



Exploring How Practical Flexibility is Correlated with Procedural Knowledge in Linear Equations



Maz Farabee, Qiushan Liu, Dr. David Braithwaite

Abstract

This project is meant to explore the role of practical flexibility in problem solving cognition, specifically concerning basic linear equations. This is important to understand how people solve logic problems, and what factors predict success. Within this study we hypothesize that practical flexibility is correlated with procedural knowledge. This study's research method has participants solve a set of algebra linear equations without any direction, then in a second section solve a different yet similar set of equations but this time using the innovative strategy outlined in the problem instructions. In the results, for the first problem set participants ability to pick the most efficient strategy was evaluated. This was coded as a 1 point for every time they use the efficient strategy. For the second problem set, the participants' ability to execute an innovative strategy by correctly solving the problem was evaluated. For practical flexibility to be correlated with procedural knowledge, an individual's ability to pick the best strategy should be correlated with their ability to successfully execute the innovative problem-solving strategy. This data is preliminary, and there are plans to continue collecting data into the future to better understand how practical flexibility and procedural knowledge relate to each other, and problem solving.

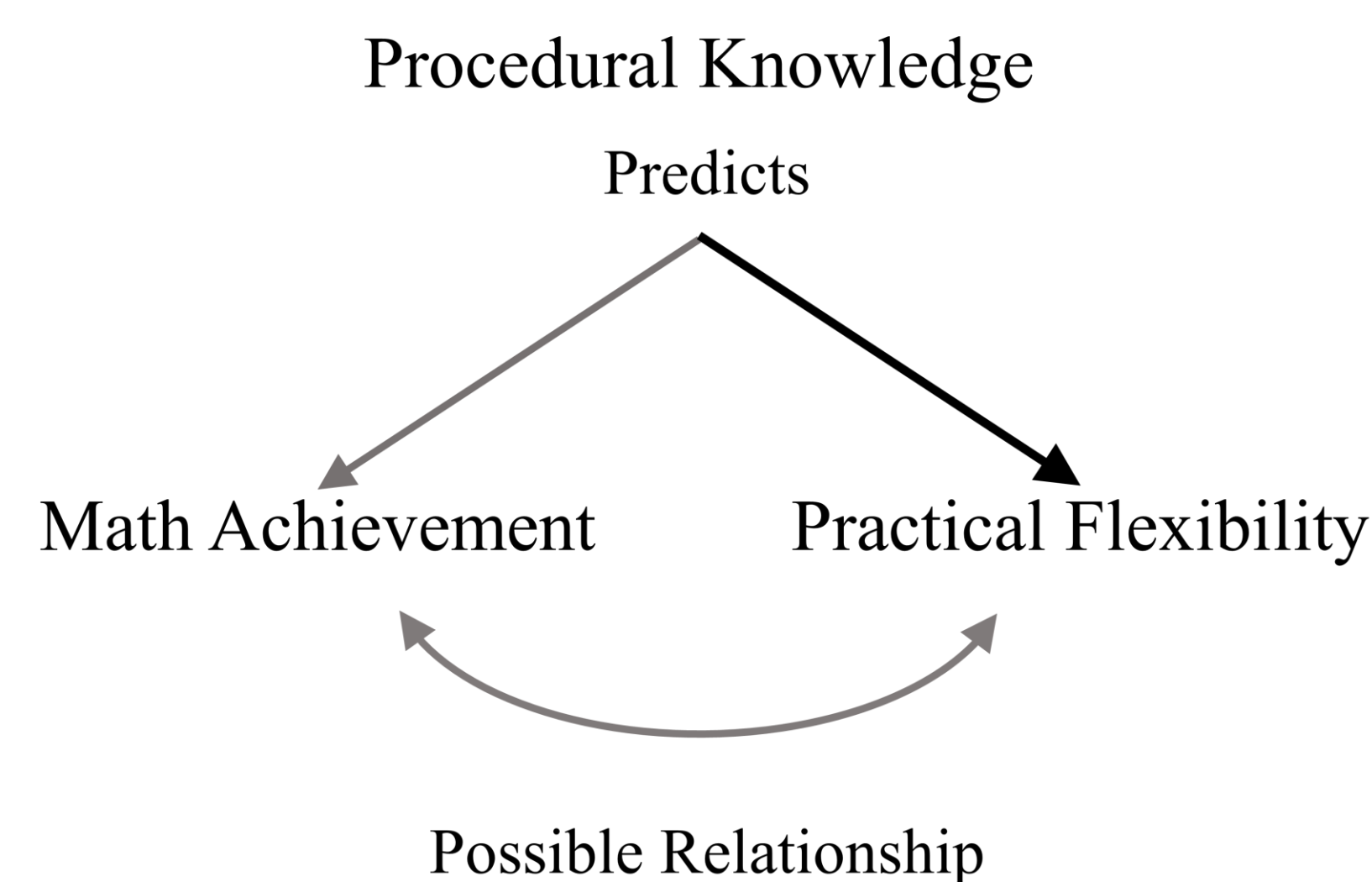
Introduction

Background

- Hope to understand math cognition through breaking it down into multiple smaller and more study able concepts
- Focus on algebra linear equations, such as $5(x+3)=20$.
- Concept studied is practical flexibility
 - Ability to select and execute the best strategy while solving a problem (Liu et al, 2018).
 - Associated with an individual's procedural knowledge (Schneider, et al, 2011).
- Procedural knowledge
 - Measures the extent someone knows how to solve a problem step-by-step, or the procedures associated with a problem.
 - Predictor of math achievement (Schneider, et al, 2011)

Purpose

- To better understand the role practical flexibility plays while an individual is solving algebra linear equations problems.
- Understand the relation between Practical flexibility and procedural knowledge
- Gain insight into how people use logic to solve algebra linear equations problems
- Furthering understanding on how to teach techniques to solve these types of problems.



Theoretical relationship found during literature review. The black line indicates relationship studied here

Methods

Participants

FSU students recruited through the SONA system, since this study is still ongoing, we do not have accurate demographic information.

Measures

Strategy Selection Task

- Participants solved a set of problems
- Which strategies participants would use to solve problems, special note to if innovative strategy used

$$4(x - 2) = 24$$

Example of problem from Strategy Section Task

Strategy Execution Task

- Participants were directed to solve a set of problems using an innovative strategy
