

TSG 58 Agenda

TSG 58: **Empirical methods and methodologies in mathematics education**

Class: B

Session 1 (July 13th at 19:30 – 21:00 Beijing time)

1. Time: 19:30–19:50

Introduction to TSG 58

Christine Knipping¹, Soo Jin Lee²

¹University of Bremen (Germany), ²Korea National University of Education (Korea)

Research in mathematics education employs a range of Methods, Methodologies, and Paradigms (M/M/Ps) in the service of key goals. TSG 58 is organised around six diverse goals central to ongoing research in mathematics education: Improvement of Mathematics Instruction, Learning of Mathematics, Teaching of Mathematics, Classroom Processes and Interactions, Mathematics Education and Social Justice, Role of Culture and Language in Shaping the Teaching and Learning of Mathematics. Each goal might be addressed using research designs that integrate one or more different M/M/P combinations. For comparing the different research approaches taken by the participants of TSG 58, the specific goal(s) being explored, the theoretical frame on which the research design is predicated, and how effectively the research design (M/M/P bundle) addresses the designated goal(s) will be discussed after their presentation.

2. Time: 19:50–20:20

First voyage of the integrated paradigm: The case of an international study on effective mathematics teaching

Zhenzhen Miao¹, David Reynolds², and Christian Bokhove³

¹Jiangxi Normal University, China; ²Swansea University, UK; ³University of Southampton, UK

Albeit increasing popularity of the mixed methods approach, studies of this kind often cease before sufficient syntheses across methods and evidence. This paper showcases in-depth integration of a set of quantitative and qualitative methods in a recent international study on the effectiveness of mathematics teaching. The study involved children (n=579) aged nine to ten and their maths teachers (n=19) from England and China and employed methods including both structured and unstructured lesson observations, video-stimulated interviews and focus groups, questionnaires for pupils (MET) and teachers (TALIS), and pre- and post-tests (TIMSS 2003 items). Results and findings from ‘hard’ evaluations and ‘soft’ perspectives were interwoven in multiple layers to gain deeper insight into what might work internationally in maths teaching and learning, how and why. Methodologically, this international endeavour saw the birth of an updated version of the mixed methods approach – the Integrated Paradigm – and carved a more holistic path for conducting optimal research in mathematics education and beyond in the post-paradigm-war era.

3. Time: 20:20–20:35

The teaching of mathematical thinking: The conceptualization of a special class teacher in China

Na Li¹, Ida Ah Chee Mok²

¹Central China Normal University (China), ²The University of Hong Kong (Hong Kong)

Teacher’s perspectives on mathematical thinking always have a significant impact on their teaching. A “special class” teacher in China was interviewed to obtain a portrayal of her conceptions on mathematical thinking and the teaching of mathematical thinking. Results show that the teacher treated mathematical thinking as a tool for learning mathematics and suggested six kinds of mathematical thinking supported with examples in her own teaching: categorization, symbolic-graphic combination, simplification, transformation, generalization and specialization.

4. Time: 20:35–20:50

Teaching design of combination from HPM perspective

Fan Weiyuan

Jiading No.1 High School, Shanghai (China)

In this paper, teaching design of "combination (lesson 1)" is conducted from the perspective of HPM, integrating historical materials of mathematics into the classroom teaching with additional, replicating and adaptive methods to fully tap the educational value of historical materials of mathematics and appreciate the charm of mathematical culture. All these efforts were done to help students correctly differentiate combination from permutation. The Xinjiang regional culture element was integrated based on the students' learning condition to promote students' understanding of the combination number's formula. 218 effective questionnaires from 6 classes were analyzed to learn about students' mastery of "Combination (Lesson 1)". Finally, a conclusion is drawn based on the analysis of the 218 effective questionnaires and the evaluations from 9 teachers including experts who observed the class.

5. Time: 20:50—21:00

Summarizing Discussion

Christine Knipping¹, Soo Jin Lee²

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Session 2 (Fri July 16th, 21:30-23:00 Beijing time)

1. Time: 21:30—22:00

Understanding the relations between instructional quality and task quality in mathematics classrooms

Ann-Kristin Adleff¹, Natalie Ross¹, Gabriele Kaiser¹, Johannes König² & Sigrid Blömeke³

¹University of Hamburg (Germany), ²University of Cologne (Germany), ³University of Oslo (Norway)

The quality of mathematics instruction is a complex, multi-dimensional construct. The studies TEDS-Instruct and TEDS-Validate aim to better understand this phenomenon by measuring the instructional quality and the quality of the tasks that the students work on. This allows to examine the relations between different dimensions of instructional quality and aspects of task quality. Trained raters assessed the instructional quality in the classrooms using a standardized

observation protocol comprising items concerning the surface and the deep structure of instructional quality. The potential of the tasks taken from the observed classrooms was rated based on a newly developed classification scheme for mathematical tasks. First results suggest the validity and reliability of the instruments. However, the quantification of classroom processes and of task potentials leads to a significant loss of information, resulting in a limited overview of the complex concept that is instructional quality.

