01 PISA 2003 mathematics results in Finland and in Macao: comparisons and observations

In May 2005 the high-level Macao Education Council Delegation visited in the Institute for Educational Research, University of Jyväskylä, which was the Finnish national centre for the PISA 2003 study. During this visit I gave a short presentation in which I compared some mathematics results between Macao and Finland. This brief article sums up the key points made in my presentation. But first I give an overview of the Finnish comprehensive school system, hoping that this would make it easier for the teachers in Macao to discuss the Finnish results.

Features of the Finnish comprehensive-school education

Finland has nine years of compulsory schooling and children generally start school at the age of seven. Usually, for the first six years of comprehensive school, the children are taught by a class teacher, who generally teaches all or at least most subjects. Then, during the last three years, the different subjects are taught by specialised subject teachers. Almost all of the age group (99.7%) complete compulsory schooling.

The school network covers the whole country: there are some 4,300 comprehensive schools in Finland. Comprehensive schools are primarily run by local authorities, with the exception of a few private schools. The government contributes to the financing of all schools. For children, the teaching and educational equipment are free of charge. In addition, the pupils get a free warm meal at school. As a rule, transportation is arranged by the education provider for distances of 5 km and over (for the lowest grades often for shorter distances, e.g. 2-3 km, as well). Presently, the smallest schools have fewer than ten pupils, and the largest ones about 900.

Statutes determine the core subjects which all pupils study, and the government determines the national objectives for education and the number of classroom hours allocated to each subject. At comprehensive schools, all pupils thus study the same core subjects with similar instructional contents. Besides this, learning usually takes place in heterogeneous groups. All this means that the core programme is almost identical to all students. Yet, of all classroom hours about 20 per cent are reserved for optional subjects freely chosen by the pupil and his or her parents. Furthermore, the schools can develop individual profiles by focusing on some area, such as languages, mathematics, natural sciences, sports, music or arts.

Pupils with learning difficulties are entitled to remedial education. Since 1997, educational authorities have been responsible for the education of all children, including those with profound developmental disabilities. The aim is to integrate special-needs education as far as possible into ordinary schools, but there are those who benefit more from separate special-needs education.

There is no actual graduation certificate or qualification to be gained upon completing the comprehensive school, but once a student's compulsory education is over, it opens the way to all secondary education options, i.e. different types of vocational training or upper secondary school.

Comparing mathematics results between Macao and Finland

An overall picture of PISA 2003 mathematics performance shows that Finland and Macao performed very well: both were in the group of nine top-performing countries. The results also show that the percentages of 15-year-old students at different levels of mathematics performance (seven proficiency levels in all) were fairly similar in Macao and in Finland. In Finland only 6 per cent and in Macao 11 per cent of students performed below Level 2. The OECD average was 21 per cent. Correspondingly, 24 per cent in Finland and 19 per cent in Macao performed above Level 4, whereas the OECD average was 15 per cent.

Gender differences in mathematics performance were different in Macao and in Finland. Liechtenstein, Korea and Macao were the countries where performance differences between boys and girls were the largest in favour of boys (in Macao 21 points). In contrast, Finnish boys outperformed girls only slightly: the difference was only 7 points. However, there was a similar tendency in both countries: the percentages of boys were larger than the percentages of girls at the upper levels of mathematics scale (Levels 5 and 6) and the percentages of girls were larger at lower levels of scale (Levels 2 and 3).

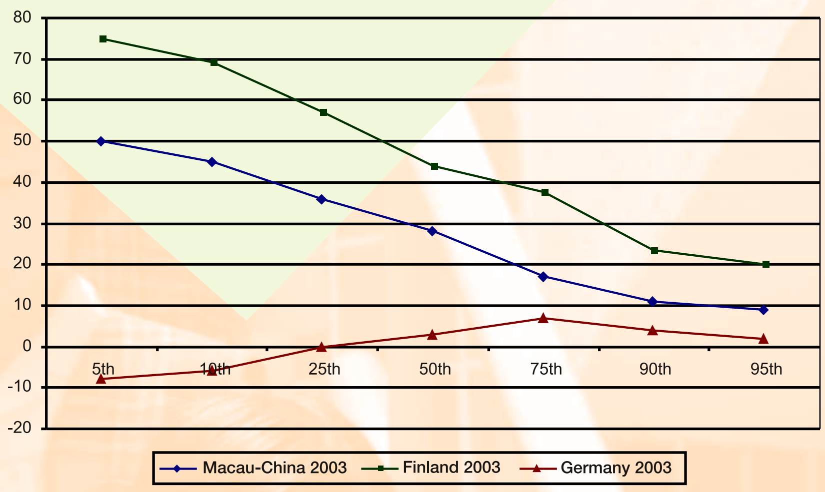

Figure 1. Country percentile scores compared to OECD average percentile scores in PISA 2003 mathematics scale.

