

# TSG Agenda

TSG 17: Problem posing and solving in mathematics education (number and title)

Class: A (Class A for TSGs with odd numbers; Class B for TSGs with even numbers)

**\*\*Please prioritize the sessions in “core-time” (from 19:30-23:00, Beijing time, i.e. Session 2, 3 for Class A and session 1, 2 for Class B) as they are friendly to most of the time zones in the world.**

## Session 1 (13<sup>th</sup> July)

**Session Chair:** Dan Zhang, Nor Azura Abdullah, Tin Lam Toh

1. Time: 14:30—14:40

Title of the Paper: Analysis on Creating Problem Situation in Middle School Mathematic Teaching

Author(s) (with the presenter name in BOLD if more than 1 name here): Zheng PeiJun

Institution(s) (to school/department/research center) and Country/Region: Qinghai normal University, CN

Short abstract of the paper (20 lines maximum):

This paper conducts researches based on specific case analysis, learning theories and the characteristics of middle school students. Creating interesting problem situations in middle school mathematic class can not only transform abstract knowledges into specific problems, but also attract students attentions, stimulate their interests so that they will take the initiative to learn and gain something. In this kind of classes, students are not learning abstract knowledges but knowledges deeply related to our daily lives. This paper aims at studying the necessity of creating problem situations, the ways of creating problem situations and the misunderstandings of creating problem situations. The main purpose is to make full use of the advantages and bypass the disadvantages of creating problem situations.

2. Time: 14:40—14:55 (Long Oral)

Title of the Paper: HISTORICAL COMPARISON AND ANALYSIS OF PROBLEMS AND PROBLEM-POSING IN MIDDLE SCHOOL MATHEMATICS TEXTBOOKS

Author(s) (with the presenter name in BOLD if more than 1 name here): Rong Wang,  
**Cuiqiao Wang**

Institution(s) (to school/department/research center) and Country/Region: Peoples Education Press, CN

Short abstract of the paper (20 lines maximum):

Through a historical comparison of the problems and problem-posing (PP) tasks of three series of middle school mathematics textbooks published by People's Education Press, we found that although the number of PP tasks had increased, the percentage is still quite small, and the distribution of PP tasks across content areas is very uneven. We also found that the content text section had added a large number of problems. In terms of quantity, the distribution of these problems across grades and content areas are well balanced, indicating that problem-guided learning has become a new feature of the textbooks, from the perspective of types, these problems provide rich mathematical learning opportunities for students, not only for them to acquire knowledge (knowing and understanding), but also for them to go through the thinking process (abstraction and generalization exploration and discovery reflection and induction). However, the distribution of each type of problems across different grades and content areas are both uneven, which suggest that the problems should be further refined and problem-posing should be a main feature of the textbook in the future.

3. Time: 14:55—15:05

Title of the Paper: PROBLEM POSING AMONG PRE-SERVICE AND IN-SERVICE MATHEMATICS TEACHERS

Author(s) (with the presenter name in BOLD if more than 1 name here): MA NYMPHA BELTRAN-JOAQUIN

Institution(s) (to school/department/research center) and Country/Region: UNIVERSITY OF THE PHILIPPINES, QUEZON CITY, PH

Short abstract of the paper (20 lines maximum):

This study examined word problems constructed by pre-service and in-service mathematics teachers. Ten teachers enrolled in a mathematics graduate class and another ten students enrolled in an undergraduate class were given semi-structured problem-posing tasks. Their outputs were analyzed in terms of context, content, type, clarity, and accuracy. Results showed that the problems posed by pre-service teachers dwelled more on varied contexts, although the content were mostly on basic mathematics concepts. In contrast, the problems generated by in-service teachers generally lacked context and situation, but involved more mathematical content and processes. It was notable that most of the problems constructed by both groups were routine translational word problems and that some were unrealistic, lacked clarity or had errors. The findings of the study underscore the potential of problem posing for assessing mathematical content knowledge. They further highlight the need to strengthen problem-posing skills among teachers of mathematics.

4. Time: 15:05—15:15

Title of the Paper: REGULATION OF COGNITION DURING PROBLEM POSING - A CASE STUDY

Author(s) (with the presenter name in BOLD if more than 1 name here): Puay Huat Chua

Institution(s) (to school/department/research center) and Country/Region: Nanyang Technological University, NIE, Singapore, SG

Short abstract of the paper (20 lines maximum):

The regulatory phases of cognition during problem posing is being presented through a case study of a Grade 9 student, Tan, engaged in a geometric problem-posing task. The study paints the different phases in the regulation of cognition during problem posing, namely, property noticing, problem construction, checking solution, and looking back. The looking back phase is not strongly exhibited. Discussion of these phase descriptors in classroom problem-posing instructions are also made.