2. Time: 22:00—22:15

What is six-questions cognitive model?

Ying Zhou, Xiaofeng Lan, Tommy Tanu Wijaya

Guangxi Normal University (China)

Knowledge transfer is not easy especially for mathematics. There are various factors that needs to be considered and think about how to transfer the knowledge effectively. The traditional teaching method does not help students to achieve deep learning and to solve this problem, there is a need to new learning method. The 6-questions cognitive model is a new learning model that is developed in China in 2012. This model can stand on its own or can also be combined with a technology-based learning media. This research aims to introduce the 6-questions cognitive model by using a qualitative method. Researchers did a literature research to know the deeper meaning of the 6-questions cognitive model. The result of this research shows that the cognitive model can help students to achieve deep learning and it can also be combined with a technology-based learning media. This research result can be use by teachers to teach mathematics in school. Future research can find out about the effect of 6-questions cognitive model on the students' high order thinking skill.

3. Time: 22:15—22:30

Units coordination as a theoretical construct to understand students mathematical activities”

Soo Jin LEE, Jaehong SHIN

Korea National University of Education (Korea)

Students' ability to reason with quantitative units, especially, their ability to produce and coordinate multiple levels of units has been considered as a cognitive core, connected to their development of several mathematical concepts including counting, whole number multiplication and division, integer addition, fraction, ratio and proportion, algebra, and function. In this paper, we are going to introduce Steffe(1992)'s Units Coordination and how the theoretical construct can be used to understand mathematical activity of cognizant subjects. Specifically, we will share our analysis of one student JuHa who reasoned with two levels of units as given and could create three levels of units in activity.

4. Time: 22:30—22:45

The influence of ICT on the students' science literacy at the national and student level based on ITU IDI Index and PISA2015

Zhenrong Xiong, Ying Zhang, Bo Li, Na Li
Central China Normal University (China)

Big data in education is inseparable from the wide application of information and communication technology (ICT). Based on the ITU international IDI report and PISA2015 student ICT report, this study explores the relationship between ICT development and students' scientific literacy in 14 developing countries or regions including China. This study has revealed that at the national level, the central and local government should control the development level of ICT reasonably, and lay a solid foundation for realizing the modernization of education; at the student level, schools or educators should actively improve students' ICT abilities, guide them to establish a correct ICT usage concept since childhood, and strictly control their total time of using electronic products rather than frequencies.

5. Time: 22:45—22:50

Poster Presentation I: The Effectiveness of teaching mathematics in circle equation by using 5E instructional model in inquiry-based learning

Try Kimhor,
National Institute of Education, Phnom Penh (Cambodia)

Cambodia aspires to reach the status of an upper-middle-income country by 2030 and a high-income country by 2050. Consequently, the Royal Government is focusing on human resource development to ensure competitiveness in an increasingly open regional labor market among the ASEAN countries. In this case, mathematics is a science subject which is a foundation among all of sciences subjects. Hence, this paper is manual support mathematics teacher for teaching in circle equation by using 5E instructional model in inquiry-based learning.

6. Time: 22:50—22:55

Poster Presentation II: The trend of mathematics teaching method has changed from fragments to systematics

Lin Yi¹, **Tommy Tanu Wijaya**², Zhou Ying³

^{1,2,3}Guangxi Normal University, Guilin, China

According to the school observation, There are still fragmentation and superficiality problems in front-line teachers' mathematics teaching method. The reason is that the general system theory has not been rooted in the mathematics teaching method. This study aims to develop Dick-Carey model of systematic design and used in the learning activity. Based on system analysis model, Dick-Carey model of systematic design, and the "Six Questions" cognitive concepts, this paper tries to construct a systematic plan of teaching mathematics At the same time, taking the design of "intersecting lines" as an example, this paper explores the effective strategies of systematic design in mathematics teaching.

