EHR Core Research (ECR) Virtual Poster Hall

Promoting Productive Disciplinary Engagement and Learning with Open Problems and "Just-In-Time" Supports in Middle School Mathematics

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Research Question

What is the nature of productive disciplinary engagement (PDE) and student learning of mathematics at key development points in a connected sequence of problems and lesson goals?

The Framework for PDE

- We've built on Engle and Conant's (2002) concept of PDE to develop a framework that describes student engagement in terms of student behaviors aligned with the four principles.
- Small group work on mathematical tasks can show high, medium, or low quality of PDE based on the prevalence of student behaviors.

Problematizing	• Working towards conceptual understanding • Disciplinary practices in mathematics • Pushing to resolve uncertainties or get "unstuck" • Deep uncertainties
Authority	• Using own words to discuss mathematics • Students' ideas shape the solution path • Credible experts in their group
Accountability	• Questioning and explaining to make sense of mathematics • Multiple ideas debated • Wide-spread collaboration
Resources	• Using digital, physical, and inter-personal resources to make sense of mathematics

Methods

Context of the Study

- 2 units of *Connected Mathematics* curriculum:
  - *Stretching and Shrinking* (proportionality)
  - *Moving Straight Ahead* (linearity)
- Each unit is a sequence of connected problems across 12-20 days of instruction
- Testing involved 5 teachers across 4 schools, each with 3-5 sections of 7th grade math

Collaborative Digital Environment

- Design research process to create the environment
- CMP STEM problem format to deepen student engagement throughout open problems
- Includes digital tools to create and modify inscriptions
- Features for viewing, sharing, and saving work in groups

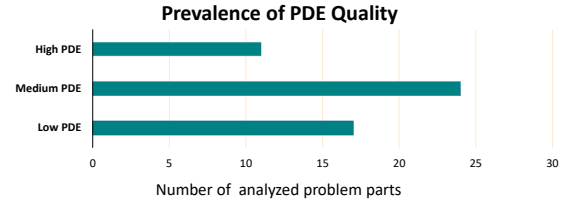
Data Sources

- Video and audio recordings of small groups
- Screen recordings of students' digital workspaces
- Teacher interviews and audio recordings of instruction
- Engagement analytics for the digital workspace

Analysis Procedures

- Open coding grounded in data to develop framework for students' PDE
- Coding small groups' work on mathematical problems in terms of nature and quality of PDE

Preliminary Findings



High levels of PDE can occur during early parts of mathematical tasks when students work on open problems and have access to digital collaborative tools.

Students can develop high levels of PDE quickly on new tasks if they can draw on high or medium PDE on related prior tasks. A problem structure that includes open questions that deepen throughout the lesson or unit allows for this.

When students develop higher levels of one principle for PDE, it can support the development of higher levels of another principle (illustrated in the excerpt of student dialogue below).

Speaker	Timecode	Utterance	Principles of PDE
Rose	35:51	So the scale factor. If it's L to N then the scale factor's going to be... it's not times 3? Because if it's times 3...	Problematizing: Uncertainty about how to determine correctness and justify their answer
Eva	35:59	Wouldn't it be times...	
Rose	36:00	(overlapping speech) It's times 3. (pause). And for the heights it's still times 3. But for the perimeter?	Resources: Using interactive graphs to move and compare shapes
Carter	36:02	Yeah.	
Eva	36:03	That's true, because it's 3 across.	Accountability: Confirming that peers' ideas makes sense.
Rose	36:06	It's times 3. And for the heights it's still times 3. But for the perimeter?	Authority: Contributes mathematical ideas and seeking peers' ideas/expertise
Carter	36:13	It's going to be 3+3+... it's going to be 12. 12 of L go into N. This is the dumbest pencil. (pause)	Authority: Multiple students contribute mathematical ideas
Noah	36:58	It's 3 times on each side.	Accountability: Multiple students collaborating
Rose	37:01	True. And then the area's 12 times the size. So up here (pointing to another problem) we did this wrong on the first one.	Problematizing: Making connections between tasks toward conceptual understanding

Ongoing Work

- Continuing analysis of the full set of data for students' group work
- Identifying factors that allow for the development of high levels of PDE (including problem structure, teacher support, and digital resources)

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