TSG 2: New developments and trends in mathematics education at secondary level

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Introduction

TSG 2 aimed at discussing and sharing opinions, experiences and research results within the ICME Community related to this broad theme.

Several movements characterized secondary mathematics education during the past decades. Most of them are deeply related to changing societies and technological worlds and at the same time, they are often inspired by the results of leading research in mathematics education. There is much diversity in mathematics education research depending on communities and academic societies in the world, but the common aim of mathematics education research has been to improve curricula, teachers' practices, students' learning, assessment, and teachers' education.

There are several trends and projects in the world that represent the reform of mathematics education at the secondary level. These include policy, curriculum or textbook development research; developing teaching practices based on classroom research such as lesson studies and the development of teaching-learning environments for mathematics using new technologies; and the results and the impact of international comparative studies.

TSG 2 focused on future movements in mathematics education at secondary level and exemplarily illustrated these movements by presentations on:

1. Research projects for curriculum development having the potential to influence mathematics education in the next decades;
2. Policies of secondary schools' reforms having the potential to generate new trends in secondary mathematics education;
3. Developmental studies of teaching new contents in mathematics;
4. Developmental studies of new ways of teaching mathematics;
5. Influential research results in mathematics education for the secondary school level.

In the first session of TSG 2, internationally known specialists presented their ideas on three main issues related to the central theme of TSG 2, namely the impact of new technologies, curricular developments, and the role and results of international comparative studies. In the second and third session, papers were grouped around two themes. The first, *Curricular Developments and New Contents* provided our community with a description of current events in different parts of the world, and the second, *Learning from Research and Classroom Practice,* provided us with some of the means to critically reflect on the new trends. In the fourth and final part, the chairs and members of the Organising Team presented their personal opinions and reflections on *New Development and Trends in Secondary Education* and on the different papers that were presented in the first three sessions.

Keynote presentations

Paul Drijvers (Freudenthal Institute, the Netherlands) in his presentation addressed the integration of technology in mathematics education at secondary level. From a retrospective point of view, he argued that initial pedagogical approaches sometimes turned out to be too optimistic and too straightforward. Furthermore, important questions concerning the influence on the curriculum, the relation between paper-and-pencil work and technology use, the need for traditional practice and the role of the teacher did not receive satisfactory answers. This brought the presenter to the "state-of-the-art" concerning the integration of technology in mathematics education. He observed positive trends on the research and development front (technology is no longer the concern of a group of "enthusiasts" with little communication with research in mathematics education in general), but also with respect to the practical conditions, at least in the Netherlands. The original optimism concerning the influence of technology on the learning of mathematics has changed so as to become more nuanced ways. By now, it is fairly widely accepted that skills and understanding cannot be separated, and that machine techniques and mental concepts are related. Looking into the future, infrastructural arrangements, adequate research, curriculum development and teacher training were identified and discussed as critical factors affecting a productive integration of ICT in mathematics education.

In a second keynote presentation, *Florence Glanfield* (University of Saskatchewan, Canada) discussed curricular developments from a Canadian perspective. She first described the current trends and the backgrounds of these trends. Across Canada, mathematics curricula now include a focus on problem solving, applications, the development of mathematical concepts from a concrete approach, the design of programs intended for those students who are university-bound but not going into science and mathematics, and the integration of computer technology. According to the presenter, this last aspect is strongly related to the idea of "humanizing" mathematics: rather than mathematical work being accessible only to those patient and diligent enough to develop the many procedures for calculation needed for completing the foregoing tasks, technology may widen access to all pupils. She believed that the trend to humanize mathematics for all students and teachers will continue to prevail in Canada.

Ross Turner (Australian Council for Educational Research) focused on the impact of international comparative studies on mathematics education, more specifically on the role of PISA (OECD's Program for International Student Assessment). The presenter outlined some of the objectives and features of PISA, comparisons with TIMSS were briefly discussed, some results and outcomes were presented regarding the impact of PISA on mathematics education, and some limitations of PISA were also briefly explored. He concluded that PISA is now established as the major international comparative study of the mathematical ability of 15-year-olds. PISA's emphasis on assessing students' ability to *use* their mathematical understanding has led to many countries reviewing how their curricula "prepare their students for life". The PISA 2003 results, in which mathematical literacy was the major domain, are sure to precipitate further debate about the PISA approach and its relevance to universal mathematics education.

Paper presentations: Curricular developments and new contents

The first paper reported on the reform movement in mathematics education in People's Republic of China, focusing on curriculum at the compulsory levels. *Kwok-cheung Cheung* (University of Macau, China) argued that China's mathematics curriculum reform has been actively underway since the turn of the century. This paper sought to provide an introduction to new developments in mathematics education at the compulsory education levels (grade 1-9) based on the Mathematics Curriculum Standards (Experimental Version) released by the Ministry of Education. Basic concepts, design considerations, curriculum objectives, curriculum contents, curriculum implementation and recommendations on mathematical background knowledge were explicated in detail.

In a second paper *Guo Rong Xu* (London South Bank University, UK) discussed problems in Chinese education. Recently, the government initiated a mathematics education reform, influenced by Western educational ideologies and focused on changing the classroom practice to promote more active and creative learning. However, this reform, like previous reforms in Chinese mathematics education seems to be ineffective in implementing substantial changes in mathematics classroom practices. In her study in collaboration with *Stephen Lerman*, she looked at the actual impact of the reform on classroom practice and attempted to identify and analyse some factors that hindered it.

