TSG Agenda

TSG 14: **Teaching and learning of programming and algorithms**

Class: B

Session 1 19:30-21:00 Beijing time, July 13th

1. Time: 19:30─19:40

   Title of the Paper: **INTRODUCING TSG 14**

   Chantal Buteau & Maryna Rafalska
   Brock University (CANADA)
   Université Côte d'Azur (FRANCE)

   Introducing TSG 14 and Session 1

2. Time: 19:40─20:05

   Title of the Paper: **ALGORITHMIC THINKING: EMERGING IMPLICATIONS FOR SCHOOL MATHEMATICS EDUCATION**

   Max Stephens & Djordje M. Kadijevich
   The University of Melbourne, Melbourne (AUSTRALIA)
   Institute for Educational Research, Belgrade (SERBIA)

   In many countries, the curricular relationship with digital technologies is moving very rapidly. These technologies are not only seen as learning and teaching tools for existing disciplines such as mathematics but are also associated with new forms of literacy to be developed for scientific, societal and economic reasons. Algorithmic thinking (some prefer the term Computational thinking) is a key element of the new digital literacy. This paper draws attention to the mutual interfaces between algorithmic (computational) thinking (CT/AT) and school mathematics, arguing that each should contribute to the development of the other in the school curriculum, and it outlines different models and practices currently used in different countries to integrate CT/AT into the curriculum, and discusses some curriculum challenges and opportunities to realizing that integration.

3. Time: 20:05─20:20

   Title of the Paper: **MATHEMATICS EDUCATION AND COMPUTATIONAL THINKING**

Takuma Takayama
Shimoda Junior High School (JAPAN)

The purpose of this paper is to propose a manner of teaching to develop computational thinking in mathematics education. According to Aho (2011), computational thinking is the thought processes involved in formulating problems so their solutions can be represented as computational steps and algorithms. Mathematical thinking is closely related to computational steps and algorithms. Therefore, programming education can be made more effective by clarifying the scene of mathematical thinking in computational thinking. This research paper will consider the scene where the mathematical thinking and computational thinking, especially when examining the solution by programing. From the results of class practice for 3rd grade in junior high school, it became to evident that the classes incorporating program improvements program is good curriculum which make students improve both mathematical thinking and computational thinking.

4. Time: 20:20─20:35

Title of the Paper: **TEACHERS PERCEPTIONS OF COMPUTATIONAL THINKING AS PART OF THE TEACHING OF MATHEMATICS: A HERMENEUTIC LITERATURE REVIEW.**

Camilla Finsterbach Kaup
Aalborg University, Denmark

***Background**: To work with the inclusion of Computational Thinking (CT) in mathematics in primary and lower secondary school, it is important to consider the attitudes and understandings related to the concept of CT. This study explores knowledge connected to the teachers' understanding of the concept of CT in regard to mathematics by examining the existing literature within the field. **Results**: The literature review's inclusion criteria are based on research articles that are peer- reviewed and are compatible with the research question, and which have been published in a scientific journal between 2006 and 2019. The work has been based on a hermeneutic understanding of the study of literature, and there is also a use of thematic analysis to find themes across the data. A total of six key texts are included in this review. It is identified that it is important that teachers have knowledge and understanding of CT in order to be able to integrate it into their teaching and to be able to pass this knowledge on to their pupils. Teachers often do not know what CT means, and they lack clear ideas about how they can integrate it into their teaching. It is also found to be important to have worked with computational ideas already by the teacher education program, as this can help to increase the understanding of CT for the preservice teachers so they can begin to integrate CT concepts in their subject area teaching. It is concluded that the literature includes similarities between CT and mathematics, but that there is still a lack of knowledge about how CT can be understood and integrated into the teaching of mathematics. It is recommended that more research is carried out into this phenomenon in order to understand the implications for how mathematics teachers can integrate CT.*

5. Time: 20:35─20:40

   Title of the Paper: **Engaging Prospective Teachers and Students in Programming Activities**

   Allyson Hallman-Thrasher, **Susanne Strachota**, Danielle Dani
   Ohio University (USA)

   We describe a coding lesson enacted by prospective secondary math and science teachers with students ages 11-13. We discuss challenges of introducing this content to learners for whom it is unfamiliar and the pedagogical skills teachers needed to effectively address coding activities with students.

