

TSG Agenda

TSG 26: The role and the use of technology in the teaching and learning of mathematics at upper secondary level

Class: **B**

Session 1: 11h30-13h00 (UTC), 13th of July Beijing+8h

Introduction 11h30-11h45

1. Time: **11h45-12h00 (UTC)**, 13th of July

Title of the Paper: FORMATIVE ASSESSMENT AND TECHNOLOGY: AN ATTEMPT OF FRAMEWORK

Author(s): **Gilles Aldon***, Monica Panero**

Institution(s) and Country/Region:

*IFÉ-ENS de Lyon, France

**SUPSI, Locarno, Confédération Helvétique

Short abstract of the paper (20 lines maximum):

This proposal aims to contribute to research regarding the place and the role of technology in the assessment process and more particularly on formative assessment. It addresses the professional development of teachers integrating technology into their practices in order to enhance formative assessment. The main claim of this paper is that technology does modify classroom assessment processes but at the cost of a reorganization of the act of teaching.

2. Time: **12h00-12h15 (UTC)**, 13th of July

Title of the Paper: STUDENTS AS DESIGNERS OF DIGITAL CURRICULUM RESOURCES

Author(s) **Annalisa Cusi***, Agnese Ilaria Telloni**

Institution(s) and Country/Region:

Sapienza University of Rome, **University of Ancona

Short abstract of the paper (20 lines maximum):

In this paper we present the first results of a study focused on an educational programme aimed at involving upper secondary students in the design of digital curriculum resources

(DCR) using the GeoGebra software. We characterize the praxeologies, developed by the students in relation to the task of DCR-design, through the analysis of the reflections they proposed during semi-structured interviews at the end of the educational programme. Our characterization of students praxeologies highlighted their awareness both on the characteristics of the DCR that supports students learning and on the role of the design process in fostering the designers learning itself.

3. Time: **12h15-12h30 (UTC)**, 13th of July

Title of the Paper: STRAIGHTENING THE BEND: SEQUENCING EMBODIED EXPERIENCES WITH HIGH AND LOW-TECH DESIGNS FOR THE NOTION OF RADIANT

Author(s): **Rosa Annalucia Alberto**, Anna Shvarts, Arthur Bakker, Paul Drijvers

Institution(s) and Country/Region

Freudenthal Institute, Faculty of Science, Utrecht University, the Netherlands

Short abstract of the paper (20 lines maximum):

We aim to support students to move from calculation to reasoning strategies in trigonometry by the design of technology-enhanced learning activities inspired by embodied mathematical cognition and embodied design. From a previous design cycle we conjectured that novel mathematical relations need to be enacted physically to provide opportunities to actively conceptualize these relations. We follow up on this by exploring embodied interactions that foster students understanding of the input of trigonometric function in the unit circle and the sine graph. Students appeared to lack physical experience with measuring circular arc lengths and using the radius as a unit of measurement. Low-tech paper materials seem to afford sensible enactments like folding and bending better than would digital materials. We present three activities that sequentially reify embodied experiences to enable students to measure digitally an arc length using the circumference measured in radii.

Discussion **12h30-13h00**

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Session 2: 13h30-15h00 (UTC), 16th of July

Introduction 13h30-13h40

1. Time: 13h40-13h45 (UTC), 16th of July

Title of the Paper: QUESTIONS OF DESIGN RESEARCH: A TECHNOLOGY MATHEMATICS LESSON FRAMED BY THE DIDACTICAL TRIANGLE

Author(s): Marie Joubert, Geoff Wake, Marc North

Institution(s) and Country/Region

University of Nottingham, Great Britain

Short abstract of the paper (20 lines maximum):

This paper concerns the process of design research, within the context of teaching a technology mathematics lesson in Further Education colleges in England. It explains the context, then uses the didactic triangle to frame an analysis of the design requirements for a lesson on factors and multiples. Having determined the design requirements, an example of a lesson is given, with an explanation of how it meets the requirements. It concludes that, although the design requirements have been met, the end product perhaps lacks a sufficiently coherent narrative. It ends by speculating on whether a fourth vertex, to represent technology, should have been added to the didactic triangle or whether there is a way of capturing a coherent narrative within the design requirements.