5. Time: 15:15—15:25

Title of the Paper: CHARACTERIZING THE PROBLEM-SOLVING PROCESSES USED BY PUPILS IN CLASSROOM: PROPOSITION OF A DESCRIPTIVE MODEL

Author(s) (with the presenter name in BOLD if more than 1 name here): Stephane Favier

Institution(s) (to school/department/research center) and Country/Region: Universite de Geneve, FR

Short abstract of the paper (20 lines maximum):

Our research aims at characterizing the processes used by pupils when they solve problems in the ordinary context of the classroom. In this paper, we focus on the external dimension of the process, i.e. the temporal organization. Embedded cameras installed on the pupils head were used to collect audiovisual data as close as possible to the pupils' work. We mobilize the framework for the analysis of videotaped problem solving sessions by Schoenfeld (1985). The analysis of these empirical data leads us to discuss and enrich the descriptive model proposed by Rott et al (2021) with an additional dimension that allows us to take into account the interactions between pupils and teacher.

6. Time: 15:25—15:35

Title of the Paper: A Study on Primary school students mathematical problem-posing abilities in China

Author(s) (with the presenter name in BOLD if more than 1 name here): **Na Yan**, Lianchun Dong

Institution(s) (to school/department/research center) and Country/Region: Minzu University of China, Beijing, CN

Short abstract of the paper (20 lines maximum):

This study examined the current status of mathematics problem-posing of 238 fifth-grade primary school students in Xinjiang Uygur Autonomous Region. The results showed that Han students can pose more mathematical problems than minority students; Girls have

more awareness and ability to pose mathematical problems than boys; Girls are generally better than boys in the problem of flexibility and innovation; There is no difference in mathematics problem-posing ability between ethnic minorities and Han students; There is a significant positive correlation between the mathematics problem-posing ability and their mathematics achievements.

**7. Time: 15:35—15:50 (Long oral)**

Title of the Paper: A framework for examining mathematical communication in problem posing

Author(s) (with the presenter name in BOLD if more than 1 name here): **Ling Zhang**, Jinfa Cai, Naiqing Song

Institution(s) (to school/department/research center) and Country/Region: Southwest University, CN

Short abstract of the paper (20 lines maximum):

Mathematical communication in problem posing refers to the process of conveying and expressing information during activities of problem posing. We conceptualized the communication in mathematical problem posing in three stages: a) input-understanding the meaning of the problem-posing tasks, b) processing-determining and understanding the processes of how problems are posed, and c) output-representing posed problems. The framework is theoretically conceptualized. Then the framework is illustrated by using data from two case studies based on the same problem-posing task. The usefulness of the framework is discussed to understand the mechanisms involved in students understanding of the problem-posing situation and posing and representing mathematical problems

**8. Time: 15:50—16:05 (Long oral)**

Title of the Paper: Using Problem Posing to Diagnose and Understand Preservice Teachers Conceptual Understanding

Author(s) (with the presenter name in BOLD if more than 1 name here): **Yiling Yao**,  
Jinfa Cai

Institution(s) (to school/department/research center) and Country/Region: Hangzhou  
Normal University, Hangzhou, CN

Short abstract of the paper (20 lines maximum):

This study focuses on preservice teachers conceptual understanding of fraction division, a topic that is important for students mathematical education but is also hard for teachers to teach and difficult for students to learn. Three tasks were used to investigate preservice teachers computing and understanding of fraction division: computing six fraction division problems, a drawing task, and a problem-posing task. Although the results showed that almost all the samples obtained correct answers to all six computation problems, a high percentage of the preservice teachers exhibited procedural understanding on the drawing task rather than conceptual understanding. Posing problems contributes to preservice teachers conceptual understanding, and it also can be used to diagnose and understand their mathematical understanding.

9. Time: 16:05—16:15

Title of the Paper: ELEMENTARY MATHEMATICS TEACHERS LEARNING TO  
TEACH THROUGH PROBLEM POSING: INITIAL FINDINGS OF A  
LONGITUDINAL STUDY

Author(s) (with the presenter name in BOLD if more than 1 name here): **Dan Zhang**,  
Yiling Yao, Jinfa Cai

Institution(s) (to school/department/research center) and Country/Region: BEIJING  
ACADEMY OF EDUCATION SCIENCES, China, CN

Short abstract of the paper (20 lines maximum):

This study reports initial findings from a large research project to longitudinally investigate how teachers learn to teach mathematics using problem posing. In particular, this study was designed to report initial findings that answer the following research

question: What is the effect of a year of problem-posing intervention for teachers learning to teach using problem posing on students learning? Initial findings after a year of the experiment have shown that students in the experimental schools not only have increased significantly in their mean scores in problem-posing tasks from pre-test to the post-test, but also increased in their mean scores in mathematical grit and problem solving.