6. Time: 20:40─21:00

   Title of the Paper: **DISCUSSION**

   Chantal Buteau & Maryna Rafalska
   Brock University (CANADA)
   Université Côte d'Azur (FRANCE)

   Discussion

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

7. Time: 21:30─21:35

   Title of the Paper: **INTRODUCTION**

   Chantal Buteau & Maryna Rafalska
   Brock University (CANADA)
   Université Côte d'Azur (FRANCE)

   Introducing session 2

8. Time: 21:35─22:00

   Title of the Paper: **THREE IMPORTANT ASPECTS OF RESEARCH ON COMPUTATIONAL/ALGORITHMIC THINKING**

   Djordje M Kadijevich & Max Stephens
   Institute for Educational Research, Belgrade (SERBIA)
   The University of Melbourne, Melbourne (AUSTRALIA)

Although the educational relevance of computational/algorithmic thinking (CT/AT) is not questionable, research on CT/AT is still in its infancy. This contribution considers three important aspects of CT/AT research. The first aspect is related to clarifying the notion of CT/AT that calls for addressing a number of issues properly. The second aspect is concerned with (implemented/proposed) ways to embed CT/AT in the school mathematics curriculum. It draws attention to key principles for the inclusion of CT/AT in the school mathematics curriculum and points to the urgent need to consider appropriate pedagogical principles to achieve this inclusion in in best possible ways. The third, last aspect is related to the importance of internationalizing research on CT/AT, which has already taken place in various disciplines. Implications for research and practice are included.

9. Time: 22:00─22:25

   Title of the Paper: **On enumeration in mathematics and computer science: some didactical issues**

Simon Modeste
IMAG, University of Montpellier, CNRS, Montpellier (FRANCE)

We investigate, from mathematics and computer science, theoretical and practical points of view, the notion of enumeration. We defend that, with the introduction of programming in secondary school, enumeration becomes a relevant activity for students allowing computer science to contribute to the experimental dimension of mathematics. We show the potentiality of enumeration problems and discuss how the availability of enumeration as a tool changes the solving of some problems.

10. Time: 22:25─22:40

    Title of the Paper: **A FRAMEWORK FOR ANALYZING THE INTEGRATION OF ALGORITHMS AND PROGRAMMING INTO MATHEMATICS TEXTBOOKS**

Tran Kiem Minh, Nguyen Thuy Viet Anh, & Tran Trong Ha
College of Education, Hue University (VIETNAM)

Algorithms and algorithmic thinking play a very important role in our daily life, especially in the context of the fourth industrial revolution. Recently, many reformed secondary mathematics curricula have paid special attention to algorithms and programming, as well as their integration into secondary school mathematics textbooks. However, to date, there have been few studies of the role and nature of algorithms and programming integrated in mathematics textbooks, as well as learning opportunities for students provided by the textbooks. In this study, we provided a framework that allows characterizing the integration of algorithms and programming into mathematics textbooks. We then used this framework to make sense of the integration of algorithmic and programming into a French mathematics textbook. The results indicated a diversity of contexts, formal structures, roles, degrees of integration of algorithms and programming through different topics of the textbook.

11. Time: 22:40─23:00

Title of the Paper: **DISCUSSION**

Chantal Buteau & Maryna Rafalska
Brock University (CANADA)
Université Côte d'Azur (FRANCE)

Discussion.

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

12. Time: 14:30─14:35

Title of the Paper: **INTRODUCTION**

Chantal Buteau & Maryna Rafalska

Brock University (CANADA)
Université Côte d'Azur (FRANCE)

Introducing session 3.