The results illustrated in Figure 1 reveal that weaker students both in Macao and in Finland performed especially well compared to the OECD average level (the zero level). We could even say that in Finland it was the weak students who made our excellent result. The scores of the weakest Finnish students (5^{th} and 10^{th} percentile) were about 70 points higher than the respective OECD averages. In Macao the corresponding difference was about 50 points. The scores of best-performing students (90^{th} and 95^{th} percentile) were in Finland only 20 and in Macao only 10 points above the OECD average level. In contrast, the German profile, for instance, is rather even and follows closely the OECD average level.

The PISA 2003 results reveal that both in Finland and in Macao mathematics performance is largely unrelated to the schools in which students are enrolled. The proportion of between-school variance was one of the smallest in Finland (5 per cent) and relatively small also in Macao (19 per cent) compared to the OECD average (34 per cent). This suggests that the learning environment in both countries is similar with respect to effects on the performance of students.

There were interesting results and marked differences between Macao and Finland in students' interest in and enjoyment of mathematics, their self-related beliefs and their emotions related to mathematics. These attitudinal and motivational results are seen important because research show them to influence decisions about enrolment in study programmes or courses where mathematics is an important subject. These decisions also usually shape students' post-secondary education and career choices.

15-year-old students in Macao showed higher interest and enjoyment in mathematics and stronger self-efficacy than students in Finland. On the other hand, Finnish students showed stronger instrumental motivation and stronger self-concept in mathematics than their fellow students in Macao. Furthermore, Figure 2 clearly shows that students in Macao felt much more anxiety dealing with mathematics than Finnish students did. For example, only 7 per cent of students in Finland reported that they get very tense when they have to do mathematics homework

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whereas the corresponding proportion in Macao was 32 per cent. The gender differences in all these attitudinal dimensions were strikingly large in both countries: Girls reported lower interest and instrumental motivation, weaker self-concept and self-efficacy and stronger anxiety in mathematics than boys (the anxiety index for boys in Macao was zero).

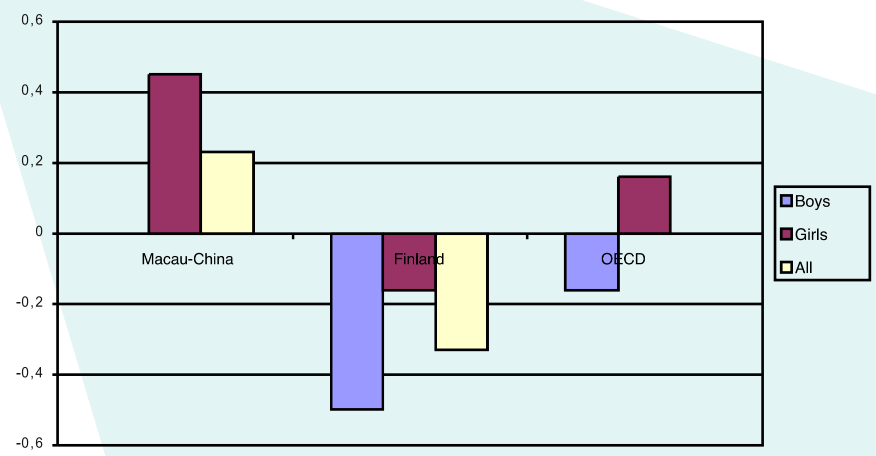


Figure 2. Gender differences in anxiety related to mathematics.

In summary, the comparisons show that there were many similarities but also differences in PISA 2003 mathematics results between Macao and Finland. Both countries performed very well and the proportion of between-school variance was quite small. When all the participating countries were categorised on the grounds of their average student achievement in mathematics and effect of students' socioeconomic background, with relation to the OECD averages, Finland and Macao were placed in the same country category together with Hong Kong (China), Japan, Canada, Australia, and Iceland. These countries had achievements above the OECD average and the effect of socioeconomic background was smaller than in OECD countries on average. This means that parents in these countries can be less concerned about school choice in order to enhance their children's performance and can be confident of high and consistent performance standards across schools in the entire education system.

Some reasons behind the Finnish success in PISA 2003

The results of PISA 2003 show that the Finnish education system has succeeded both in academic terms and in providing relatively high equity among the 15-year-old students. What are the reasons for this success? The analyses of results suggest that there is no single factor behind the high mathematical literacy performance of Finnish students. Rather, Finland's successful performance seems to be attributable to a constellation of interrelated factors. In the following, some of them will be briefly discussed.

The Finnish strategy for building up education has been based on the principle of equity and particularly on an effort to minimise low achievement. As a token of equal educational opportunities, the differences found between schools in Finland proved among the smallest in the OECD. Small between-school variation is also characteristic of all the Nordic countries. This is largely due to the fact that these countries have non-selective education systems where all students are provided with the same kind of comprehensive schooling. In contrast, variation between schools tends to be more pronounced in countries where students are enrolled into different kinds of schools at an early age.

