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Proportions Playground: Using Interactivity to Support Mathematical Reasoning

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Objective & Theoretical Framework

This exploratory project seeks to understand how to promote mathematical reasoning about proportional situations in a dynamic environment. We draw from Knowledge in Pieces (KiP; diSessa, 2006), which posits that people develop understanding in the form of fine-grained knowledge resources. These resources are refined and interconnected as expertise develop.

Research Questions

- How do teachers interact with the Proportions Playground toys to reason about proportional situations?
- What knowledge resources do teachers invoke to solve tasks using the toys in the Proportions Playground?
- What evidence is there of participants making connections between and among knowledge resources as they work with the Proportions Playground task sets?
- What evidence is gained about the potential value of the Proportions Playground for supporting teachers in reasoning about proportional situations.

Theory of Proportions Playgrounds

We are using a design-based research approach (Design-based Research Collective, 2003) to develop a theory of teacher learning along with toys and professional development that embody that theory. Our theory:

- Dynamic tasks engage teachers in reasoning about proportional relationships rather than focusing on calculating answers.
- Dynamic tasks provide a basis for rich discussion in PD settings.
- Conversations, combined with rich tasks, support the development of connections between knowledge resources.
- Engaging with multiple representations promotes reasoning in a variety of ways and that is a feature of having a robust understanding.
- Engaging with student thinking (e.g., through sample work) provides opportunities to push teacher understanding deeper because it encourages teachers to think in ways that are novel to them and that rely on multiple knowledge resources.
- Focusing on playing with mathematical ideas allows engagement in reasoning and argumentation rather than learning to find shortcuts.

Data & Iterative Design

We have begun to collect data from our teacher advisors. They provide us with input about the usability of the toys, the value of the toys, and how they might use them. We will then pilot six hours of professional development in 2-3 settings. These are face-to-face with 12-20 people per setting. The goal is to collect data to better understand how teachers think about these dynamic environments and how we might use the toys to encourage mathematical reasoning, arguing, and communication. Data will be collected as video, then transcribed and analyzed.

Warrants for Arguments

This study grew out of a prior study in which we noticed teachers approach proportional tasks different in dynamic environments than in static (pencil and paper) environments.

We have also seen that certain productive knowledge resources, such as multiplicative reasoning and "fixed number of variable sized parts" reasoning were rarely relied upon by previous participants in paper-and-pencil settings.

Significance

While this project is not one that would traditionally be called Blended learning, it represents an approach to professional development that, while face-to-face, is inseparable from the technical toys.

Acknowledgement

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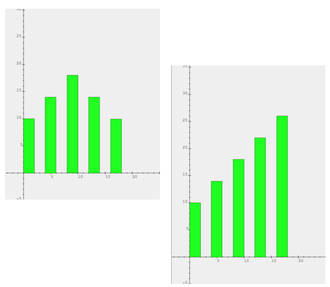
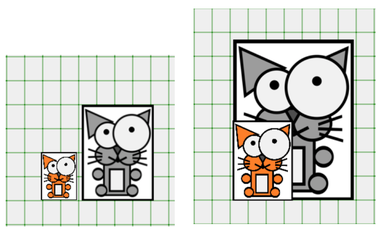
Wiggle Image Toy: allows teachers to resize images without constraints on aspect ratio.

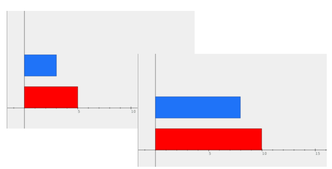
Cactus Toy: create graphs that show the relationship of two variables over time.





Critters: Examine variance and invariance as two critters dilate.

Thermometers: Examine what linear, proportional, and inversely proportional situations look like in real time.



Buildings: examine how to maintain a proportion using "chunky" thinking.