**10. Time: 16:15–16:30 (Long oral)**

Title of the Paper: Primary school teachers' behaviors, beliefs, and their interplay in teaching for problem solving

Author(s) (with the presenter name in BOLD if more than 1 name here): Benjamin Rott

Institution(s) (to school/department/research center) and Country/Region: University of Cologne, Cologne, DE

Short abstract of the paper (20 lines maximum):

How do teachers in primary schools organize teaching for problem solving? Lessons on this subject by nine teachers were videotaped. The behavior of the teachers was coded using a grid combining Polya's phases of problem-solving processes with the way in which teachers emphasize their pupils' strategic diversity in problem solving. These teachers were interviewed after the lessons to obtain their beliefs regarding mathematics and problem solving. Comparisons of both codings reveal the importance of beliefs in the context of teaching for problem solving.

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**Session 2 (14<sup>th</sup> July)**

**Session Chairs:** Puay Huat Chua, Nicolina Malara, Tin Lam Toh

**1. Time: 19:30–19:45 (Long oral)**

Title of the Paper: Teaching Students How to Pose Mathematical Questions

Author(s) (with the presenter name in BOLD if more than 1 name here): **Peter Juhasz**, Reka Szasz, Lajos Posa, Ryota Matsuura

Institution(s) (to school/department/research center) and Country/Region: Alfred Renyi Institute of Mathematics, Budapest, HU

Short abstract of the paper (20 lines maximum):

The paper presents how the Posa method facilitates problem posing for students. The Posa method was developed for gifted students, but it was also implemented for the mainstream school curriculum and teacher training. Its main aim is teaching students how to think like mathematicians, including problem posing, and its main technique is guided discovery through problem threads. The paper describes different techniques that teachers use to help students pose good mathematical questions, and hence create their own problem threads. It shows such a problem thread in the topic of geometrical transformations, dealing with axes and points of symmetry.

2. Time: 19:45—19:55

Title of the Paper: HOW ELEMENTARY AND MIDDLE SCHOOL TEACHERS FORMULATE MULTIPLICATION AND DIVISION WORD PROBLEMS

Author(s) (with the presenter name in BOLD if more than 1 name here): **Sintria Lautert**, Alina Galvao Spinillo, Rute Elizabete Borba, Juliana Silva, Ernani Martins dos Santos

Institution(s) (to school/department/research center) and Country/Region: Universidade Federal de Pernambuco - UFPE, Recife, BR

Short abstract of the paper (20 lines maximum):

We analysed how Elementary and Middle School teachers formulate problems within the conceptual field of multiplicative structures. Thirty-nine teachers who teach 1st to 9th grade students from state schools in Recife (Brazil) were asked to formulate problems whose resolution would involve multiplication and/or division. The main result was that teachers of all grades tended to formulate single step mathematical problems that did not have multiple approaches and solutions. A lack of variability was also found, since most

of the problems were of the same type. It was concluded that Elementary and Middle School teachers have difficulties to pose complex and challenging mathematical word problems that make use of the various aspects that characterize the concepts of multiplication and division. The findings suggest that teachers need additional instruction related to problem formulation in order to propose problems that are cognitively complex and that involve a large variety of situations that might help their students to understand multiplicative concepts.

3. Time: 19:55—20:05

Title of the Paper: GIFTED STUDENTS STRATEGY FLEXIBILITY IN NON-ROUTINE PROBLEM SOLVING

Author(s) (with the presenter name in BOLD if more than 1 name here): **Yeliz Yazgan**

Institution(s) (to school/department/research center) and Country/Region: Bursa Uludag University, Bursa, TR

Short abstract of the paper (20 lines maximum):

The current study intends to seek strategy flexibility of gifted middle-schoolers. Seven sixth-graders, six seventh-graders, and five eight-graders participated in the study. Each student was interviewed individually and asked to solve seven non-routine problems. Three criteria were established to determine strategy flexibility levels of students: Selection and use of the most appropriate strategy, changing strategy when it does not work for the solution of a problem or using multiple strategies for the solution of a problem (intra-task flexibility), changing strategies between problems (inter-task flexibility). Answers given by a student were examined as a whole, and each criterion was scored as 1, 2, 3, and 4. According to results, students were comfortable in choosing and implementing the proper strategy and changing strategies across problems. However, students had more difficulty in changing strategy or using multiple strategies while working on a problem. Generally, students strategy flexibility level was quite above average.

4. Time: 20:05—20:15

Title of the Paper: TYPES OF REASONING PROMOTED IN MATHEMATICS CLASSES IN THE CONTEXT OF PROBLEM-SOLVING INSTRUCTION IN GENEVA

Author(s) (with the presenter name in BOLD if more than 1 name here): Maud Chanudet

Institution(s) (to school/department/research center) and Country/Region: University of Geneva, FR

Short abstract of the paper (20 lines maximum):

In this paper, I present some results of a study aiming to learn what types of mathematical reasoning are involved in problems students have to face in the context of problem solving instruction. This research focuses on a course centred on problem solving in the canton of Geneva (Switzerland) delivered to 8th-grade students. In the first part, I present different types of mathematical reasoning. Then I show in which proportion each one is at stake in the problems proposed in official resources. Finally, I study the practices of two teachers. I analyse problems they submit to students and how they articulate these problems during a school year.

