

WORKING GROUP: TASK DESIGN FOR EARLY ALGEBRA

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The focus of this newly established working group is on the complexities of designing tasks for engaging children in algebraic thinking. The working group aims to engage PME participants in interrogating the multiple ways in which robust task design supports teachers in facilitating children's learning, within the topic of early algebra. The facilitators of the working group will present relevant theory from the distinct research fields of task design and early algebra, and participants will be invited to explore how insights from task design may be made manifest to address the specific needs of children engaging with algebraic thinking in elementary school.

THEORETICAL BACKGROUND

For the purpose of the Working Group, we define a task as information that prompts students' work, including representations, context, questions and instructions (Sullivan, Clarke & Clarke, 2013). In referring to tasks and the design of tasks, we will remain cognisant of the disparities that arise between the intended use of tasks and the enacted use of tasks in classrooms by teachers (Sullivan, Knott & Yang, 2015). In aiming to establish a *domain-specific frame* for task design, we anticipate that such a frame would encompass explanatory materials for teachers to support interpretation, and mathematical knowledge for teaching (Kieran, Doorman & Ohtani, 2015; Sullivan, et al., 2015).

Kieran, Pang, Schifter, & Ng (2016) identify essential elements of algebraic lessons as including the language of generalisation, the search for structure, and thinking analytically about indeterminate amounts (Radford, 2014). Seeking and describing structure in algebraic ways requires teaching approaches that encourage discussion, justification, conjecturing and exploration. Sullivan, et al. (2015) emphasise the potential of tasks to either (a) facilitate discovery within specific mathematical content, or (b) identify to learners the target content at the beginning of the lesson, thus removing the potential for discovery learning. Tasks presented for use by teachers in early algebra lessons should play a dual role in providing a catalyst for children's thinking, while also motivating teachers to facilitate children in thinking deeply about relationships and change.

GOAL AND ORGANIZATION OF THE WORKING GROUP

In the ICME-13 Topical Survey of Early Algebra Kieran, et al. (2016) highlight that many early algebra interventions in classrooms involve *researchers* teaching the

content to children. The authors emphasise the need for resources to be developed to support teachers' independence in teaching early algebra content. In addition, where resources are available for teachers, the implemented curriculum may too easily diverge from the intended curriculum, when teacher understandings, beliefs and approaches are not consistent with the perspective of the task designers.

The goal of this working group is to define a framework of task design principles to provide structure for the design, development and implementation of early algebra tasks. We will draw upon the framework of Sullivan et al. (2015) in delineating the mathematics of the tasks, the pedagogies and the student learning (p. 84). We, the proposers of this working group, intend to present theoretical foundations for task design and for early algebraic thinking to participants during a preliminary session. Thereafter, we intend to draw on the expertise of participants to formulate specific design principles for tasks that will contribute to our understanding of the interplay between the two fields of task design and early algebra. We plan to devote the first 90-minute working group session to drafting a framework through small group focus on task design for (a) generalised arithmetic and (b) functional thinking. For the second session we will share the output from the first session, and invite participants to further develop the framework by incorporating considerations relating to teacher interpretation. We anticipate that the working group will apply existing theory to formulate design frameworks, and also develop theory in identifying specific tasks, (to include representations, foci of questioning, and anticipated interpretations) within a theoretical developmental pathway. We anticipate that the working group facilitators will be joined by participants in preparing a Research Report for submission to PME44.

References

- Kieran, C., Doorman, M. & Ohtani, M. (2015). Frameworks and principles for task design. In A. Watson & M. Obtain (Eds.), *Task design in mathematics education, an ICMI study 22* (pp. 19-81). Switzerland: Springer, Cham.
- Kieran, C., Pang, J., Schifter, D., & Ng, S. F. (2016). Early Algebra: Research into its Nature, its Learning, its Teaching. In G. Kaiser, (Ed.) *ICME-13 Topical Surveys*. Springer Open.
- Kilpatrick, J., Swafford, J., & Findell, B. (2001). *Adding it up: Helping children learn mathematics*. Washington: National Academies Press.
- Radford, L. (2014). The progressive development of early embodied algebraic thinking. *Mathematics Education Research Journal*, 26, 257–277.
- Sullivan, P., Knott, L., & Yang, Y. (2015). The relationships between task design, anticipated pedagogies, and student learning. In A. Watson & M. Obtain (Eds.), *Task design in mathematics education, an ICMI study 22* (pp. 83-114). Switzerland: Springer, Cham.
- Sullivan, P., Clarke, D., & Clarke, B. (2012). *Teaching with tasks for effective mathematics learning*. New York: Springer Science & Business Media.