DG 11: International comparisons in mathematics education

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Introduction

International Comparisons have had considerable impact to educational debates in the last years. What we can learn from these studies? Do they widen our perspectives towards mathematics education? These questions come with a lot of problems: How should we cope with the apparent different traditions when comparing students and/or countries? How can international comparisons foster further developments in mathematics education?

There are many ways to address the issue. The public interest in international comparisons is mainly bound to large-scale achievement studies such as TIMSS and PISA. However, in the mathematics education community also comparative studies of smaller scale are greatly appreciated, as well as other types than achievement studies. In the introductory remarks to the Discussion Group, the organisers exhibited several fields to which a comparative study could be related. E.g. there are

- studies on achievement,
- studies on lesson structures,
- studies on teaching materials,
- studies on beliefs,

to mention only those themes the group was going to discuss. Consequently, DG 11 gave space to a broad spectrum of international comparisons. Furthermore, it was also a permanent topic in the discussion, how the various kinds of international comparisons should be balanced, and what the respective benefits could be.

The invitation to take part in this group pointed to three strands that should be discussed:

- Overview on recent international comparisons in mathematics education,
- Overview on topics addressed in comparative studies, and the central question:
- What can we learn from international comparisons for the development of mathematics teaching and learning?

According to the guiding questions above, the three sessions each covered a special topic. The discussion always started from papers, arranged in such a way that similar questions could be discussed in one session. A total of 10 papers, distributed in advance of the congress, were considered for discussion, and these papers are described below.

Basic issues

The first session was devoted to questions of a basic nature. The discussion started with some arguments about why and at what level international comparisons are to the benefit of mathematics education. One can there distinguish three lines of argumentation:

1) International comparisons as a means for "benchmarking": This idea addresses questions like, where a certain country is placed in the world, to what degree an educational system is "effective" in relation to comparable others. Public discourses on education are likely to be influenced and to even be initiated by using the international data in this way.

2) International comparisons as an opportunity to reflect one's own way to organize and to achieve educational progress: Related questions in this line of argumentation could be the following. Are "others" better in some interesting respect? What do they do, and which of their ideas are adaptable to one's own situation? Essentially, international comparisons can be a means to see one's own system better, through the mirror of observing other systems. Such observations can even be an impulse for starting to act.

3) International comparisons as an instance to start with reflections on principles of education, teaching and learning: International comparisons are always exposed to the argument that their focus is biased, by selection of materials, posing contextual questions, asking questions not in the accustomed way, etc. Therefore, international comparisons are more strongly than national studies forced to make clear their assumptions and their theoretical conceptions. However, just by that critical attitude, such studies can contribute to the development of mathematics education. One can learn and critically discuss how the common ground for a comparison was defined in the studies, or in which ways the results were gained and communicated.

One of the really "basic" questions of any comparative study is: How to understand what's going on in a different culture's classroom, and therefore how to find a common ground to map the observed differences? It was exactly this problematique the Discussion Group started with. Two presenters opened the discussion.

Paul Andrews (Cambridge, UK) reported on a joint project in five European countries (Flemish Belgium, England, Finland, Hungary and Spain), the "Mathematics Education Traditions of Europe" (METE) project. To examine how learning was structured over sequences of lessons taught on a particular topic, video recordings of such sequences are made. However, to ensure the elimination of cultural bias from subsequent analyses, data collection was preceded by an extensive programme of live observations to facilitate the development of a descriptive framework for the analysis of videotaped lessons. Paul Andrews exhibited how observation schedules were constructed, facing the problem that even the simplest assumptions about the vocabulary of mathematics classroom activities proved to be far from unproblematic. An iterative process finally produced a schedule that all participants could use with confidence, understanding, reliability and which satisfied the project's desire to describe lessons in ways that highlight both similarities and differences among teachers and countries.

