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STUDENTS

Some of the papers reinforced the image that we know from the literature: student knowledge of probability and statistics is disappointing in many countries. Eichler and Vogel developed a framework for analysing tasks' potential to diagnose young students' intuitions or understandings. Sproesser and Kuntze emphasized the importance of language as a mediating tool in learning statistics. Their research suggests that students may have good intuitions but often not the statistical language to express these.

The discussant asked for more prescriptive research that would help us to improve probability and statistics education. There were indeed several papers and posters that presented promising ideas or evaluated interventions (Bakker et al.; Plicht; Schnell; Soto-Andrade).

TEACHERS

Compared to previous working groups on stochastic thinking, this one had a large set of presentations on teachers' knowledge and learning. We consider this encouraging, because the field has produced a lot of insight on student learning, instructional materials and innovative computer software but we still know too little about teaching. The discussant even flippantly wondered if teachers were ready to teach the probability and statistics curricula in most countries.

Again, many presentations underlined the existing image from the literature (which is mostly Anglo-Saxon), that teacher knowledge about probability and statistics is poor. Yet there are directions of research that are encouraging, for example the use of applets (Nascimento et al.) or *TinkerPlots* (Frischemeier and Biehler) in teacher

education. However, Arteaga et al. noted that teachers made more mistakes in graphig with Excel spreadsheets than without; the cause of this needs to be investigated further.

One striking observation is that there are many frameworks on teacher knowledge around. As a group we could hardly remember all the abbreviations concerning pedagogical content knowledge, mathematical and statistical knowledge for teaching. Apparently there is still a long way to go to understand what teachers need to know in order to teach the domain of stochastic thinking. It would be helpful to clarify the different emphases in the different frameworks and over time reach some convergence in terminology.

TERTIARY EDUCATION AND THEORETICAL ISSUES

Cañadas and colleagues highlighted students' problems with association – a topic that has so far received relatively little attention despite its importance in research.

The paper by Primi and Chiesi showed the importance of knowing mathematics for students self-efficacy in statistics education. The relation between mathematics and statistics is indeed one to investigate further.

Andra and Stanja addressed the thorny question of what characterizes stochastic thinking in terms of ideas, symbols and procedures.

GENERAL ISSUES

As commonly necessary in any working group, some time had to be devoted to the discussion of what we mean by particular *concepts*. Variability, statistical thinking, thinking and literacy are a few that returned in our discussions. It also struck us that we do not have conventional language to talk precisely about students' concept formation in flux. Depending on delegates' theoretical backgrounds, they preferred to talk about constructs or conceptions. We also discussed the difference between semiotic and cognitive conflicts.

Because of its applied and non-deterministic nature of stochastics, its link with *context* is crucial. Eckert and Nilsson showed how challenging it can be for a teacher to focus students' thinking on statistical ideas when tackling a contextual problem. Bakker et al. addressed vocational education, where the main focus seems work tasks rather than the statistical ideas behind them. Hauge proposed a more holistic approach to real-life problems that involve risk, which in itself combines probabilistic and contextual aspects. The latter two papers stress the interdisciplinary nature of stochastic thinking.

It was occasionally noted that statistics education is a younger field of research than mathematics education. Many of the issues raised have already been investigated in some related way in mathematics education. However, because of the differences between mathematics and statistics, we cannot always assume that findings from mathematics education research apply equally in statistics education.

FINAL COMMENTS

The group work was much appreciated. Delegates could make themselves well understood in English, even if they normally talked Turkish, Greek, Italian, Spanish, Portuguese, German, Dutch, Norwegian or Swedish. The size of the group was good and participation was not too skewed.

In the last sessions ideas were expressed for a European project and some joint effort in collecting data.

As a group we decided to change our name to *Probability and Statistics Education*. The main reasons are:

1. Though in German *Stochastik* refers to the combination of probability and statistics, stochastics has a rather narrow meaning in most other languages.
2. The new name better captures the broader issues addressed in the working group, not only thinking about also what is involved more generally in realizing better probability and statistics education.