5. Time: 20:15—20:25

Title of the Paper: INVESTIGATING ELEMENTARY SCHOOL STUDENTS' STEM PROBLEM POSING: THE WALKSTEM AFTER-SCHOOL CLUB

Author(s) (with the presenter name in BOLD if more than 1 name here): **Min Wang**, Candace Ann Walkington

Institution(s) (to school/department/research center) and Country/Region: Southern Methodist University, Dallas, US

Short abstract of the paper (20 lines maximum):

Problem posing has been identified as an important component in mathematics education and the positive relationship between students problem posing skills and mathematical learning has been confirmed by extant studies. In this study, we observed and investigated early elementary grades students problem posing in an informal setting the walkSTEM

after-school club. In this after-school club, club members along with two elementary school teachers created a walk around their school where they presented the mathematical problems they generated during weekly meetings. We analyzed students interactions while posing and solving mathematics problems with video clips and identified the critical role of scaffolding interactions from the leading teachers, prior participants, and peers. We also noted that students posed more solvable problems, more mathematically meaningful problems, and more cognitively demanding problems by the end of this program.

6. Time: 20:25—20:35

Title of the Paper: DESIGNING PROFESSIONAL DEVELOPMENT PROGRAMS THAT SUPPORT TEACHERS' INCORPORATION OF PROBLEM SOLVING IN THEIR MATHEMATICS INSTRUCTION - THE DCP MODEL

Author(s) (with the presenter name in BOLD if more than 1 name here): **Jillian White**, Patrick Johnson, Merrilyn Enid Goos

Institution(s) (to school/department/research center) and Country/Region: University of Limerick, Limerick, IE

Short abstract of the paper (20 lines maximum):

Upon completion of their initial teacher education, continuous professional development opportunities are often the only form of formal education teachers receive in how to teach. In-service professional development programs are therefore key for assisting/supporting teachers to incorporate problem solving and problem posing into their instruction. Many common forms of professional development have been shown to be ineffective and have little to no impact on participating teachers or their students. This paper aims to summarize the wide range of literature on effective professional development into a single model - the DCP model. The model is divided into three key domains - design, content and progress - all of which are centred on impact.

7. Time: 20:35—20:45

Title of the Paper: MATHEMATICS PROBLEM MULTICONTEXTUAL EXPLORATION, SOLVING AND POSING IN THE CLASSROOM AND TEACHER EDUCATION: A PERSPECTIVE IN CRITICAL EDUCATION

Author(s) (with the presenter name in BOLD if more than 1 name here): SILVANIO DE ANDRADE

Institution(s) (to school/department/research center) and Country/Region: UEPB, Campina Grande, BR

Short abstract of the paper (20 lines maximum):

This article calls for a problem solving and posing interconnected approach via problem exploration in a critical education perspective. We have titled it as Mathematics Teaching and Learning via Problem Critical Multicontextual Exploration, Solving and Posing. We have developed it, anchored by an intense classroom work, done with elementary and secondary school students, teachers, and teacher educators. In such a proposal Problem Solving and Posing, besides being adopted as a teaching methodology, are treated in the light of a perspective of critical education, not just seen at the level of mathematical concepts and processes, but also at the level of socio-politico-cultural questions, education in general and mathematics education in particular and the classroom is observed in all its many aspects, that is, in all its multicontextuality. This choice entails an opportunity to collaborate the emancipation of students through Mathematics Teaching and Learning via Problem Critical Multicontextual Exploration, Solving and Posing and so developing mathematics understanding as well as broader contextual extensions in citizenship promoting.

8. Time: 20:45—20:55

Title of the Paper: THE PROBLEMS POSED BY PRIMARY SCHOOL TEACHERS, ON ADDITION WITH FRACTIONS

Author(s) (with the presenter name in BOLD if more than 1 name here): Tuba AYDOGDU ISKENDEROGLU

Institution(s) (to school/department/research center) and Country/Region: Trabzon University, Trabzon, TR

Short abstract of the paper (20 lines maximum):

Students have difficulties in solving problems of fractions in almost all levels and in problem posing. Problem posing skills influence the process of development of the behaviors observed at the level of comprehension. That is why it is very crucial for teachers to develop activities for student to have conceptual comprehension of fractions and operations involving fractions. The achievement of such conceptual comprehension can be accelerated through the use of mathematical models. For this the aim of the study is to identify the difficulties in the problems posed by primary school teachers with respect to addition with fractions. The present study employs both quantitative and qualitative methods together. This study was carried out with 31 primary school teachers. The study employs the "Problem Posing Test" comprising four items of addition with fractions. The test drawn up with reference to the operation of addition with fractions includes one item for each: adding a proper fraction to another proper fraction, and adding a mixed fraction from another mixed fraction. First of all, the answers provided by the teachers were categorized as problem, not-a-problem, or empty. Following such a classification is an analysis of the difficulties observed in the responses provided in the problem category. At the end the study reveals that the most common difficulty was committed in item 2, with reference to the addition of a mixed fraction with a proper one, whereas the difficulties regarding item 1 involving the addition of two proper fractions were rare.