2. Time: 13h45-13h50 (UTC), 16th of July

Title of the Paper: MERLO ITEM AS BOUNDARY OBJECT IN TEACHERS PROFESSIONAL DEVELOPMENT

Author(s): Ornella Robutti*, **Theodosia Prodromou****, Gilles Aldon***

Institution(s) and Country/Region

* University of Torino, Italy ** University of New England, Australia, ***IFÉ-ENS de Lyon, France

Short abstract of the paper (20 lines maximum):

This paper is focused on the possibility to consider Meaning Equivalence Reusable Learning Objects (MERLO) item as a boundary object in crossing the boundary between two communities: researchers and teachers. The boundary crossing is seen as a process of transformation that can influence a modification (more or less stable) in the praxeologies of the teachers. Primary pre-service teachers are engaged in this experiment, during their professional development. Results are on the possible existing intertwining of their

praxeologies and the MERLO items they produce, seen as boundary objects in their evolution over time. For this reason, the frame by Akkermann and Bakker for boundary crossing is particularly useful to connect the parallel evolutions of praxeologies on one side and MERLO item on the other side.

3. Time: **13h50-13h55 (UTC)**, 16th of July

Title of the Paper: ACCEPTABILITY OF THE PROPOSED MULTIMEDIA INSTRUCTIONAL MODULE IN SELECTED PRE-CALCULUS TOPICS AMONG STEM STUDENTS OF MUNTINLUPA NATIONAL HIGH SCHOOL

Author(s): **Maxima Joyosa Acelajado**, Arlene B. Miyas

Institution(s) and Country/Region

*De La Salle University-Manila **Muntinlupa National High School, Main

Short abstract of the paper (20 lines maximum):

Efforts to achieve excellence in mathematics paved the way to think of ways and actions that would help learners with mathematics learning difficulties as well as problems related to class attendance and facility in understanding. With the emergence of multimedia, a new technology tool was developed to address these problems: the Multimedia Instructional Module (MIM). To evaluate its acceptability, a quasi-experimental research method was employed to randomly selected grade 11 STEM learners of Muntinlupa National High School-Main who served as experimental and control groups. The experimental group used the MIM while the control group was exposed to the Conventional Teaching Approach (CTA) in the delivery of selected topics in Pre-calculus. A teacher-made test and a researcher-made survey questionnaire were used to gather data. Statistically significant difference in the posttest mean scores between the two groups revealed that the experimental group performed better and that the participants of this group perceived the MIM to be Highly Acceptable.

4. Time: **13h55-14h00 (UTC)**, 16th of July

Title of the Paper: TWITTER, EMOTION AND MATHEMATICS

Author(s): **Mario Sanchez Aguilar**

Institution(s) and Country/Region

Instituto Politecnico Nacional, CICATA Legaria, Mexico City, MX

Short abstract of the paper (20 lines maximum):

Although twitter has been proposed as a tool to engage mathematics students in and out of the classroom and to positively impact their learning of mathematics, in this article it is

argued that this social network can serve as a medium that provides us with an insight into students emotional experiences related to the teaching and learning of mathematics. To illustrate this, a selection and categorization of tweets about mathematics is presented. The categories in which the tweets are organized are: (1) mathematics its difficult, (2) mathematics is useless, (3) mathematics tests, (4) I like mathematics, and (5) love and mathematics.

Discussion **14h00-14h25**

5. Time: **14h25-14h30 (UTC)**, 16th of July

Title of the Paper: INTEGRATING GEOGEBRA IN CLASSROOM TEACHING OF 3D GEOMETRY: CONTRASTING A FRENCH AND A CHINESE CASES

Author(s): **Mingyu Shao**

Institution(s) and Country/Region

East China Normal University, China/ENS de Lyon, France

Short abstract of the paper (20 lines maximum):

Drawing on the instrumental orchestration and the instrumental genesis frameworks, this paper contrasted the case of a Chinese mathematics teacher with a French one, investigating how they have managed to integrate GeoGebra in their class on 3D geometry. The analysis results opened some perspectives for further investigation, including teachers' documentation work before the class, and the factors that could influence their choices of instrumental orchestration.

6. Time: **14h30-14h35 (UTC)**, 16th of July

Title of the Paper: MATHEMATICS PROSPECTIVE TEACHER DISPLAY OF TECHNOLOGICAL CONTENT KNOWLEDGE IN A GEOGEBRA-BASED ENVIRONMENT

Author(s): **Kim Agatha Ramatlapana**

Institution(s) and Country/Region

Botswana Open University, Gaborone, BW

Short abstract of the paper (20 lines maximum):

I explore geometry technological content knowledge displayed by mathematics prospective teachers when working on a high school circle geometry task within a GeoGebra-based environment. The investigation was conducted by probing into six prospective mathematics teachers thinking as displayed in their solutions to the

technological content knowledge-based task. I examined what do the GeoGebra constructions reveal about the prospective teachers competence with geometry diagrams within a GeoGebra environment. The narratives and constructions were expected to reflect the teachers ability to transform the statements from a static environment to a dynamic construction employing GeoGebra as a construction tool. The affordances and constraints of GeoGebra when making connections between the construction and geometric principles emerged.

