

Intro

- NCTM (2014) views students' mathematical struggles as "opportunities for delving more deeply into understanding the mathematical structure of problems and relationships among mathematical ideas, instead of simply seeking correct solutions" (p. 48).
- This study focused on investigating productive struggles of prospective teachers (PTs) because they are the ones who will support productive struggle in learning mathematics (NCTM, 2014) in their future K-12 classes.

Literature Review

- Types of struggles (e.g., DuCloux et al., 2018; Warshauer, 2015)
- Factors that foster productive struggle in classes (e.g., Roble, 2017; Russo et al., 2021)
- Ways to help PTs to support productive struggle in their future classes (e.g., El-ahwal & Shahin, 2020; Warshauer et al, 2021)

Research Question

What do PTs' mathematically productive struggles look like when they are engaged in a challenging task in a middle school mathematics methods course?

Theoretical Framework

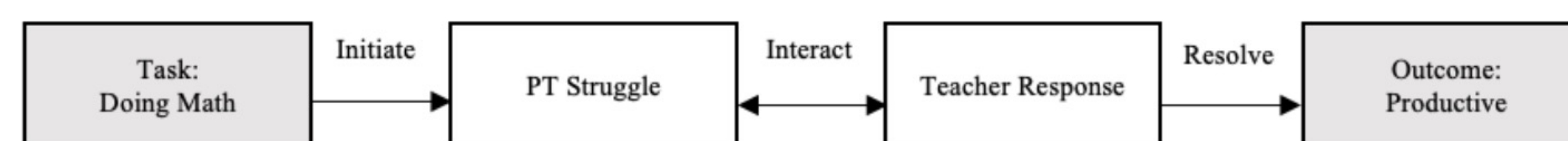


Figure 1: PT Productive Struggle Framework (Developed from Warshauer, 2015)

A mathematically productive struggle is an interaction that begins with some expression of struggle that provides the opportunity to better understand a mathematical point (MP) and ends when some sense has been made of the MP and the focus of the interaction changes.

Mathematical Point (MP): d is a constant that represents a common difference between each consecutive term in an arithmetic sequence.

