



Productive Disciplinary Engagement: Digital Affordances for Open Problems in Middle School Mathematics

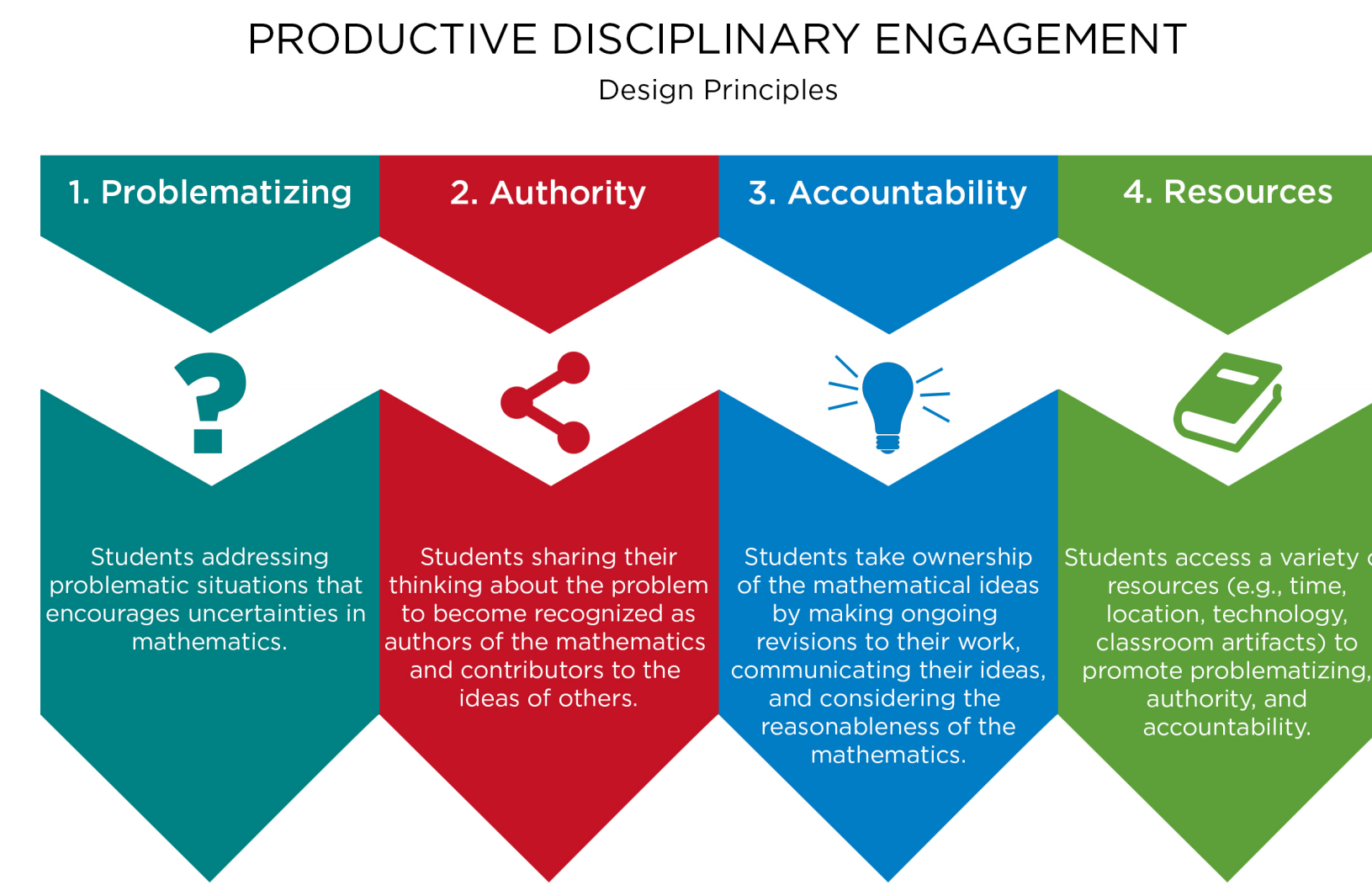
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Research Questions

- How can productive disciplinary engagement be fostered in digital learning environments with open problems and “just-in-time” supports? How can student learning of mathematics be enhanced?
- What is the nature of productive disciplinary engagement and student learning of mathematics at key development points in a connected sequence of problems and lesson goals?
- What information do teachers draw upon when they use open problems and “just-in-time” supports? How do teachers adapt the supports for specific problems?

Productive Disciplinary Engagement



Embodiments of PDE	New Possibilities for PDE
<ul style="list-style-type: none"> Students generate, discuss, and interpret complex problem situations (problemating and authority) Students consider different ways to think about, assess, and refine problem-solving strategies (accountability) Students reflect on their learning – what they have learned, how it connects to prior knowledge, and possible new directions moving forward (accountability) Students consider the work of others as alternate thinking and approaches and form conceptual connections to the different ways of thinking (resources and authority) Students form connections between and among multiple representations (resources) Students access supports to extend perseverance (problemating and resources) 	<ul style="list-style-type: none"> Students can access high cognitive demand tasks that focus on conceptual understanding (problemating) Students can use tool supports that do not reduce cognitive demand or limit focus on conceptual understanding (problemating and resources) Students can make their own decisions on the problem solving approach without teacher intervention (problemating and authority) Students can select their solution pathway and maintain authorship of ideas (authority) Students can model and press each other for answer completeness (authority and accountability) Students can probe deeper into mathematical justifications (accountability)

Print Version of the Orange Juice Problem

Redesigned Version of the Problem

Digital Prototype

Arc of Learning for Connected Mathematics3

Introducing Setting the Scene	Exploring Mucking About	Analyzing Going Deeper	Synthesizing Looking Across	Abstracting Going Beyond
<ul style="list-style-type: none"> reveal the mathematical theme for the unit informally highlight the key mathematical concepts in the unit assess prior understandings related to the goals of the unit 	<ul style="list-style-type: none"> establish a platform for developing key aspects of the understanding of the concepts and strategies explore (consider) a context that students can use to build, connect, and retrieve mathematical understandings 	<ul style="list-style-type: none"> make connections between concepts and representations examine nuances in key aspects of the core mathematical ideas often with a variety of contextual situations 	<ul style="list-style-type: none"> recognize core ideas across multiple contextual or problem situations begin to consolidate and refine emerging mathematical understanding(s) into a coherent structure 	<ul style="list-style-type: none"> make judgments about which representations, operations, rules, or relationships are useful across various contexts look back on prior learning to generalize, extend, and abstract the underlying mathematical structure assess understandings at a more general level

Arc of Learning for Comparing and Scaling

Investigation 1: Ways of Comparing, Ratios, Percents, and Proportions	Investigation 2: Comparing and Scaling Rates	Investigation 3: Markup, Markdowns, and Measures Using Ratios, Percents, and Proportions
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Arc of Learning for Comparing and Scaling

Open Questions

- Is the extent to which we can productively redesign a problem tied to the Arc of Learning?
- How do students build conceptual understanding over time through engagement in open problems?
- How might PDE look different in a collaborative digital environment than in a purely physical space?
- How can we infer, through coding and analysis, the ways in which “Just-in-Time” supports are being used by students and teachers?
- How can the platform help with learning analytics?

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