

Mathematics education in Finland – what makes it work?

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Abstract: The achievements of Finnish students in the PISA studies have raised questions regarding possible explanations for the success. Even if the interpretations of the results have to be cautious, there is reason to analyze the characteristics of mathematics education in Finland and Finnish teacher education to search for features that contribute to good performance in tests of the type that the PISA studies represents.

The results

What you see in a measurement is not reality, but a picture of reality. The instrument itself and the words that are used in the interpretation of the results both contribute to that picture. Good results in the PISA studies are not necessarily equivalent to saying that mathematics education in a specific country is functioning the way it should. But the good results show that, in a relative way, the circumstances of that country could be interesting for other countries to consider, if they would like to improve their results in later studies of the PISA type.

The purpose of the PISA studies is related to the concept of literacy. The mathematics scale, specifically, deals with mathematical knowledge and skills necessary for coping in the world of today (“mathematical literacy”), and it differs from mathematical knowledge and skills as tested for instance in the Mathematical Olympiads. The items typically include a fairly long text, but the mathematical complexity is not necessarily very high.

In the 2003 PISA mathematics study, 15-year-old students in Finland scored significantly better than their counterparts in most other participating OECD countries, and were only topped by the non-OECD Hong Kong students. The results of Finland were characterized by high homogeneity. The differences between students in different parts of the country, in different schools, with different socio-economic background, and of different gender were all relatively small. The proportion of students with very weak results was remarkably low. Finland has no history of placing well in international comparisons of achievement in mathematics. However, the results of the PISA 2000 and 2003 studies are quite impressive, and they are further corroborated by similar results in the parallel scales in “ordinary” literacy, in science, and in problem solving (2003 only).

Some background factors were also investigated as part of the PISA 2003 study. It is notable that interest in mathematics is not particularly high in Finland (lower than in all OECD countries except Japan, Austria and Luxemburg). Students’ self-concept in mathematics is about average, whereas mathematics anxiety is lower than in all OECD countries except Sweden, Denmark and the Netherlands.

The investigated cultural patterns harmonize well with earlier knowledge about literacy. (Finns tend to achieve very well in international comparisons of literacy.) For example, in Finland libraries are in frequent use. Reading newspapers and magazines regularly is part of everyday life. It should be mentioned that the Finnish language is pronounced the way it is written, in the very regular way, which makes it easier to concentrate on the meaning of that which is read. Since there are strong correlations between the results on the different scales of the PISA study, these factors are relevant in the interpretation of the results with respect to mathematics.

If, on the other hand, the interpretation is based on the mathematical degree of difficulty, which is comparatively low in the PISA study, it is easy to see that in a country with fairly homogeneous abilities (such as Finland) a larger proportion of the students will pass an “easy” item than in a similar country with less homogeneous abilities among the students.

Part of the interpretation of the PISA mathematics results can thus be made by reference to the very specific purpose and structure of the PISA studies and the type of items that are used. The value of a good result is quite a different thing – it is highly dependent on the status of the study, the publicity given to its results, and its influence on the practice of mathematics education in the near future.

Some features of mathematics education in Finland

Beside the reasons that come out of the study itself, some suggested reasons for the Finnish achievements can be derived from knowledge of the Finnish educational system. This is basically an educational system of a Nordic (Northern European) type. One of its foremost aims is to promote equity in educational opportunity for all population groups and regions of the country. As Finland is a fairly large country with a population of only 5 million, this involves comparatively many educational institutions (comprehensive schools for everyone up to the age of 16, upper secondary schools, vocational schools, universities and other institutions of higher education) and the expenditure for education at all levels is mainly a common concern of the taxpayers.

In accordance with this philosophy, the Finnish comprehensive schools are geared to accommodate the heterogeneity that occurs in the student groups. It calls for a flexible, decentralized system with a large portion of the educational decisions made at the local (or even school) level. The central school authorities (the National Board of Education) do not prescribe curricula, they only provide curricular guidelines, the purpose of which is to safeguard against too many differences between schools and between regions of the country. The main part of the planning is done by the teachers themselves. There is no centralized system for approval of textbooks – variety in this respect is seen as a necessary component for functional autonomy in methods of teaching.