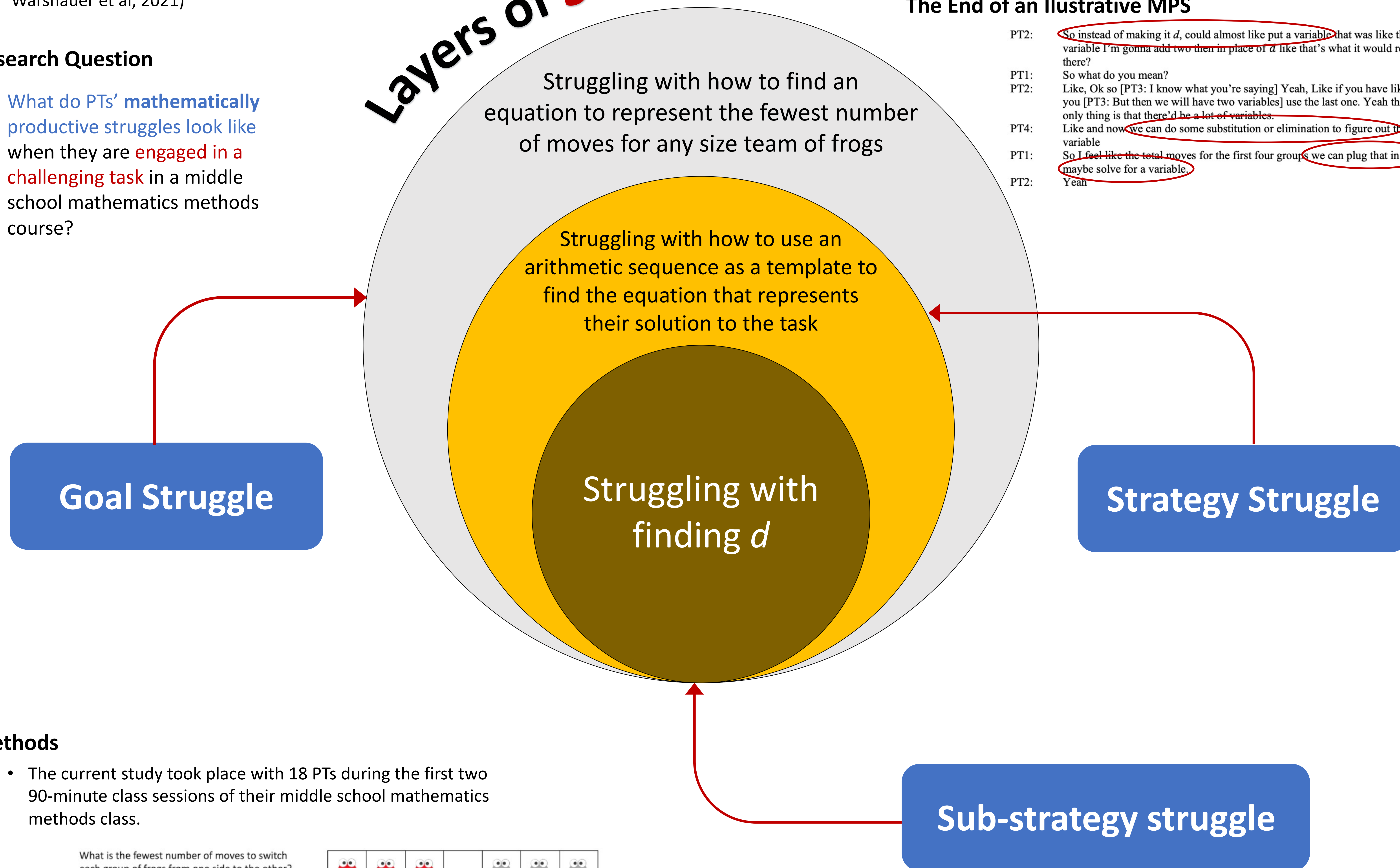
The Beginning of an Illustrative MPS

- PT1: So wait, what would d be then?
 PT3: That's what I'm trying to figure out because the difference increases so $[d]$'s not consistent. So I don't know that it's technically arithmetic because the, an arithmetic sequence is consistent.
 PT1: That's true.
 PT3: So I don't know if I can change the d to be something like that.

The End of an Illustrative MPS

- PT2: So instead of making it d , could almost like put a variable that was like the last variable I'm gonna add two then in place of d like that's what it would represent there?
 PT1: So what do you mean?
 PT2: Like, Ok so [PT3: I know what you're saying] Yeah, Like if you have like when you [PT3: But then we will have two variables] use the last one. Yeah that's the only thing is that there'd be a lot of variables.
 PT4: Like and now we can do some substitution or elimination to figure out the other variable
 PT1: So I feel like the total moves for the first four groups we can plug that in and maybe solve for a variable.
 PT2: Yeah

Layers of Struggle



Methods

- The current study took place with 18 PTs during the first two 90-minute class sessions of their middle school mathematics methods class.

What is the fewest number of moves to switch each group of frogs from one side to the other? (Allowed moves are jumping over one frog to an empty spot or sliding to an adjacent empty spot.)

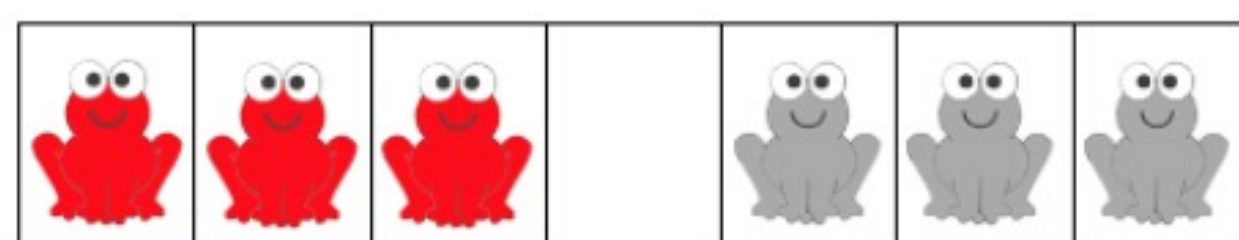


Figure 2: The Frog Problem Prompt and Representation of Two Frog Teams of Size Three

- Data collection included:
 - videos and audio recordings of both class sessions
 - electronic copies of all related PT written work
 - Desmos formative assessments and reflections
 - Data analysis process:
 - identified interactions that contained expressions of struggle
 - assessed whether a mathematical point (MP) could be better understood from the struggle
 - looked for evidence of sense being made of that MP
- mathematically productive struggle (MPS)
- Our analysis of these productive struggles was supported by coding the answers to these questions:
 - Who is struggling?
 - What are they struggling with?
 - Why is it a productive struggle?

Conclusion

- The results of this exploratory study revealed the complexity of the inner workings of PT's productive struggle. We hypothesized that a mathematically productive struggle can consist of different layers of struggle—goal struggle, strategy struggle, and sub-strategy struggle—that may coexist simultaneously.
- Mathematically productive struggles can occur even when students are not making progress towards getting the answer.