7. Time: 22:55—23:00

Summarizing Discussion

Christine Knipping¹, Soo Jin Lee²

¹University of Bremen (Germany), ²Korea National University of Education (Korea)

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Session 3 (Sat July 17th, 14:30-16:30 Beijing time)

1. Time: 14:30—15:00

Eye movements and collaborative problem solving: what do long fixations tell about student cognition?

Markku S. Hannula¹, Enrique Garcia Moreno-Esteva¹ & Miika Toivanen²

¹University of Helsinki (Finland) & ²SeeTrue Technologies (Finland)

Eye-tracking is a method to get information on student cognition as it happens. In MathTrack project we use mobile eye-tracking to study eye movements in the context of collaborative problem solving. In this paper we report the gliding average fixation durations of four collaborating students using both paper and GeoGebra to solve a non-routine geometry

problem.. We identified four types of student activity related to long fixations: 1) Manipulating GeoGebra (18 events), 2) Looking at a figure (6 events), 3) Drawing on paper (5 events), and 4) Looking at a person speaking (3 events).

2. Time: 15:00—15:15

Examining the phenomenon of interlocutors talking past each other in collaborative proof constructions

Ann Sophie Stuhlmann

Universität Hamburg

The reported study examines students' small group work dealing with proving unique existence within the scope of an undergraduate linear algebra class. The focus is on communication processes in group work settings involving a tutor; more precisely, interaction situations are explored, in which the interlocutors seem to talk past each other. An interactionist perspective was chosen to explore the phenomenon. Audio recordings of authentic small group proving activities, which were supported by a tutor, were collected along with the related materials created by the participants during the activities. Data analysis was based on transcripts of the audio recordings, which were interpreted through interaction analyses. The results indicate that due to different understandings in the context of mathematical uniqueness students attributed different meanings to certain words and expressions, which prevented the students from negotiating a consensus during the proving process.

3. Time: 15:15—15:30

Summarizing Discussion

Christine Knipping¹, **Soo Jin Lee**²

University of Bremen¹ (Germany), Korea National University of Education² (Korea)

4. Time: 15:30—15:45

Using MRGQAP to analyse the development of mathematics pre-service trainees' communication networks

Christian Bokhove¹, Jasperina Brouwer², Chris Downey³

University of Southampton¹, University of Groningen², University of Southampton³

This paper looks at a data analysis method for analyzing longitudinal network data called MRQAP. We describe a dataset from a study on the development of peer networks of one cohort of pre-service mathematics trainees in the south of England and apply the MRQAP method to its four timepoints. We include attributes for gender, study programme, trust and self-efficacy. The analysis shows that MRQAP is a viable data analysis method for looking at the longitudinal development of networks. We conclude with a short discussion of further methodological challenges and limitations.

5. Time: 15:45–16:00

Case study of personalized teaching based on the Q-learning algorithm in the era of big data

Lei Wang, Yong Zhang, Na Li, Bo Li

Central China Normal University

The latest advances in information technology and data science make it possible to study various phenomena in the educational process and explain the reasons behind it, and then provide personalized education support, especially in traditional school education. A Q-learning based personalized learning framework is developed to model it as a dynamic optimization problem and solve with the Q-learning algorithm. A specific case of high school mathematics teaching is used to illustrate how to carry out personalized teaching intervention under the goal of maximizing academic performance, given students' characteristics.

6. Time: 16:00–16:15

Learning research in a laboratory classroom: Advancing methodology and technology

Man Ching Esther Chan & David Clarke

Melbourne Graduate School of Education, The University of Melbourne (Australia)

This paper follows up on the ICME-13 paper (Chan & Clarke, 2016) to provide an update on the development of the Social Unit of Learning project, which generated an extensive multimodal data set (lesson video, audio, and artefacts) using a laboratory classroom facility at the University of Melbourne, Australia. The project was designed to investigate the social aspects of classroom practice, particularly focusing on student-student and student-teacher interactions. Ten video cameras and up to 15 audio inputs recorded the interactions of eleven classes of Year 7 students ($N = 264$) and their teacher as they engaged in purposefully developed mathematical activities. A multi-theoretic research design was used which involved

examining the complex project data set from multiple discrete perspectives by different researchers. This paper describes the methodological and technological advancements of the project to date. Illustrative project findings are also described.

7. Time: 16:15—16:30

Summarizing Discussion

Christine Knipping¹, **Soo Jin Lee**²

University of Bremen¹ (Germany), Korea National University of Education² (Korea)