2016 NCTM RESEARCH CONFERENCE
April 11-13 • San Francisco

Paper Title: Utility of the TMSSR Framework for Investigating Instructional Practices

Author(s): Lindsay Reiten, Zekiye Ozgur, and Amy B. Ellis

Session Title: Utility of the TMSSR Framework for Investigating Instructional Practices

Session Type: Brief Research Report

Presentation Date: Tuesday, 12 April 2016

Presentation Location: San Francisco, California

UTILITY OF THE TMSSR FRAMEWORK FOR INVESTIGATING INSTRUCTIONAL PRACTICES

Supporting meaningful and productive student reasoning is an important goal of mathematics instruction. Two essential means for achieving this goal are the implementation of conceptually rich tasks and teachers' abilities to support and foster student engagement in such tasks. The *Teacher Moves for Supporting Student Reasoning* (TMSSR) Framework is used for investigating the different ways teachers provide instructional support for students, and how those differences may support students' reasoning. In this paper, we discuss the affordances of the framework. This study is part of a larger project (http://tinyurl.com/badgerellis) that aims to (a) help students develop deductive reasoning competencies in algebra through quantitative reasoning opportunities, and (b) support teachers in achieving this goal. We will present the analysis of two classroom implementations of a research-based unit via the TMSSR framework (15-20 minutes). During the presentation, we will engage the audience in a discussion about the utility of the TMSSR framework as a tool for studying teacher practices, as well as future research directions (10-15 minutes).

Theoretical Background

Studying the nature of teacher moves is essential in better understanding how to best support student learning. While some researchers focus on the questions teachers ask (e.g., Driscoll, 1999; Franke et al., 2009), others focus on teachers' discursive moves (e.g., Herbel-Eisenmann, Steele, & Cirillo, 2013; Hufferd-Ackles, Fuson, & Sherin, 2004; Krussel, Edwards, & Springer, 2004; Stockero et al., 2014). By combining teacher questioning and other discursive moves, we extended the literature base to develop a more inclusive teacher moves framework, *Teacher Moves for Supporting Student Reasoning (TMSSR)*, which emerged from the analysis of a classroom teacher's implementation of a research-based unit (Ozgur, Reiten, & Ellis, 2015). To account for the different ways teachers can support student reasoning, the TMSSR framework (Figure 1) identifies four major functional categories of teacher moves: eliciting, responding, facilitating, and extending.

The moves in the *eliciting student reasoning* category serve to engage students in sharing their thinking; moves in the *responding to student reasoning* category aim to make students' reasoning more public. The moves in the *facilitating student reasoning* category aim to help students develop their reasoning through various forms of guidance and explanations, while the moves in the *extending student reasoning* category serve to further advance students' reasoning by asking them to make connections, think about underlying concepts, and justify their ideas. The framework also distinguishes which types of teacher moves afford different levels of potential support for student reasoning, locating moves along a continuum based on their potential support (e.g. low/high) relative to each other (see Ozgur, Reiten, & Ellis, 2015 for more details).

Eliciting Student Reasoning	
Eliciting Answer	Eliciting Ideas
Eliciting Facts or Procedures	Eliciting Understanding
Asking for Clarification	Pressing for Explanation
Figuring Out Student Reasoning	
Checking for Understanding	

Responding to Student Reasoning	
Validating a Correct Answer	
Re-voicing	Re-representing
Encouraging Student Re-voicing	
Correcting Student Error	Prompting Error Correction

Facilitating Student Reasoning		
Cueing	Providing Guidance	
Topaze Effect[a]	Building[b]	
Funneling		
Providing Procedural Explanation	Providing Summary Explanation	Providing Conceptual Explanation
	Providing Information	
	Encouraging Multiple Solution Strategies	
	Providing Alternative Solution Strategy	

Extending Student Reasoning	
Pressing for Precision	Encouraging Reasoning
Encouraging Evaluation[c]	Encouraging Reflection
Topaze for Justification[d]	Pressing for Justification
	Pushing for Generalization

Figure 1. The Teacher Moves for Supporting Student Reasoning (TMSSR) Framework
Note. See Ozgur, Reiten, & Ellis (2015) for definitions of teacher moves. [a]Topaze is defined as a teacher breaking a task into smaller parts, reducing the complexity of the task by asking easier and easier questions, thereby reducing students' opportunity to engage in authentic problem solving. [b]Building is defined as using students' earlier contributions to support new understanding, or encouraging students to build on one another's contributions. [c]Encouraging Evaluation is defined as the teacher asking students whether they agree or disagree with one another's answers or explanations. [d]Topaze for Justification is defined as the teacher initially pushing for justification, but then immediately downgrading her question to a less-sophisticated why question.

