Embracing Student Language As Scaffolding During Mathematical Modeling

Abigail Quansah and Jennifer A. Czocher

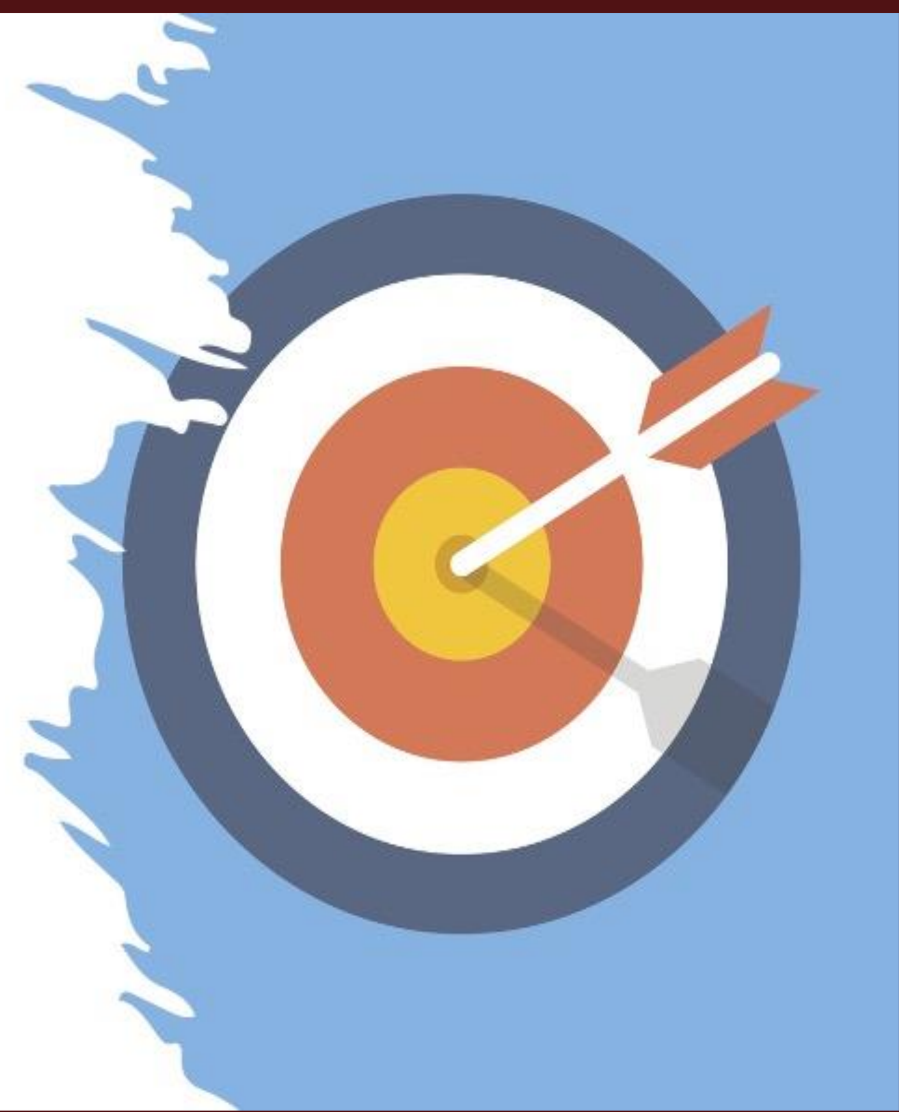
Ph.D. in Mathematics Education

Motivation/Research goals

Maxwell (2013) identifies three distinct goals that researchers should keep in mind. These aspirations are of a more personal, intellectual, and practical nature. Although the researcher's personal goals act as motivations that may not matter to others, intellectual goals focus on knowledge acquisition, while practical goals are concerned with satisfying a specific need.

•**Intellectual Goals:** Over time, we would like to connect the embrace of student language as scaffolding moves to student learning outcomes.