7. Time: **14h35-14h40 (UTC)**, 16th of July

Title of the Paper: AN IMPLEMENTATION OF TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE FRAMEWORK FOR ANALISING THE DESING OF TASKS IN AN DIGITAL ENVIRONMENT

Author(s): **Carolina Guerrero Ortiz**

Institution(s) and Country/Region

Pontificia Universidad Catolica de Valparaiso, Valparaiso, CL

Short abstract of the paper (20 lines maximum):

With support on the Technological Pedagogical Content Knowledge (TPACK) framework and following a qualitative perspective some tasks designed by preservice mathematics teachers are analyzed. Through analyzing the characteristics of the tasks designed by the participants elements related to the domains of TPACK are identified. In this process aspects related to modelling, simulation, visualization and the use of the tools of a Dynamic Geometrical System (DGS) highlighted. This work allows us to know how in the tasks design the preservice teachers knowledge can be evidenced, the results also show how they conceptualize modelling in a technological environment.

Discussion **14h40-15h00**

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Session 3, 6h30 – 8h30 (UTC) 17th of July

Introduction 6h30-6h40

1. Time: **6h40-6h45 (UTC)**, 17th of July

Title of the Paper: MATHEMATICS VR TEACHING DESIGN MODE AND ITS PRACTICE AT UPPER SECONDARY LEVEL: BASED ON VR ALL-IN-ONE COMPUTER

Author(s): **Jijian Lu**, Xiaoyuan Shen, Yi Lv

Institution(s) and Country/Region

Hangzhou Normal University, Hangzhou, CN

Short abstract of the paper (20 lines maximum):

In order to solve the limitations of traditional online, VR head display and VR glasses in students' collaborative interaction and integration in mathematics teaching at upper secondary level, we built mathematics VR teaching design mode, which include resource selection, interaction design, development and innovation. Combined with the mathematics VR teaching resources of volume of combination -using rainbow cube, we also applied the mathematics VR teaching design mode to practice and found that it is effective.

2. Time: **6h45-6h50 (UTC)**, 17th of July

Title of the Paper: MOBILIZING MATHEMATICS: HOW TECHNOLOGY ENHANCES EMBODIED LEARNING

Author(s): **Stefan Rothschuh**

Institution(s) and Country/Region

University of Calgary, Calgary, CA

Short abstract of the paper (20 lines maximum):

This paper discusses the theoretical considerations and the practical implementation of my dissertation research on technologically enhanced embodied mathematics learning. My research is seeking to study and improve the practice of learning and teaching mathematical functions at the secondary school level by incorporating embodied learning designs. It draws on established theories of how individuals learn mathematics, recent developments that aim to incorporate embodiment and technology in mathematics learning processes, and the desire to study learning where it naturally occurs. Using a design-based research approach, the researcher and

partnering teachers developed and implemented a set of technologically enhanced embodied lesson designs. Over the course of three iterations, designs were continuously revised and improved to advance classroom practices that promote embodied learning of the function concept, and harmonize technology-integration in these learning environments. In-class video recordings enable the close study of moments that entail rich mathematics learning and how it unfolded in classrooms. Preliminary findings of my dissertation research will be shared.

3. Time: **6h50-6h55 (UTC)**, 17th of July

Title of the Paper: THE READING AND THE COMPREHENSION OF MATHEMATICS TEXT: AN EYE-TRACKING STUDY WITH PRIMARY PRE-SERVICE TEACHERS

Author(s): Roberto Capone, Federica Ferretti, Alessandro Gambini, **Camilla Spagnolo**

Institution(s) and Country/Region

Free University of Bolzano/Bozen, Forli, IT

Short abstract of the paper (20 lines maximum):

The central role of argumentation in the teaching-learning process is internationally recognized. Interdisciplinary studies have shown how much the type of text affects a student's reading and, consequently, their performance. Selective readings with focus on some textual elements considered essential, often lead to a lack of understanding of the problematic situation. The present research, carry out with the innovative tool of eye track, shows a first exploratory study conducted with primary pre-service teachers while dealing with mathematics texts.