Methods

We report on the findings of two classroom implementations of a research-based unit focused on linear relationships grounded in the context of gear ratios. Because reasoning with quantitative relationships has been found to support students' understanding of algebraic relationships (Ellis, 2007; Smith & Thompson, 2007), we designed quantitatively rich tasks in a series of teaching experiments, which we then provided to teachers for classroom implementation. In this study, students encountered tasks that required them to identify the number of teeth and the number of rotations as the relevant quantities and then to explore relationships between those quantities.

We analyzed teacher moves in two eighth-grade mathematics classrooms situated in two public middle schools in a large, urban district. Both teachers had the same set of tasks and were free to modify the tasks as they saw fit. To capture teachers' implementation, we observed and videotaped their instruction, took field notes, collected student work, and interviewed the teachers. The implementation in Ms. L's classroom occurred over 10 days (75-minute lessons) with a heterogeneous group of seventh and eighth grade students. In Ms. B's classroom, the implementation occurred over 11 days (45-minute lessons) with a group of homogeneous eighth grade students.

All lessons were transcribed. Prior to analysis, each transcript was enhanced to include gestures and images of classroom work, and then parsed into topically related sets (Mehan, 1979), which provided sufficient detail and context on a related idea or topic as the unit of analysis. Two researchers independently coded the data according to the TMSSR framework and then compared for discrepancies. Final codes were determined in consensus (Harry, Sturges, & Klingner, 2005).

Findings and Discussion

The findings are based on our investigation of teachers' moves using the TMSSR framework. Because the teachers modified the tasks as they saw fit, there were only five common tasks across both classes. Although we analyzed the entire implementation for both teachers, we restrict our report to the common tasks in order to eliminate the differences in teacher moves that may occur as a result of the different nature of the tasks. Rather than using the framework to distinguish between a *good* and *poor* teacher, we use the TMSSR framework to investigate *how* each teacher supported her students. Figure 2 provides the categorical representations of the teacher moves for the common tasks, which are representative of the broader set of moves across the entire implementation.

a. Ms. L

Eliciting	**Responding**
36.47% (62)	20.59% (35)
Facilitating	**Extending**
30% (51)	12.94% (22)

b. Ms. B

Eliciting	**Responding**
51.31% (137)	17.97% (48)
Facilitating	**Extending**
21.72% (58)	8.99% (24)

Figure 2. Distribution of two teachers' categorical moves in the TMSSR Framework. a. Represents the 170 teacher moves in Ms. L's classroom for the five common tasks. b. Represents the 267 teacher moves in Ms. B's classroom for the five common tasks. The shading corresponds to the percentage of teacher moves in each category compared to the total number of moves for the common tasks. The actual percents and number of teacher moves (located within the parenthesis) for each category are also provided.

Although Ms. L and Ms. B showed similar proportions of moves in the *Responding* and *Extending* categories, they showed different proportions in the *Eliciting* and *Facilitating* categories. Both teachers supported student reasoning the most through eliciting, which is not surprising because the other categories consist of moves that typically occur after eliciting students' responses. Half of Ms. B's teacher moves focused on eliciting compared to only a third of Ms. L's moves. This suggests that Ms. B spent less time advancing students' initial reasoning through facilitative and extending moves. The framework also reveals that compared to Ms. B, Ms. L had a greater proportion of moves focused on facilitating student reasoning.

Overall, Ms. L's moves demonstrated more variety compared to Ms. B. They were distributed across many teacher moves whereas Ms. B's moves were more focused on the lower end of the continuum (see Figure 3). The variety of moves used by Ms. L enabled her to provide support for her students' reasoning that moved students from their initial reasoning to a deeper level as they progressed through tasks.

