

Topic Study Group 7

Teaching and Learning of Algebra at the Secondary Level

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1. Scope and Focus of TSG-7

The teaching and learning of algebra at the secondary level is a well-researched field. TSG-7 aims to bring together international researchers, teacher educators and teachers who investigate students' ways of doing, thinking and talking about algebra, and investigate teachers' ways of designing and implementing the teaching of algebra at the secondary level and the knowledge needed to support effective algebra student learning. The group envisages integrating young researchers and established scholars in the field with the intention of sharing new findings and current research trends in the teaching and learning of algebra at the secondary level. In addition, we aim to foster discussion of theoretical and methodological issues challenging the field. The topic study group will engage a group of interested participants in rigorous discussions emphasising the following themes:

- Algebraic thinking: defining and characterising algebraic thinking in students; issues of representation, symbolisation, and manipulation, and how algebraic thinking is identified and assessed; relationships between conceptual and procedural knowledge of algebra; and, how students progress from arithmetical to algebraic thinking
- Proving and justifying: Their role in the learning of algebra; ways of characterising and understanding their features and processes (e.g., in expressing generality); and, socio-mathematical norms and didactical contracts associated with generalising, proving and justifying
- Mathematical tasks: Principles of task design aiming at developing algebraic thinking, and analysis of algebraic tasks used as instruments in classroom research
- Relationships between teacher knowledge, teaching practice, and student learning: Mathematical knowledge for teaching algebra; classroom practices that support algebra learning and their connection to teacher knowledge; links between teacher practice and changes in student learning of algebra

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- Teaching experiments and design research studies: Conditions that enable or hinder the teaching and learning of algebraic thinking; how new teaching and learning opportunities (e.g., the role of technology, the design principles used) are created and studied in terms of their impact on teachers, students and other actors; the classroom discourse during the teaching experiment; and, how the transition of research into practice is studied

2. Submission to TSG-7

Tab. 1 below shows the number of papers submitted and accepted for presentation.

Tab. 1. Number of papers submitted and accepted for presentation

Number of papers	Received	Accepted
Total	30	17
Long oral		5
Short oral		10
Poster		2

The 30 papers came from 17 countries. Tab. 2 shows the breakdown of papers by countries.

Tab. 2. Breakdown of papers by countries

Country	Number of papers	Country	Number of papers
Australia	1	Luxembourg	1
Belgium	1	Malaysia	1
China (incl. Hong Kong SAR)	4	Nepal	2
Indonesia	1	Norway	1
Iran	2	Panama	1
Israel	2	Russia	1
Japan	1	Rwanda	1
South Korea	1	South Africa	2
		USA	7

3. Program Overview

During the congress in July 2021, three sessions were organised for TSG-7. Of the 17 accepted papers, there were eventually 4 long oral presentations, 8 short oral presentations and 1 invited talk (Tab. 3 on the next page).

4. Future Directions and Suggestions

Many studies in the literature on teaching and learning of algebra at the secondary level had investigated students' learning difficulties and misconceptions. There is already much for researchers in different countries to learn from these existing studies. Instead

Tab. 3. The list of papers presented

Paper and author(s)	
Session 1	
[1]	Knowledge for teaching algebra: variation in the use of knowledge in the light of classroom constraints. Demonty Isabelle (Belgium) and Vlassis Joëlle (Luxembourg).
[2]	Constructing the link between graphical visualization and algebraic computation by means of analogy: the case of a system of equations. Klila Copperman and natoli Kouropatov (Israel).
[3]	Using an online card game-based activity to build algebra foundation. Jiqing Sun (Australia).
[4]	Investigating students' algebraic proficiency from a symbol sense perspective. Al Jupri (Indonesia).
[5]	Diagnosis and treatment of students' algebraic misconceptions and errors. Mukunda Prakash Kshetree (Nepal).
[6]	Examining the quality of classroom interactions in the teaching of algebra for upper secondary schools. Aline Dorimana , Alphonse Uworwabayeho , and Gabriel Nizeyimana (Rwanda).
Session 2	
[7]	Generalization as a marker for robust mathematical meanings among in-service algebra teachers. Lori Burch and Erik Tillema (USA).
[8]	Student knowledge of exponential functions. Robert Powers , Alees Lee , Melissa Troutd , and Jodie Novakl (USA).
[9]	The importance of teacher–student interactions in mathematical learning: the example of generalization. Vlassis Joëlle (Luxembourg) and Demonty Isabelle (Belgium).
[10]	Learners' number patterns generalizations in a south African evaluative assessment. Zwelithini Dhlamini (South Africa).
Session 3	
[11]	Thinking about algebra from the anthropological theory of the didactic: reference models for the analysis and the design. Noemí Ruiz-Munzón , Marianna Bosch , and Josep Gascón (Spain).
[12]	Students' unconventional graphical representations of covariational reasoning. Laurie Cavey , Tatia Totorica , and Patrick Lowenthal (USA).
[13]	The impact of an online learning platform in algebra. Zachary Stepp (USA).

of duplicating some of these studies on students in different countries, perhaps, in order to add new knowledge to this field, future studies could examine students' learning (a) using different theoretical lenses, for example, through a constructivist lens, (b) using different concrete manipulatives or technological tools or approaches that might improve and deepen students' understanding of algebraic concepts and procedures, and (c) in a different learning environment, for example, a virtual setting which becomes vital during the Covid-19 pandemic. For the teaching of algebra, future studies could consider examining the “invisible” professional thinking of teachers behind their teaching practices. One such potential aspect for research is to capture teachers' pedagogical reasoning and actions.