4. Time: **6h55-7h00 (UTC)**, 17th of July

Title of the Paper: COMPUTATIONAL THINKING FOR MATHEMATICAL LEARNING

Author(s): **Yahya Tabesh**

Institution(s) and Country/Region

Polyup Research, US

Short abstract of the paper (20 lines maximum):

We will present an intuitive digital learning model, which is focused on problem solving through computational thinking and is targeted to empower teenagers. The proposed model is a hands-on interactive web platform for mathematical problem

solving that enables creative engagement, develops mathematical skills, and supports a growth mathematical mindset. We illustrate the benefits arising from engaging youth with progressively more complex tasks and giving them increased ownership of their learning. As a foundation, we consider the use-modify-create framework to offer a helpful progression for developing mathematical thinking. We will present a computational thinking playground and a functional programming paradigm in a platform for creative problem solving. In this platform we can use models and simulations to represent phenomena which, by playing with a mathematical framework, will be learned through creative and innovative thinking. The gained knowledge and skills of this cognitive learning both empower learners and enhance creativity.

Discussion **7h00-7h25**

5. Time: **7h25-7h30 (UTC)**, 17th of July

Title of the Paper: STUDENTS' UNDERSTANDING OF THE NOTION OF COLLINEAR VECTORS IN DYNAMIC GEOMETRY ENVIRONMENT

Author(s): **Jose Orozco-Santiago**, CARLOS ARMANDO CUEVAS VALLEJO, Luc Trouche

Institution(s) and Country/Region

CINVESTAV, Mexico City, MX

Short abstract of the paper (20 lines maximum):

The purpose of this study is to analyze students work in performing elementary linear algebra tasks, particularly regarding collinear vectors. We designed the tasks considering the potential of the dragging tool in a dynamic geometry environment. The tasks were assigned in a linear algebra course in engineering, and the work of one student was analyzed, as a case study, to examine the actions instrumented under the framework of instrumental genesis. The study is part of a broader research project based on a sequence of didactic tasks to introduce the concepts of eigenvalues and eigenvectors using collinearity.

6. Time: **7h30-7h35 (UTC)**, 17th of July

Title of the Paper: ENHANCING METACOGNITION BY USING FLIPPING CLASSROOM WITH GEOGEBRA

Author(s): **Chak Him Fung**, Poon Kin-Keung, Michael Besser

Institution(s) and Country/Region

Education University of Hong Kong, Hong Kong, HK

Short abstract of the paper (20 lines maximum):

Flipping classroom (FC) has becoming more and more popular recently. By shifting the in-class instruction section into the pre-class section, more meaningful activities could be applied and thus it could benefit the teaching and learning process theoretically. However, video may not be the best pre-class material and educators are now looking for possible alternatives. In this study, GeoGebra is proposed as an alternative and its effect are investigated in terms of metacognition development among students. Three classes of 161 students, who were studying form 4 (Grade 10) in a senior secondary school in China, were recruited and a 3x2 ANOVA (three groups with pre-test and post-test) was conducted. The result revealed that the main effect of the metacognition ($F(1,158)=68.16, <.001, \eta^2=.301$) was significant while the interaction between the metacognition and the teaching methods ($F(2,158)=.641, =.528, \eta^2=.008$) was not significant. It further suggested that the FC supported by GeoGebra is an effective teaching method in terms of students metacognition development.

7. Time: **7h35-7h40 (UTC)**, 17th of July

Title of the Paper: STUDENTS COPING WITH A POST-16 MATHEMATICS COURSE: FLIPPED LEARNING, SELF-REGULATION AND TECHNOLOGY

Author(s): **Sofya Lyakhova**, Marie Joubert, Dominic Richard Oakes

Institution(s) and Country/Region

Swansea University, Swansea, GB

Short abstract of the paper (20 lines maximum):

In 2010 the Further Mathematics Support Programme Wales (FMSPW) was set up in Wales, UK, with the aim of supporting state-funded schools in offering an advanced post-16 mathematics course of Further Mathematics whenever the schools could not timetable the course. The study considers the findings of two research projects which employed technology to compensate for the lack of in-school resources. Using the theory of self-regulation and a construct of mathematical resilience we argue that there are learner benefits for implementing flipped learning environments going beyond simply granting access to the course.

Discussion **7h40-8h00**

Synthesis and conclusion **8h00-8h30**

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