Permanently, these issues arise when setting up video studies, as *David Clarke* (Melbourne, Australia) pointed out. The very general theme of "Voice and Variation" dominated the first session. "Voice" in this context refers not only to the voices of the participants (teachers and students) in classroom settings, but also to the voices of the interpreting researchers, whose cultural affiliations inevitably contribute to the form of their analyses. Concern with "variation" relates to the need in international comparative

research not to minimize variation. The simplistic aggregation of data at the level of nation, or the implicit imposition of a common international curriculum through international testing, or the aspiration to remove variation through the identification and advocacy of uniform internationally-applicable best practices were instances of such simplistic views. In contrary, it seems necessary to document and report variation in educational policy and practice in a manner that anticipates further variation in adaptation and application of such research.

Closing the first day, *Tibor Marcinek* from Slovakia gave some personal experiences while visiting, observing and analyzing mathematics education in US and his home country. To him, the personal experience itself, while conducting qualitative research, is a key to interpreting international comparisons. He posed the question, why a consistently top scoring country, his home Slovakia, nevertheless may call for rather radical reform of teaching mathematics. Other qualitative, personal experience-based international comparisons should be made to find a common ground on which outcomes may be communicated.

Teachers

The second session of the Discussion Group focused the discussion and collected contributions that dealt - in a wider sense - with issues of teachers in an international perspective. Teachers' knowledge, teachers' aids, teachers' beliefs were addressed among other issues. Three papers served as the starting point for the discussion.

Linda Haggarty and *Birgit Pepin* (Oxford, UK) could unfortunately not attend personally, but contributed with a background paper on an investigation of mathematics textbooks and their use in English, French and German classrooms. In particular they looked at the treatment of "Angle" in these textbooks, and examined teachers' mediation of those books. They observed and interviewed a small sample of teachers in those countries. An analysis of the data suggests that learners in the different countries are offered different mathematics and given different opportunities to learn that mathematics, both of which are influenced by textbook and teacher. So, who gets an opportunity to learn what?

Bracha Kramarski and *Zemira Mevarech* (Bar-Ilan, Israel) reported on a study, using PISA data, which proved the mutual relations of enhancing students' mathematics literacy on the one hand and their teachers' attitudes towards mathematics literacy on the other. PISA gave a good data basis since PISA's aim to assess students' literacy in a large-scale study is rather unique because the traditional approach focuses mainly on curriculum assessment. However, it is not clear at present to what extent teachers adopt this approach and teach accordingly. The present study addresses this issue by utilizing a PISA national option in Israel. About 150 mathematics teachers answered to a questionnaire that asked them about their attitudes toward mathematics literacy, emphasizing mathematics literacy in mathematics classrooms, and the extent to which they apply metacognitive and self-regulated learning (SRL) techniques in mathematics classrooms. The results, though showing only small effect sizes, indicated that teachers' attitude towards enhancing mathematics literacy plays a somewhat contradictory role. Students of teachers who believe that mathematics literacy is important, tend to score lower on the PISA test. The suggestion was made, and also the discussion sticks to this point, that teachers and students are to be exposed more intensively to literacy materials, particularly

in mathematics and science, and that materials alone do not suffice as long the underlying principles are not made explicit.

An Shuhua (Long Beach, USA) compared teachers' knowledge in USA and Chinese mathematics education. The study addressed mathematics teachers' pedagogical content knowledge within the respective cultural context and tried to identify missing components in the teachers' knowledge bases. Eight "missing components" were found, among them problems like that of bridging from manipulatives to mathematical ideas, of approaching students' misconceptions by using probing questions, of engaging students in study-questions, and of seeing the whole picture of the knowledge network. The study's benefit for the development of mathematics education research was seen in that it provides insight in how to set up dimensions for further international comparative studies in teachers' knowledge.

Students

At the third session of DG 11, some ways students are taught in different cultures, and views on student's beliefs were taken into the focus. This topic was addressed under diverse perspectives, from extensive studies to local investigations, and even plans for further collaboration.