- Included to test participants ability to solve using the innovative strategy

1 . Please solve the problem by subtracting the like terms from both sides

$$3(x - 9) + 4 = 7(x - 9)$$

Example of Problem from Strategy Execution Section

Procedural Fluency Task

- Participants given sample of problems
- Asked to solve as much as possible in 3 minutes

The order of the problems was randomized in each booklet as a counter balancing procedure. At the start of the booklet there was a demographics questionnaire.

Procedure

- Conducted in person with a paper booklet in which the participant worked with pencil. Participants were asked to read aloud each problem they completed and clearly show their work and solutions to each problem.

Data Analysis

Data analysis: Basic descriptive statistics, such as mean, standard deviation, with special attention to how each problem is performed.

Results

Results in preliminary methods testing phase so there is no current data to analyze. After collecting data, we plan to

- Tested practical flexibility by observing if the participant solved the problem with the most innovative strategy, denoted by adding 1 point per correct strategy used.
 - Test procedural knowledge by seeing the number of problems the participant successfully executed, observed by if the participants answer matched the answer key.
- For the hypothesis to be supported, the number of times the participant choose the most innovative strategy should be positively correlated with the number of times the participant successfully execute the innovative strategy.

Discussion

In this study we hope to better understand specifically how people solve these types of problems, and how to best guide individuals towards understanding and successfully solving problems themselves.

Future Research

- Why a participant does not use the most efficient strategy when they know how to successfully execute it.
- Relationship between practical flexibility and math achievement

References

DeCaro, Marci S. (2016) "Inducing mental set constrains procedural flexibility and conceptual understanding in mathematics." *Memory & cognition* 44.7: 1138–1148. Web.

Kanold, Timothy D, et al. Houghton Mifflin Harcourt Algebra 1, Geometry, and Algebra 2 : Algebra 2. Houghton Mifflin Harcourt, 2015.

Liu, Ru-De et al. (2018) "Turning potential flexibility into flexible performance: moderating effect of self-efficacy and use of flexible cognition." *Frontiers in Psychology* 9: 646–646. Web.

Schneider, M., Rittle-Johnson, B., & Star, J. R. (2011). "Relations among conceptual knowledge, procedural knowledge, and procedural flexibility in two samples differing in prior knowledge." *Developmental Psychology*, 47(6), 1525–1538. <https://doi.org/10.1037/a0024997>

Shaw, Stacy T., Anahit A. Pogossian, and Gerardo Ramirez (2020). "The mathematical flexibility of college students: the role of cognitive and affective factors." *British journal of educational psychology* 90.4: 981–996. Web.

Xu, L., Liu, R.-D., Star, J. R., Wang, J., Liu, Y., & Zhen, R. (2017). "Measures of potential flexibility and practical flexibility in equation solving." *Frontiers in Psychology*, 8. <https://doi.org/10.3389/fpsyg.2017.01368>