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THE CHALLENGES OF IDENTIFYING RESEARCH "AT THE FRONTIER"

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The metaphor of frontier inspires this WG's topic, for the second year. In the WG organised in PME45, we argued that research considered at the "frontiers" of mathematics education included: a focus on minority/underrepresented populations (e.g., Butler-Barnes, Cheeks, Barnes & Ibrahim, 2021), thus focusing on students who might be considered at the frontier of mainstream schooling; technology and digital environments, especially in the context of the developing world (e.g., Srinivas, Bose & Kumar, 2019), thus considering didactical environments that are at the frontier compared to more traditional ones; and the theories, methodologies, and tools that drive and support such research (Sriraman & English, 2010), thus considering research that lies at the frontier. In the WG realised in PME45, we reflected on this multi-faced understanding of "frontiers" and offered new theoretical and operational ways of dealing with frontiers, from a mathematics teacher perspective. In fact, we built a shared definition for "being at the frontier" in mathematics education, identified current and emerging frontiers ripe for examination, and established a network of researchers interested in doing research in frontiers. The WG proposed for PME46 is the result of one year of interactions, among its organisers, on digging deeper into the construct of frontier, which has been considered a framework for understanding research in mathematics. More specifically, the group of organisers of the PME46 WG met several times to share and discuss the results of searches for articles at the "frontier" of math education in well-acknowledged international journals including *Educational Studies in Mathematics*, *For the Learning of Mathematics*, *Research in Mathematics Education*, *Journal for Research in Mathematics Education*, and the *International Journal of Science and Mathematics Education*. Additional searches were made for papers published outside the "core" of the Mathematics Education community, such as books, which discuss what could be considered items at the "frontier" of math education. We agreed to consider only items published from January 2020 to December 2021.

The goal of the WG for PME46 is to present the results of our joint effort, to provide examples of research that can be clearly considered at the frontier (we propose to consider such research as being at the frontier in a strong sense), and cases that can be considered at the frontier only to a certain extent (i.e., frontier in a weak sense). We will also consider the temporal aspect of being at the frontier,

namely that some research topics can be considered at the frontier because little research has been done on that topic, while others would permanently be at the frontier due to their peculiar features.

The first 90-minute slot (Slot 1) will be dedicated to examining examples of weak/strong and temporary/permanent papers at the frontier, discussing possible extensions and inviting for alternative interpretations from the group. Slot 1 unfolds as follows: i) [10 mins] Present the way in which the previous PME45 WG addressed the metaphor of frontiers and how the organisers worked during this year; ii) [15 mins] Introduce six examples of papers being "at the frontier" in a either weak or strong, and temporary or permanent, sense; iii) [30 mins] Small group discussion on the cases shown; iv) [30 mins] Share out with the entire WG, each small groups' discussions; and v) [5 min] Conclusions.

Slot 2 is dedicated to theoretical approaches that support examination of the frontiers in mathematics education, to formulate research questions, to develop a sound methodology, and to identify what can be considered a result in this line of research. Slot 2 unfolds as follows: i) [10 mins] Summarise the discussions from Slot 1; ii) [10 mins] Recall the six examples presented in Slot 1 with a focus on the methodology used to analyse them; iii) [30 mins] Invite WG participants to analyse a new set of papers, to test the coding method, to develop research questions and to apply the theoretical model which would have been under development; iv) [30 mins] Share with the entire WG and discussion; v) [10 mins] Propose to relaunch/establish a network of researchers willing to continue the work of the WG over the next year.

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