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### **Session 3 (17<sup>th</sup> July, Additional Time Slot)**

**Session Chair:** Dan Zhang, Nor Azura Abdullah, Tin Lam TOH

1. Time: 14:30—14:40

Title of the Paper: How do Chinese textbooks incorporate mathematical problem posing in different stages?

Author(s) (with the presenter name in BOLD if more than 1 name here): **Jiajie Yan**,  
Yufeng Guo, Wenjia Zhou

Institution(s) (to school/department/research center) and Country/Region: Beijing normal  
university, Beijing, CN

Short abstract of the paper (20 lines maximum):

This study examines how standards-based mathematics textbooks used in China implement problem-posing (PP) tasks in different stages. We analyzed the PP tasks in two Chinese standards-based mathematics textbook series. The quantity of PP tasks in textbooks we examined is relatively small, but larger than that in the 1990s and 2000s textbook. In every stage, the structured situations account for the largest. Among all the textbooks, the majority of the problem posing tasks were in the content area of numbers and algebras. The results of this study also showed evidence that there are different main types at different stages. The vast majority of the PP tasks in the primary textbook series are those posing additional questions based on the given information and sample questions, while the vast majority of the PP tasks in the junior high textbooks are those posing a problem that matches the given arithmetic operation(s).

2. Time: 14:40—14:50

Title of the Paper: Appreciation of the aesthetic qualities of mathematical objects: an analysis of students problem solving

Author(s) (with the presenter name in BOLD if more than 1 name here): **Hayato HANAZONO**

Institution(s) (to school/department/research center) and Country/Region: Miyagi  
University of Education, JP

Short abstract of the paper (20 lines maximum):

Although the importance of being able to appreciate the aesthetic qualities of mathematical objects during problem solving is now clear, there has been little research to date on helping students to appreciate the aesthetic qualities valued by mathematicians. The present study describes and characterizes the process whereby students appreciate the aesthetic qualities of mathematical objects under teaching interventions through a case

study on problem solving by high-school students. The results show that the participants could appreciate aesthetic qualities, and that to recognize the mathematical object under consideration as a special case of a wider class of mathematical objects played an important role.

3. Time: 14:50—15:00

Title of the Paper: Towards LITE, a Local Instructional Theory for mathematical Explorations

Author(s) (with the presenter name in BOLD if more than 1 name here): **Jayasree Subramanian**, K. Subramaniam, R. Ramanujam

Institution(s) (to school/department/research center) and Country/Region: Homi Bhabha Centre for Science Education, Chennai, IN

Short abstract of the paper (20 lines maximum):

Mathematical explorations are a desirable experience at the secondary school level. However, there are currently no instructional theories that advise teachers on carrying out such explorations in the classroom. Drawing on the examples of Local Instruction Theories (LIT) for content areas, we examine how a Local Instruction Theory for Explorations (LITE) would be similar and different from an LIT. Based on the Realistic Mathematics Education (RME) framework and the experience of conducting 5 different explorations in 3 schools, most of them repeated across schools, we propose a preliminary LITE framework and identify potential questions that need to be addressed in arriving at a definitive theory.

4. Time: 15:00—15:10

Title of the Paper: GRAPHIC ORGANIZERS FOR PROBLEM-SOLVING IN PRIMARY MATHEMATICS: TEACHERS' REFLECTIONS

Author(s) (with the presenter name in BOLD if more than 1 name here): **Nor Azura Abdullah**

Institution(s) (to school/department/research center) and Country/Region: Universiti Brunei Darussalam, Brunei, BN

Short abstract of the paper (20 lines maximum):

This study is to report the action research of primary school teachers in utilizing graphic organizers as a tool to teach problem-solving in a professional development setting. The importance of performing problem solving among children has eventually been highlighted in the Brunei educational reform. Solving word problems has been a problem among Brunei bilingual school children. One of the inhibiting factors is the low level of comprehension and transformations skills needed to solve word problems. Graphic organizers are an instructional strategy used to help students to compartmentalize the necessary information to solve word problems. Teachers reflected on the challenges and affordances graphic organizers posed in teaching problem-solving.