Maitree Inprasitha (Center for Research in Mathematics Education, Thailand) described the movement of lesson study in Thailand. Lesson study, a Japanese form of professional development, is a well-known approach to improve teacher practice. In his paper, he introduced how to use the lesson study approach for another purpose, namely to improve the recently launched 5-year program for educating mathematics teachers at all faculties of education in Thailand. In his concluding remarks, he stated that the lesson study approach has begun to have great influence on the reform program for professional development in Thailand. Furthermore, the National Commission on Science and Mathematics Education has incorporated the concept of lesson study into a national scheme of development of science and mathematics education.

Sofia Anastasiadou (Aristotle University of Thessaloniki, Greece) presented a research-based report on the perceptions, attitudes and conducts of Greek mathematicians towards statistics in secondary education. Sixty-three mathematics teachers responded to a Tatsp scale ("Teachers' attitude towards statistics and probability", a questionnaire with a Likert scale). These teachers generally had a wide range of teaching experience and knowledge of mathematics but not of statistics. Mathematics teachers showed both positive and negative attitudes towards statistics. The presenter suggested that the negative attitudes were a product of the long absence of statistical teaching, possibly creating repugnance, anxiety and disdain towards this science.

In a rather controversial paper, *Allan Tarp* (Grenaa International Baccalaureate, Denmark) looked for completely new ways to teach mathematics at the secondary school. Therefore, he introduced the concept of and operations with per-numbers. To solve the relevance paradox in mathematics education, he used post-modern "sceptical Cinderella" research. The presenter argued that the addition of per-numbers can be seen as a more user-friendly

approach to the traditional subjects of proportionality, linear and exponential functions and calculus.

Paper presentations: Learning from research and classroom practice

Also on behalf of *Dirk De Bock*, *An Hessels*, *Dirk Janssens* and *Lieven Verschaffel*, *Wim Van Dooren* (University of Leuven, Belgium) presented a paper related to the role of modelling and applications. Despite the increased attention for the modelling aspect in mathematics education, educational practice and research in the last decades uncovered many difficulties and systematic errors that may impede students' learning of a mathematical modelling disposition. The paper reported on a research-based teaching experiment with 8th graders aimed at remedying one of these errors, namely students' tendency to see and apply the linear model everywhere. Although the experiment was successful in improving students' performance on non-linear problems, it did not lead all students to a profound conceptual understanding of linear and non-linear relations, including the disposition to distinguish between situations that can and cannot be modelled linearly.

Athanasios Gagatsis presented a collaborative investigation with *Modestina Modestou* (University of Cyprus) on the predominance of the linear model in 12-13 year old Cypriot students, while solving non-proportional word problems involving area and volume of rectangular figures. Using three different kinds of tests, related to the context of the word problems presented, they attempted to identify a differentiation in students' responses. Two different statistical analyses were used on the data: Factor analysis and implicative statistical analysis. Both statistical analyses suggested the same grouping of students' responses and confirm the existence of improper proportional reasoning.

Also on behalf of *José Antonio Salvador* and *Pedro Luiz Aparecido Malagutti*, *Yuriko Yamamoto Baldin* (Universidade Federal de São Carlos, Brazil) presented the so-called Project Pró-Ciências carried out at their university in 2001 and 2002, in collaboration with elementary school authorities and governmental educational agencies. The project aimed at professional development of secondary school teachers, updating them with modern requirements of the school curriculum. The project grounded on National Curriculum Standards and focused on the understanding, planning and carrying out of interdisciplinary activities, connecting mathematics to other sciences and the real world.

In a last paper presentation, *Jiansheng Bao* (Suchow University, China) compared the old middle school mathematics syllabus to the newly published National Mathematics Standards in China. Numerous changes, both regarding the curriculum and the mathematical contents in China were noticed, leading to the following questions: What precisely are the differences between the new and the old mathematics textbooks? How do these differences affect the styles of mathematics teaching and learning? In order to answer these questions, the presenter used a self-developed model to evaluate the composite difficulties of new and old eighth grade maths textbooks using five factors of difficulty so as to highlight some initial findings.

Discussion papers

Dirk De Bock (University of Leuven, Belgium) outlined some major recommendations expressed in reform documents of the eighties making a strong plea for reforming mathematics education in all areas taking seriously into account the psychological aspects of teaching and learning processes and the societal demands and expectations with respect to mathematics. He wondered how these recommendations were implemented in school curricula and asked some questions about future trends that seem to appear in our field.

Masami Isoda (Graduate School of Human Comprehensive Science, Tsukuba, Japan) reported on "Mathematical Activity as a Human Endeavor" projects. Based on four basic ideas (mathematization, mediational means, theory of embodiment and hermeneutics), materials related to history and technology were developed for the project. He illustrated this approach with an example of studying an ellipse compass.

Elaine Simmt (University of Alberta, Canada), drawing from the papers presented, suggested that the illusion of linearity exists for more than just students of mathematics. In her view, this illusion is prevalent in teachers', researchers' and policy makers' interpretations and understandings of curricula. In her discussion paper, she proposed that new trends in secondary education discussed during ICME–10 challenged this illusion.

Athanasios Gagatsis (University of Cyprus) discussed the growing attention to the role of representations in learning and teaching mathematics. His paper was an attempt to exemplify the different roles representations can and should play in meaningful mathematics learning and in general mathematics education.

Finally, *Juan Antonio Garcia Cruz* (Universidad de La Laguna, Spain) reflected on the way mathematics and mathematics education is reported in the media and the mathematics classroom practice. He argued that we have to change teacher's attitudes and beliefs and also the way mathematical practice is perceived in our society.

The session ended with a panel discussion chaired and moderated by *Elaine Simmt*.

All papers presented can be downloaded from the TSG 2 ICME-10 website.

This report has been written by Dirk De Bock and Masami Isoda. They are happy to be contacted at dirk.debock@avl.kuleuven.be and msisoda@human.tsukuba.ac.jp for further information on the work of this TSG.