13. Time: 14:35─15:15

Title of the Paper: **WORKING MATHEMATICALLY AND THINKING COMPUTATIONALLY: CAPITALISING ON COMMONALITIES FOR INTEGRATED TEACHING**

Elena Prieto & Kathryn Holmes

The University of Newcastle (AUSTRALIA)
Western Sydney University (AUSTRALIA)

The number of students choosing higher-level mathematics in Australia is declining at a worrying pace. Many factors contribute to this decline, but there seems to be a consensus that the integration of digital technologies in mathematics teaching could increase engagement and participation. One of the biggest barriers to this integration is the amount of time required in the classroom for meaningful digital explorations in an already overcrowded mathematics curriculum. There are multiple examples, however, of potentially timesaving opportunities afforded by digital technologies when mathematical concepts and processes are aligned to technology outcomes. In this paper, we explore links between algorithmic thinking and mathematics curriculum outcomes to determine

areas of alignment for cross- curricular integration. Using the Australian Digital Technologies and the Mathematics curriculums as a case study, we argue that the integration of these two curricular areas holds tremendous potential to enhance the teaching of both. We make recommendations for integrated teaching practices to increase student achievement and participation in higher-level mathematics.

14. Time: 15:15─15:30

    Title of the Paper: **MODELLING AND 3D PRINTING A CIRCULAR STAIRCASE FOR A DOLLS HOUSE: TEACHING COMPUTATIONAL THINKING USING A RANGE OF DIFFERENT TOOLS**

    Gregor Milicic & Matthias Ludwig
    Goethe University Frankfurt

    Algorithms and Computational Thinking (CT) are key topics in STEM Education. A problem many educators face is how to embed CT in the curriculum and motivate the students. We suggest a sequence of activities to tackle both aspects by using a modelling cycle and a range of different tools to plan and print a circular staircase for a doll's house. The students are asked to develop an algorithm which produces a 3D model fitting the requirements of the real application. During the problem solving process the students acquire a deeper understanding of CT, get familiar with the modelling program OpenSCAD and use the 3D printer not as an end unto itself, but for a specific application.

15. Time: 15:30─15:45

    Title of the Paper: **RESEARCHING THE TEACHING AND LEARNING OF PROGRAMMING FOR UNIVERSITY MATHEMATICAL INVESTIGATION PROJECTS**

    Chantal Buteau, Eric Muller, Ghislaine Gueudet, Joyce Mgombelo, Ana I. Sacristán
    Brock University (CANADA)
    Brock University (CANADA)
    University of Brest (FRANCE)
    Brock University (CANADA)
    Cinvestav (MEXICO)

    Since 2001, mathematics students and future teachers at Brock University (Canada) learn in a sequence of three courses to use programming for pure and applied mathematical investigations. In this presentation, we briefly highlight our research on the learning and teaching in these courses, and discuss how students are guided to progressively learn (i.e., develop a scheme) to articulate a mathematics process in a programming language.

16. Time: 15:45─16:00

    Title of the Paper: **Math & CS Labs: a bi-disciplinary course for second-year undergraduates in mathematics or computer science**

David Doyen, **Antoine Meyer**
LAMA (UMR 8050), UPEM, UPEC, CNRS, Université Paris-Est (FRANCE)
LIGM (UMR 8049), UPEM, CNRS, ESIEE, ENPC, Université Paris-Est (FRANCE)

At our university, the first three semesters of the mathematics and computer science undergraduate programs are common. They consist prominently and in equal parts in mathematics and computer science courses. From the fourth semester on, students specialize in one of the two disciplines for the next three semesters. Courses presented in this first period should thus strive toward for usefulness and attainability for both student profiles. Starting this year, we will be experimenting with a new third-semester bi-disciplinary course aiming at an exploration of first-year mathematical objects and concepts through algorithms and computer programming, using first-year computer science knowledge and skills. This course is created to serve firstly pedagogical and curricular ends, but it is also intended for the researcher as a terrain to validate hypotheses on the possible effects of this approach on student's learning, particularly on the observable benefits (or absence thereof) of a bi- disciplinary approach to objects and concepts.

17. Time: 16:00─16:30

Title of the Paper: **Discussion and Conclusion**

Chantal Buteau & Maryna Rafalska
Brock University (CANADA)
Université Côte d'Azur (FRANCE)

Discussion and conclusion.