5. Time: 15:10–15:20

Title of the Paper: THE EFFECT OF PROBLEM-POSING STRATEGIES ON PRIMARY PRE-SERVICE TEACHERS CONCEPTUAL KNOWLEDGE OF FRACTIONS

Author(s) (with the presenter name in BOLD if more than 1 name here): Eda Vula

Institution(s) (to school/department/research center) and Country/Region: University of Prishtina, Prishtina, AL

Short abstract of the paper (20 lines maximum):

This paper presents a study conducted with 101 primary pre-service teachers (PPTs) explaining the effect the problem-posing strategies has on the PPTs conceptual knowledge of fractions. Results indicate that problem-posing activities affect the PPTs ability of representation and conceptual meaning of fractions. Yet, the analysis shows that there are still difficulties in generating the correct conceptual justification from most of the PPTs. The study found that there is a need for more problem-posing based activities in order to improve the PPTs ability to be successful problem poser.

6. Time: 15:20—15:30

Title of the Paper: INVESTIGATING MATHEMATICS TEACHERS' KNOWLEDGE FOR TEACHING PROBLEM-SOLVING

Author(s) (with the presenter name in BOLD if more than 1 name here): **Brantina Chirinda**, Patrick Barmby

Institution(s) (to school/department/research center) and Country/Region: University of Johannesburg, Auckland Park, ZA

Short abstract of the paper (20 lines maximum):

Mathematical problem-solving knowledge for teaching (MPSKT) is the knowledge teachers use to identify learners mathematical problem-solving proficiency and strategies during problem-solving. This study investigated grade 9 South African mathematics teachers' knowledge for teaching problem-solving. Four teachers participated in a two-cycle professional development (PD) classroom-based design project. During the project, participant teachers attended PD workshops which focused on developing and supporting their MPSKT. Participant teachers MPSKT was measured before, during and after the project. Data were gathered through classroom observations and semi-structured reflective interviews which were audio-recorded with teachers consent. The findings of the study are considered within Chapmans components of MPSKT.

7. Time: 15:30—15:45 (Long oral)

Title of the Paper: ELEMENTS OF MATHEMATICAL ACTIVITY THAT EMERGE WHEN FUTURE TEACHERS OF SECONDARY SCHOOL MATHEMATICS USE DIGITAL TECHNOLOGIES TO SOLVE PROBLEMS.

Author(s) (with the presenter name in BOLD if more than 1 name here): **Matias Camacho-Machin**, Alexnder Hernandez, Josefa Perdomo-Daz

Institution(s) (to school/department/research center) and Country/Region: Universidad de La Laguna, La Laguna, ES

Short abstract of the paper (20 lines maximum):

This paper discusses the work done by a group of future secondary school mathematics teachers during their training period, as they solve mathematics problems using GeoGebra. Our focus is on analyzing the Mathematical Activity as they progress through the different problem-solving episodes (Santos-Trigo & Camacho-Machn, 2013): understanding, exploration and the search for multiple approaches. The results show a strong presence of mathematical creation and mathematical reasoning, components of mathematical activity, since the dynamic character of GeoGebra encourages actions such as generating new paths to represent mathematical objects, transforming representations, formulating conjectures and observing and justifying properties.

8. Time: 15:45—15:55

Title of the Paper: A study on evaluating prospective teachers' problem posing activity

Author(s) (with the presenter name in BOLD if more than 1 name here): Zoltan Kovacs

Institution(s) (to school/department/research center) and Country/Region: Eszterhazy Karoly University, Eger, HU

Short abstract of the paper (20 lines maximum):

Mathematics teachers training is incomplete if students are not prepared for mathematical problem posing. Moreover, it is necessary to measure the effectiveness of their learning process. In this paper, I describe a method that can be used to qualify students problem posing activity in terms of how the mathematical background of the original problem changed during problem posing. I present the method based on a case study.

9. Time: 15:55—16:05

Title of the Paper: USE OF VIDEO CLIPS TO ENGAGE STUDENTS IN MATHEMATICAL PROBLEM SOLVING

Author(s) (with the presenter name in BOLD if more than 1 name here): **TIN LAM TOH, ENG GUAN TAY**

Institution(s) (to school/department/research center) and Country/Region: National Institute of Education Singapore, Singapore, SG

Short abstract of the paper (20 lines maximum):

This paper presents two examples of video clips, one of which was extracted from segments of popular movies and the second one was developed by mathematics educators, that can be used for instruction in mathematics classrooms to arouse students interest in problem solving. Contextualization of the mathematics involved in problem solving tends to excite students to be engaged in the learning process, and in addition challenge them to extend and generalize the problems shown in the video clips.

