



## **TSG 20 LEARNING AND COGNITION IN MATHEMATICS (INCLUDING THE LEARNING SCIENCES)**

### The Organizing Team

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The scope of research on learning and cognition in mathematics education is extensive and diverse in relation to questions posed, theoretical frameworks selected, and methodologies employed.

Theoretical perspectives include (but are not limited to) forms of cognitive constructivism, and social constructivism, and more recently, interconnections between these (including integration, partial integration, and networking of such frameworks). Affective, and embodied elements, and personal characteristics of learners and teachers are amongst the many other constructs that form part of various theoretical frameworks.

Learning and Cognition in Mathematics, Topic Study Group 20, ICME-14 2020 specifically includes ‘the Learning Sciences’ which interrogates interplays between cognitive, social, psychological and cultural elements of learning processes in diverse contexts for the purpose of ‘improving’ learning environments. Research into learning mathematics through STEM (Science Technology Engineering and Mathematics) Education is increasing. STEM Education research fits in various ways within the three subthemes included in TSG 20, for example, the nature of the mathematical knowledge developed, pedagogical approaches that promote the development of such knowledge, and elements of the learning processes that result in such knowledge development.

Although this description contains some specific illustrations, it is intentionally worded to provide opportunities for intending contributors to focus within, or to justify other paper foci, associated with learning and cognition in mathematics education.

**Subtheme 1:** *Teacher change processes and influences upon them*

Processes of teacher learning, that can enhance student learning of mathematics, have been researched with various theoretical frameworks employed (including but not limited to cognitive, social, belief based, and dispositional frameworks, and interconnections between various of these frameworks). Areas of research into influences on teacher change processes include but are not limited to professional learning models employed, types of pedagogical approaches under focus: teacher controlled or teacher guided learning, and approaches enabling various degrees of student autonomy in the learning of mathematics. Depending on the personal characteristics of the teacher, some approaches may be easier to employ than others. Such personal characteristics include but are not limited to types of knowledge possessed, prior experiences, and whether resilience and / or self-efficacy are possessed. There are many other factors associated with teaching that could become the focus of a submitted paper, as long as that focus can be justified as belonging to TSG 20 Learning and Cognition.

**Subtheme 2:** *Student learning processes and influences upon these*

Theoretical frameworks employed to study processes of student learning of mathematics include, but are not limited to, those associated with cognitive constructivism, social constructivism, and embodied, cultural, and material conceptions of mathematics cognition. Various combinations of these theoretical framings have also been developed. Influences on the nature of mathematical understandings developed include, but are not limited to, the degree of student autonomy in the learning situation, affective elements of the process, the nature of the learning environment, and personal characteristics of the student. Study of processes associated with the construction of mathematical insights are crucial to this theme because they have been found to build deep mathematical understandings and positive student personal characteristics. Study of learning processes in situations in which students have little to no autonomy is also important as many mathematics teachers employ such pedagogical approaches. Studies of how to increase students' feelings of safety in such controlled learning situations, or decrease the boredom of other students are important areas of research, as is study of learning in particular mathematical situations.

**Subtheme 3:** *the Learning Sciences*

The Learning Sciences is dedicated to furthering the scientific understanding of *learning processes* for the purpose designing and implementing learning innovations to increase learning opportunities. This research field highlights the social nature of learning and the many different settings in which learning may occur. Studies interrogate various interplays between cognitive, social, psychological and cultural factors in learning processes in diverse contexts. To enable study of learning as it occurs in messy naturalistic settings, creative research designs have been, and continue to be, developed.

Studies in this multidisciplinary field include but are not limited to foci such as: the situated nature of knowledge and ways of knowing and learning; individual, and group learning processes; and mathematics learning in out-of-school settings, such as, museums, and homes. Student learning and teacher learning are two of the many areas of researcher attention within this field. Further study of mathematics learning in out of school settings has the potential to inform mathematics learning more generally.