Sun Xuhua (Chinese University of Hong Kong) started with a culture-bound look at the differences in mathematics beliefs between Chinese and USA students. More than two hundred Chinese students, 10^{th} and 11^{th} graders, were surveyed to compare their mathematics beliefs with American students. The overall findings indicate that the mathematical beliefs are value-laden and culture-bound. In particular, some of the most salient differences came from the attribution of success or failure (Chinese students tended to emphasize effort and interest more than Americans, and: Chinese students emphasized the teachers` attitudes in grading more than Americans), reasons to learn mathematics (mathematics is a more mandatory subject for the Chinese students), value view of parents (Chinese parents tend to stress the importance of math much more than Americans), self-belief (Chinese students tend to be lower in self-evaluation). A causal model of Chinese culture-bound mathematics beliefs and achievement was given which comprises the findings.

David Clarke and *Carmel Mesiti* (Melbourne, Australia) presented the basic assumptions and conceptions as well as findings of the Learner's Perspective Study. Data generated in 8^{th} grade mathematics classrooms in Australia, Germany, Japan and the USA were shown: How are the classroom practices of different countries most usefully compared if our goal is the improvement of those classroom practices? The aspiration to compare at one level (international) implies an aspiration to typify at another level (national). Both processes, comparison and typification, should be subjected to scrutiny. Lesson structure provides one potential unit of comparative analysis. One argument for the utility of lesson structure as a unit of comparative analysis is its potential adaptability. However this deserves intensive further conceptualization in mathematics education.

The aim of *Jiangsheng Bao* (Suzhou, China) was to introduce and present to a wider audience a newly established Video Case Study. The video clips in that study are accompanied by the plans of lesson preparation, by extensive hints to critical issues in the intended learning processes, by questions for reflective thinking about the lessons, and by selected background data. Those videos and the materials can be used as a good

and effective means to assist programs of teacher's further education. The video clips themselves and the accompanying hints are easily accessible by a hyperlink based technological platform. This platform allows both, a concrete look into the classroom, and a close tie to analysing and reflecting questions. Jiangsheng Bao presented his material, which is still in the phase of construction also with the desire to incorporate international data, in order to broaden the scope on mathematics teaching.

A more specialized topic was brought into the discussion by *Thomas Judson* from USA. In a small scale study he compared the ways, concepts, and skills, in the teaching of Calculus in USA and Japanese secondary schools. The study contained interviews and examination problems of two kinds, some probing conceptual understanding, some pointing to computational and reasoning skills. Little differences were found in the conceptual understanding if isolated, however when the examination question also contains the need of computational skills the Japanese students demonstrated much stronger capabilities.

Discussions and conclusions

The discussion several times and under various viewpoints came back to the basic distinction, already addressed in the introduction: How to cope with the two different levels on which international comparisons can focus, the systemic level and the individual level? While the aim on the systemic level is to draw conclusions in order to develop the educational system and the system of mathematics education as a whole, one searches on the individual level for understanding mathematical achievement. Both aspects could give impulses to each other, however often the two sides are not related. Several issues discussed in the DG 11 Group are sub-aspects of this basic question: Where is the place of large scale studies, and when are studies on smaller scales appropriate? On one side, the interpretation of large scale studies is bounded to an understanding of individual thinking, and vice versa, a small scale study can also draw upon concepts created for the bigger studies. But are these mutual dependencies really used enough? Apparently no, since the contacts between the researchers in the two paradigms are not as intense as they should be for close cooperation. The discussion in DG 11 once more revealed, that in mathematics education, we observe only few studies bridging the gap from the observation of the mathematical thinking of individual students to the mathematical achievement in bigger educational systems. Some of the instances shown in the topics discussed in the group however showed, that such bridges are necessary and fruitful, e.g. when one aims to compare lesson construction in different cultures or when one addresses teachers' or students' beliefs. Thus, a final conclusion of the discussions in the group could be to foster mutual exchange between the "two worlds" of international comparisons.

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