10. Time: 16:05—16:15

Title of the Paper: PROBLEM SOLVING AND GENERALIZATION WITH AN ADVANCED COMPUTING ENVIRONMENT

Author(s) (with the presenter name in BOLD if more than 1 name here): Marina Marchisio, Alice Barana, Alberto Conte, Cecilia Fissore, **Fabio Roman**

Institution(s) (to school/department/research center) and Country/Region: University of Turin, Torino, IT

Short abstract of the paper (20 lines maximum):

In the teaching of Mathematics, the focus must be put on the processes of developing and putting into practice the mathematical thinking to solve a range of problems in everyday situations. At the same time, in our modern society increasingly characterized by the use of technologies it is essential that students acquire digital skills. Therefore, it is even more important to solve problems through technologies that help in both representing and exploring mathematical tasks. One of the technologies is an ACE (Advanced Computing Environment), which allows to perform numerical and symbolic computations and to program interactive components and animated graphs in order to generalize the solution. The goal of the paper is to show how an ACE can support problem solving and the generalization of the solving process.

11. Time: 16:15—16:25

Title of the Paper: A STUDY ON IMPROVING FLEXIBILITY IN PROBLEM SOLVING: UNIT TEACHING BASED ON BIG-IDEA IN MATHEMATICS

Author(s) (with the presenter name in BOLD if more than 1 name here): Qilei Feng

Institution(s) (to school/department/research center) and Country/Region: Beijing  
Institute of education, Beijing, CN

Short abstract of the paper (20 lines maximum):

Flexibility of problem solving is an important ability in mathematical thinking. It is closely related to creativity. The flexibility of mathematical thinking is getting more and more attention. How to develop flexibility of students? This article proposed a teaching model and investigated how could to improve students the flexibility of problem solving when teaching in unit based on mathematics big ideas. The study supported the conclusion that unit teaching based on mathematics big-idea is conducive to the flexibility of student problem solving.

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### **Session 3 (17<sup>th</sup> July)**

**Session Chair:** Manuel Santos, Puay Huat Chua, Tin Lam Toh

1. Time: 21:30—21:40

Title of the Paper: SUPPORTING STUDENTS TO COMPRESS MATHEMATICAL  
KNOWLEDGE WHILE PROBLEM SOLVING

Author(s) (with the presenter name in BOLD if more than 1 name here): **Rogier Bos**,  
Rona Lemmink

Institution(s) (to school/department/research center) and Country/Region: Freudenthal  
Institute, Utrecht University, NL

Short abstract of the paper (20 lines maximum):

Compression of mathematical objects, procedures and statements could play a major role in successful problem solving. We report on a study in which we aim to design an instrument, named heuristic tree, to stimulate the process of compression in students while working in a digital problem-solving environment. In particular, we report on the evidence a second pilot study provided that improvements in the design helped to overcome issues with help-seeking that presented themselves in a first pilot.

2. Time: 21:40—21:50

Title of the Paper: A STRATEGY FOR ENHANCING MATHEMATICAL PROBLEM POSING

Author(s) (with the presenter name in BOLD if more than 1 name here): Miguel Cruz Ramírez

Institution(s) (to school/department/research center) and Country/Region: University of Holguín, Cuba

Short abstract of the paper (20 lines maximum):

Mathematical problem posing constitutes an important process in the integral formation of students. In this work we establish a heuristic strategy, the purpose of which is enhancing the posing of new problems in the school context. The strategy is supported by a cognitive model consisting of six stages: selecting, classifying, associating, searching, verbalizing, and transforming. The first five actions make up a basically creative process, while the last stage is present within the nucleus of the previous ones. This provides the process with a high level of complexity. In a compact way, we call the strategy SCASV+T. We reflect on the heuristic nature of the strategy, as well as the didactic actions that are required for its implementation.

3. Time: 21:50—22:00

Title of the Paper: INVERTED TASKS AND BRACKETED TASKS IN MATHEMATICAL PROBLEM POSING

Author(s) (with the presenter name in BOLD if more than 1 name here): Benjamin Dickman

Institution(s) (to school/department/research center) and Country/Region: The Hewitt School, New York City, US

Short abstract of the paper (20 lines maximum):

We present in this paper a pair of approaches to support mathematics educators and learners in formulating original tasks. In particular, we facilitate the posing of rich mathematical problems by using two novel methods that were created by a mathematics department at a K-12 school in the United States, and further developed alongside our students as well as a wider professional learning team of master teachers. We situate our work within the broader literature on mathematical problem posing, and describe our strategies by including examples of their use in generating problems and by providing examples of authentic student-assigned tasks that were created with our approaches.

4. Time: 22:00—22:10

Title of the Paper: The process of posing problems: Development of a descriptive process model for problem posing

Author(s) (with the presenter name in BOLD if more than 1 name here): **Lukas Baumanns**, Prof. Dr. Benjamin Rott

Institution(s) (to school/department/research center) and Country/Region: University of Cologne, DE

Short abstract of the paper (20 lines maximum):

In recent years, mathematics education research has an increased interest into the activity of problem posing, yet there is a lack of empirical insights into the process of posing mathematical problems. Whilst established normative and descriptive process models already exist for problem solving, there is no generally accepted process model for the equally relevant activity of problem posing. The study at hand focusses on the development of a descriptive process model for problem posing. For this purpose, 17

pairs of students were given a structured problem-posing situation. Using Schoenfelds Verbal Protocol Analysis, the resulting problem-posing processes were evaluated in order to identify typical phases. The results indicate five such phases, which allow a time-covering description of the observed processes. On the basis of recurring phase transitions, a descriptive process model was derived which may provide further insights into the process of problem posing.