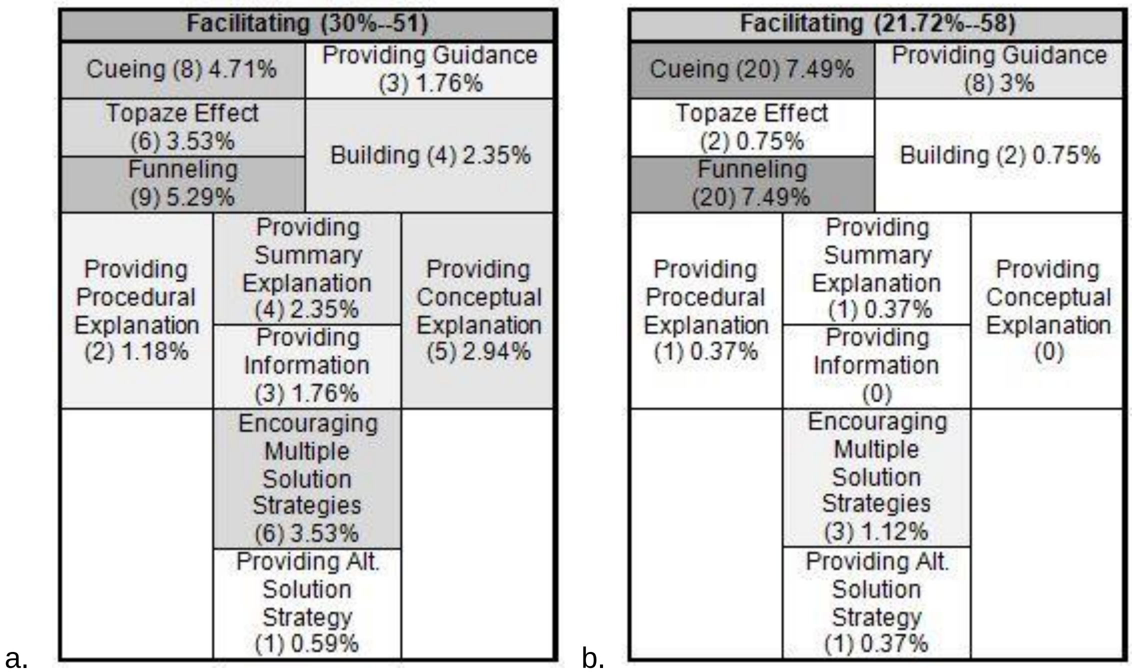

Figure 3. Distribution of teacher moves for facilitating student reasoning. Representation a. consists of Ms. L's teacher moves during the five common tasks. Representation b. consists of Ms. B's teacher moves. Shading corresponds to the proportion of a specific move compared to the total moves. The number of occurrences of each move is located within the parentheses.

In an effort to demonstrate the framework's affordances, we zoom in on the *Facilitating* category. In doing so, we see that both teachers had a similar number of moves (51 vs. 58); however, their distribution of moves was quite different. A majority of Ms. B's moves were cueing the students to particular aspects of the tasks and asking students questions that intentionally led them down particular solution paths (i.e., funneling). Although Ms. L also used cueing and funneling, she more frequently facilitated students' reasoning through providing explanations, encouraging multiple solution strategies, and encouraging students to build from what had been shared by their peers. Both teachers primarily used funneling and cueing to support students when they felt students could not engage in the tasks as written or when they wanted to support students who struggled. Additionally, Ms. L occasionally reduced a task's complexity by asking easier questions (i.e., Topaze Effect) to support students who became stuck. Ms. B seldom asked easier questions; however, she frequently modified tasks to reduce their complexity (e.g., by adding additional prompts or structure to the task, thereby focusing students' attention on the procedural rather than conceptual components of a task). Consequently, how teachers support struggling students' engagement (i.e., by asking easier questions or by modifying the tasks beforehand) is important to consider when preparing teachers to provide conceptually rich mathematical opportunities for all students.