•**Practical Goals:** Our goal is to extend this work into research on the teaching and learning of mathematical modeling, where students use mathematical language and mathematical notation to represent real-world conditions and assumptions.



Method

Research Design

Clinical task-based interviews (Maher & Sigley, 2020)

The participant, Navani, was a bilingual computer engineering student who had not completed a differential equations course from a wider research that explored effective scaffolding tactics for helping undergraduate STEM majors utilize advanced mathematics to mathematically model real-world problems.

The Sorting Task

based on the Wisconsin Card Sort (Eling et al., 2008)

measured participants' knowledge of linear vs. exponential development in various scenarios

four of the task scenarios featured a constant rate of change (linear growth)

four had a rate of change proportional to a quantity present (exponential growth).

Data analysis documented the Navani's sorting criteria and followed them through the problems she answered in later sessions. To preserve Navani's mathematical meanings, the interviewer maintained her language choices throughout the sessions.

Results

Navani sorted the prompts into 2 groups. She placed 1, 2, 7 together and named the group "Group 1 - independent" and placed 3, 4, 5, 6, 8 together and named the group "Group 2 - dependent".

She explained that items 4, 6, and 8 went together because they used the phrase "rate proportional" to an amount.

She explained that #7 was *growth independent* because there was an initial amount of $3 which adds on by the rate of $1.50, the growth did not depend on how much money had already accumulated.

The interviewer adopted these terms throughout the rest of the sessions, whose mathematics often depended on the idea that *amount of growth depends on amount present.*

Independent	Dependent
# 1, 2, 7	#3, 4, 5, 6, 8

Figure: Sorting Task

1. You open a savings account and deposit $2000. The account grows at an annual rate of 8% of the opening balance.
2. You purchase a cactus plant, and it is 10cm tall. You notice that it grows by a constant height every month.
3. A lavender plant grows at a rate such that its size doubles every month.
4. A colony of rabbits reproduce at a rate of *k* kittens per rabbit every year.
5. Wet laundry under the sun loses *w*% of its initial moisture every thirty minutes.
6. A disease spreads at a rate proportional to the number of infected people.
7. A cab company charges a $3 boarding fee in addition to its meter which is charged at a rate of $1.50 for every minute.
8. A forest fire spreads outwards at a rate proportional to the area that is already on fire.

Discussion

Building on shared knowledge through language conventions informed effective scaffolding moves for the participant.

This finding is consistent with literature claiming that building on everyday language in mathematics allows them to express initial conceptual understandings and gives educators access to the student's thinking as well as influences the teacher's instructional choices (Adams et al., 2005).

From a modeling perspective, students' conceptions are mutually influenced by how they express their mental models. Thus, it is important to have initial documenting tasks (like the Sorting Task) prior to more complex tasks to develop a shared language around the mathematical concepts.

In this study, familiarity with the participant's associations between language and concepts enabled the interviewer to enter the space of what the participant was able to do unassisted and then use that information to aid her throughout the more complex modeling tasks, enlarging the space of what the participant could achieve with guidance.

References

Adams, T., Thangata, F., & King, C. (2005). "Weigh" to go! Exploring mathematical language. *Mathematics Teaching in the Middle School*, *10*(9), 444-448.

Eling, P., Derckx, K., & Maes, R. (2008). On the historical and conceptual background of the Wisconsin Card Sorting Test. *Brain and Cognition*, *67*, 247-253.

Maher, C. A., & Sigley, R. (2020). Task-based interviews in mathematics education. *Encyclopedia of mathematics education*, 821-824.

Maxwell, J. A. (2013). *Qualitative research design: An interactive approach (applied social research methods)* (p. 232). Thousand Oaks, CA: Sage.

NSF Grant #1750813

TEXAS STATE UNIVERSITY®

MEMBER THE TEXAS STATE UNIVERSITY SYSTEM