5. Time: 22:10—22:20

Title of the Paper: Automation of math discovery support: reinforcement of problems with criteria for evaluating partial solutions

Author(s) (with the presenter name in BOLD if more than 1 name here): **Sergei Nickolaevitch Pozdniakov**

Institution(s) (to school/department/research center) and Country/Region: Saint Petersburg Electrotechnical University, St. Petersburg, RU

Short abstract of the paper (20 lines maximum):

Solving math problems is, no doubt, the best way to learn math. Polya, in his works, explores the method of teaching students that is based on this approach. However, if the search for a solution is carried out by each student individually, it is difficult for a teacher to provide customized support for everyone. Therefore, it is so interesting to research how modern computer technologies can be used to support independent problem solving. The proposed approach outlines how to provide technical support for some elements of the Polya's method. These elements include expanding the scope of the problem, simplifying it, creating subtasks, varying the initial question, etc.

6. Time: 22:20—22:30

Title of the Paper: Division Problem Posing of Fifth Graders: A Cross-National Study in China and the United States

Author(s) (with the presenter name in BOLD if more than 1 name here): **Fenqjen Luo**,  
Yali Yu, Monte Meyerink, Ciara Burgal

Institution(s) (to school/department/research center) and Country/Region: Montana State  
University, Bozeman, US

Short abstract of the paper (20 lines maximum):

In this study, we analyzed the similarities and differences between division problems posed by rural 5th graders in Inner Mongolia, China (N=58) and Montana, U.S. (N = 28). To this end, we examined the structures and contexts of posed problems. Findings showed that most students in both countries tended to pose equal groups, partitive division problems using food as context.

7. Time: 22:30—22:40

Title of the Paper: STUDENTS ENGAGEMENT IN PROBLEM POSING WHILE  
SOLVING A FERMI PROBLEM

Author(s) (with the presenter name in BOLD if more than 1 name here): **Nelia Amado**,  
Susana Carreira, Monica Alexandra Rebelo Valadao

Institution(s) (to school/department/research center) and Country/Region: UIDEF, IE-UL,  
FARO, PT

Short abstract of the paper (20 lines maximum):

Over the last years the framework developed within the PISA international tests has been proposing students involvement with real-world problem solving where the process of formulating problems is fundamental. It requires the ability to transform a situation in a way that it may be tackled by means of mathematics. A special kind of modelling problems, the so-called Fermi problems, is considered to have much potential in promoting mathematical competences related to problem posing. Our study looks at the way in which Fermi problems are fruitful contexts for problem posing. Our specific aim is to understand the relationship between problem posing and assumption making in solving a Fermi problem. Our data were obtained with 7th grade students who solved the

problem of knowing the amount of water used at home in the flush toilet over a year. The students solutions showed a very clear connection between the assumptions made by the students and the new problems they have posed to achieve a plausible estimate.

8. Time: 22:40—22:50

Title of the Paper: Develop your own problem! - Problem posing in given real-world situations

Author(s) (with the presenter name in BOLD if more than 1 name here): **Luisa-Marie Hartmann**, Stanislaw Schukajlow, Janina Krawitz

Institution(s) (to school/department/research center) and Country/Region: Muenster University, Muenster, DE

Short abstract of the paper (20 lines maximum):

In mathematics education, in addition to problem solving, problem posing is an important teaching approach that can affect students' ability to solve mathematical problems. However, problem posing rarely takes place in mathematics classes, and there is little research on problem posing in given real-world situations. Therefore, the present study drew upon this research gap and examined what kinds of problems students explicitly pose and whether they are able to work on different kinds of self-developed problems. To answer these questions, we offered students different real-world situations, asked them to pose a problem in these given situations, and asked them to solve the problems they posed. To analyze the posed problems, we used Mayring's (2015) content analysis with a category scheme based on criteria for modelling problems. The analysis revealed that students were able to pose and solve problems in given real-world situations and that they mostly posed obvious, closed problems that had a connection to reality.

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**Note:**

Class A:

- Session 1: 14:30-16:30 Beijing time, July 13<sup>th</sup>
- Session 2: 19:30-21:00 Beijing time, July 14<sup>th</sup>
- Session 3: 21:30-23:00 Beijing time, July 17<sup>th</sup>

Class B:

- Session 1: 19:30-21:00 Beijing time, July 13<sup>th</sup>
- Session 2: 21:30-23:00 Beijing time, July 16<sup>th</sup>
- Session 3: 14:30-16:30 Beijing time, July 17<sup>th</sup>