Although a high frequency of scaffolding moves can be interpreted as reducing complexity, these moves occurred in Ms. L's classroom because she more frequently challenged her students with tasks that were more demanding than those seen in Ms. B's classroom. Used strategically, scaffolding moves may enable teachers to present the same task to all students while providing opportunities for struggling students to engage in the task. Without initially modifying the tasks, Ms. L enabled her students to engage in the tasks at the original complexity level, reducing their complexity only as needed.

Figure 3 also shows us that Ms. B provided few explanations compared to Ms. L. This difference may be due in part to Ms. B not wanting to *tell* students answers, belying a belief that offering explanations is tantamount to providing answers. Ms. L, in contrast, used explanations to move the students forward, often by providing summary explanations after students had shared their ideas or by offering conceptual explanations. Ms. L's tendency to offer explanations, in conjunction with other moves such as re-representing, validating, and building, may have contributed to her students being able to progress through the common tasks more quickly as well as engage in the tasks more deeply. Without receiving validation about their reasoning or in depth explanations, Ms. B's students were not able to make as much progress. Therefore, the students spent large amounts of time *wandering through the task* without direction rather than building from the experiences and understanding gained from their peers.

Conclusion and Implications

In reporting the findings of two classroom implementations of five common tasks, we provided representations of each teacher's instructional support using the functional categories of the TMSSR framework. These representations allow us to illustrate and compare the distribution of the types of support each teacher provided. In addition, the TMSSR framework enables an analysis of the ways in which each teacher's instructional moves afforded different opportunities for student reasoning. We hypothesize that the proportion of teacher moves along the continuum from low to high moves may be useful for understanding differences in students' reasoning and engagement in the classroom. Better understanding the ways in which various distributions of teacher moves can foster student understanding could provide evidence useful to teacher educators, particularly with the goal of supporting teachers' abilities to encourage meaningful student engagement in conceptually rich mathematical tasks.

References

Driscoll, M. (1999). *Fostering algebraic thinking: A guide for Teachers Grades 6-10.* Portsmouth, NH: Heinemann.

Ellis, A. B. (2007). The influence of reasoning with emergent quantities on students' generalizations. *Cognition & Instruction, 25*(4), 439-478.

Franke, M. L., Webb, N. M., Chan, A. G., Ing, M., Freund, D., & Battey, D. (2009). Teacher questioning to elicit students' mathematics thinking in elementary classrooms. *Journal of Teacher Education, 60*(4), 380-392.

Harry, B., Surges, K. M., & Klingner, J. K. (2005). Mapping the process: An exemplar of process and challenge in grounded theory analysis. *Educational Researcher, 34*(2), 3-13.

Herbel-Eisenmann, B. A., Steele, M. D., & Cirillo, M. (2013). (Developing) teacher discourse moves: A framework for professional development. *Mathematics Teacher Educator, 1*(2), 181-196.

Hufferd-Ackles, K., Fuson, K. C., & Sherin, M. G. (2004). Describing levels and components of a Math-Talk learning community. *Journal for Research in Mathematics Education, 35*(2), 81-116.

Krussel, L., Edwards, B., & Springer, G.T. (2004). The teacher discourse moves: A framework for analyzing discourse in mathematics classrooms. *School Science and Mathematics, 104*(7), 307-312.

Mehan, H. (1979). *Learning lessons.* Cambridge, MA: Harvard University Press.

Ozgur, Z., Reiten, L., & Ellis, A.B. (2015). On framing teachers' moves for supporting student reasoning. Bartell, T. G., Bieda, K. N., Putnam, R. T., Bradfield, K., & Dominguez, H. (Eds.), *Proceedings of the 37th annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education.* East Lansing, MI: Michigan State University, 1062-1069.

Smith, J. P., & Thompson, P. W. (2007). Quantitative reasoning and the development of algebraic reasoning. In J. J. Kaput, D. W. Carraher & M. L. Blanton (Eds.), *Algebra in the Early Grades* (pp. 95-132). Mahwah, NJ: Lawrence Erlbaum Associates.

Stockero, S. L., Peterson, B. E., Leatham, K. R., & Van Zoest, L. R. (2014). The "MOST" productive student mathematical thinking. *Mathematics Teacher, 108*(4), 308-312.