disjunction between their original idea or vision and the implementation of that idea, which led to emotional overwhelm and impasse. For many participants, resolution was facilitated by social interactions, either with family members in person or with colleagues online. In these connections, participants found emotional support to persist through difficult moments. While sticking points typically arose for technical reasons, their resolution tended to be characterized not by technical troubleshooting, but by a shift in perspective and emotional regulation brought about by supportive, encouraging interactions and relational care. Perhaps surprisingly, many participants reported

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that the frustration of sticking points turned out to be a valuable part of their learning, and that they subsequently felt a greater sense of satisfaction and excitement about their tinkering experiences after they had worked through these difficult moments with emotional support from others.

Table 1

Five Types of Starting Point

Type	Freq	Description
Physical Materials	21	With focus on the properties of physical materials, participants thought creatively about how to use materials that were readily available at home and explored emergent interactions between materials.
Previous Experience	19	With focus on previous experience, participants activated existing knowledge and used past exploration as a template for new efforts or as motivation to try something different.
Practical Goals	10	With focus on a practical goal, participants designed an object to accomplish a personally meaningful task and structured their tinkering according to that goal.
Narrative Elements	8	With focus on a vivid image or character, participants created aesthetically appealing stories to guide exploration and link their creations with personally meaningful themes.
Scientific Concepts	8	With focus on a scientific concept, participants investigated physical phenomena and tested various factors or parameters related to a particular phenomenon.

Discussion

Since our participants were educators who engaged with these activities for the purpose of professional development, we note that each theme discussed above may serve a dual analytic function, simultaneously speaking to the nature of learning through tinkering and to the nature of professional development. Tinkering is recognized as a valuable mode for students' STEM learning (Resnick & Rosenbaum, 2013); here we note that it may be just as valuable for professional learning. The benefit of activities that include diverse learning pathways and ample opportunities for social collaboration may be equally applicable to facilitation of tinkering in STEM education and to provision of professional development. When considering educators as learners, it is useful to attend to both sides of their dual role in professional learning. Learning through tinkering allows educators to explore affordances of activities with their own practices in mind, developing a flexible pedagogical repertoire. Emphasis on adaptive practice is useful to address parallel challenges that arise in student learning and professional learning, such as shared challenges of adapting to pandemic constraints. In the context of counseling psychology, parallel process refers to dynamics in clinical practice that are mirrored in professional supervision (Sarnat, 2019). This concept is a useful analytic frame to conceptualize the value of tinkering for professional learning, where an educator likewise holds a dual role with respect to teaching and learning.

References

Athanases, S. Z., Sanchez, S. L., & Martin, L. (2020). Saturate, situate, synthesize: Fostering preservice teachers' conceptual and practical knowledge for learning to lead class discussion. *Teaching and Teacher Education, 88*, 102970. https://doi.org/10.1016/j.tate.2019.102970

Gutiérrez, K. D., & Rogoff, B. (2003). Cultural ways of learning: Individual traits or repertoires of practice. *Educational Researcher, 32*(5), 19–25. https://doi.org/10.3102/0013189X032005019

Resnick, M., & Rosenbaum, E. (2013). Designing for tinkerability. In M. Honey & D. Kanter (Eds.), *Design. Make. Play: Growing the next generation of STEM innovators* (pp. 163–181). Routledge.

Sarnat, J. E. (2019). What's new in parallel process? The evolution of supervision's signature phenomenon. *The American Journal of Psychoanalysis, 79*, 304–328. https://doi.org/10.1057/s11231-019-09202-5

Vossoughi, S., & Bevan, B. (2014). Making and tinkering: A review of the literature. National Research Council Committee on Out of School Time STEM, 1–55.

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