An important part of the explanation lies in the fact that comprehensive school pedagogy differs considerably from the pedagogy applied in parallel systems, characterised by explicit tracking and streaming. The pedagogy has built up to fit to heterogeneous student groups. In comprehensive pedagogy students' own interests and choices are taken into consideration when selecting course contents, textbooks, learning strategies and methods as well as assessment devices. In heterogeneous groups the class size has to be relatively small. Accordingly, PISA shows that in Finland class sizes are among the smallest in the OECD countries.

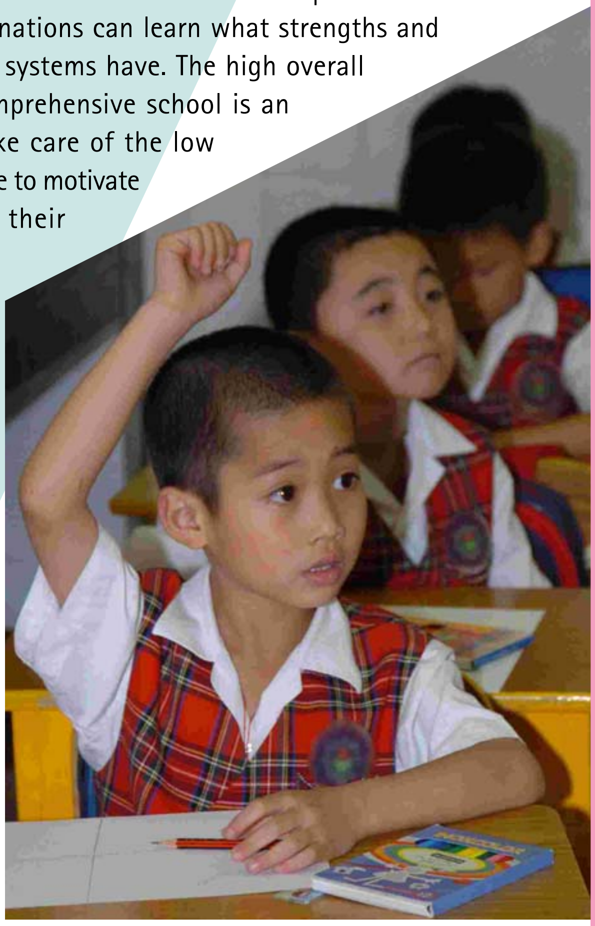
Special education has likewise played an important role in Finnish schools in catering for students who have problems following regular teaching. Special education is usually closely integrated into normal teaching and is highly inclusive by nature. Indeed, only about two per cent of students attend separate special education institutions. In practice, a student with problems in a certain subject or subjects typically has the opportunity of studying once or twice a week in a small group of 2-5 students or even individually with a special teacher.

The systematic development of comprehensive school mathematics curriculum could be seen as a significant explanation for the Finnish success in PISA 2003. Applications and problem solving have been important principles in the Finnish mathematics curriculum work during the last 20 years, and become well established in mathematics teaching practice. Because the PISA programme puts great emphasis particularly on young people's capability to apply their mathematical skills and knowledge in situations that are as authentic and close to daily-life needs as possible, most PISA mathematics items can be considered well suited to Finnish students. Our mathematics curriculum has yielded a lot of experience to students in items of this type.

Finnish mathematics teachers are well educated and highly valued pedagogical experts. All teachers have a master's degree either in educational science or in a teaching subject. A very high ratio of the mathematics teachers working in the schools is professionally qualified. For example, according to the TIMSS 1999 study 91 per cent of the mathematics teachers were qualified. Finnish mathematics teachers also have various opportunities to influence the contents and structure of instruction. They can contribute to the design of mathematics curriculum because the schools and municipalities are responsible for curricular planning and development. Moreover, teachers have a great deal of influence on many essential elements of mathematics instruction: on choosing the textbooks used, what homework and student assessment policies they adopt, and also on determining and organising course contents.

In 1996 the Ministry of Education launched the LUMA programme to promote mathematical and scientific competence. (LUMA is an acronym for the Finnish 'luonnontieteet ja matematiikka', i.e. science and mathematics.) LUMA was a six-year-long project and ended in 2002. The core operation environment of LUMA consisted of a development and information network involving 78 municipalities and 10 training schools. Great efforts were accordingly devoted in the following domains: increasing the number of university student places for mathematics, science, and technology; enhancing teacher training as concerns both subject and pedagogical studies; updating computer hardware and software as well as science laboratory equipment and material at schools; and increasing experimental activities. Even though it is not possible to establish numerically a causal link between the LUMA programme and Finland's mathematics performance, the programme has undeniably opened new educational opportunities and, above all, aroused new faith in and enthusiasm for the development of Finnish mathematics and science education.

All in all, international assessments like PISA produce valuable information through which nations can learn what strengths and weaknesses their respective systems have. The high overall standard of the Finnish comprehensive school is an asset that enables us to take care of the low achievers and at the same time to motivate the top performers to use their learning potential to the full. This kind of situation also offers a fruitful basis on developing mathematics education aiming at even better results.



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