Special education plays an important role in the provision of educational opportunities for the lowest achievers. It is highly integrated into normal teaching – only two percent of the students attend special education institutions. For those attending normal comprehensive schools, careful efforts are made to tailor the support according to the specific educational needs of the student. Mathematics is one of the subjects that need particular attention. The comparatively narrow distribution of the Finnish achievements in the PISA study can be understood against this background of special efforts directed at the weakest achievers. One factor that contributes to making it at all possible is the rather small average size of the classes (as compared with the situation in other OECD countries).

It should also be noted that, in an international comparison, Finland is a country of high cultural homogeneity. There are different language groups (Finnish 94%, Swedish 6%) with their own educational institutions, but the social structure and the system of values are such that there traditionally is wide political and social consensus about educational matters. It is fair to say that education is held in high esteem, both as a basis for national culture and as a basis for the economic security of the individual. Finland has not until recently had any substantial number of immigrants – the situation being quite different in some other OECD countries.

The attitude to mathematics (acceptance of its importance, but in general with rather little personal interest in it) is part of this general picture. The proportion of time devoted to mathematics teaching in the comprehensive school falls short of that in most other OECD countries. However, mathematics and science have recently (1996-2002) been subjects of a nation-wide project (LUMA) that aimed at raising the quality of the teaching (methods, resources) as well as increasing the number of students specializing in those subjects. Whereas the latter goal evidently was not reached, the project introduced new approaches to the teaching of mathematics and science to a large number of teachers, many of whom had completed their subject teacher education long ago, or had had their education as class teachers, with no specialization in the teaching of mathematics. From that time on, there exist

in Finland a number of schools that have adopted the teaching of mathematics and science as their special profile – such an idea was practically unheard of before the LUMA project.

The curricular guidelines that were in effect during the first two PISA studies emphasized problem solving proficiency as one of the primary goals of the teaching of mathematics. This originated in the international research on mathematical problem solving in the 1980s, much of which had made its way to Finnish in-service teacher education. There were also original contributions to problem solving research by Finnish researchers and ideas how to implement such research in classrooms were both developed in Finland and brought in from sources in other countries. This is not to say that Finnish teachers in general had much experience of the kind, but from the perspective of the curricular guidelines the PISA studies, with their emphasis on mathematical literacy and making mathematics useful in practice, came at exactly the right time and fitted the guidelines very well.

At the end of upper secondary school there is an extensive national examination in many subjects, one of which may or may not be mathematics. This high-stakes examination has no counterpart in the comprehensive school, although the National Board of Education at regular intervals has provided national tests in mathematics (for year-6 and year-9 students). Those are not compulsory for the schools to participate in – they serve as benchmarks for the assessment of the achievements of individual students, and also as collections of items or mathematical tasks which show directions in which it might be recommendable to aim in the teaching of mathematics. Such a dual purpose is hard to make efficient. It is indicative of the problems that a decentralized system will have to cope with – combining local autonomy with a reasonable amount of central control. In fact, right after the 2003 PISA study, new curricular guidelines came into effect. In those guidelines the amount of local autonomy has been lessened somewhat. Unfortunately this will confuse the interpretations of the results of the next PISA study.

Characteristics of teacher education in Finland

The high expectations that the Finnish society has on its educational system will not be met unless there is good supply of highly qualified teachers. The high esteem of education means that this is also the case, at least with respect to class teachers (grades 1-6). The recruitment of subject teachers in mathematics (grades 7-12) is somewhat more problematic. But relatively speaking, teaching is a considerably more popular occupation in Finland than in the other Nordic countries with similar educational systems. Teaching is traditionally associated with a respected status in the local community, and it continues to be that way, even if nowadays more teachers than before leave the profession for other careers – possibly with higher pay.

Teacher education in Finland is all university based, including the education of teachers for the preschool years. Class teachers and subject teachers take a master's degree in pedagogy or in one or two teaching subjects – this being part of the requirements for a tenured position. A master's degree involves the production of a master's thesis – and regardless if you major in education or in mathematics, it is possible to choose the theme of the thesis in mathematics education. This kind of basic scientific effort, included in pre-service teacher education, clearly distinguishes Finland from most other countries. The time invested in work on the thesis is considered a good investment, particularly with respect to raising the self-confidence of the teachers. The normal time taken to complete the master's degree, from the beginning of the studies, is five years.

The structure of class teacher education is continually developed, based on interplay of theory and practice. Only about one fourth of the time is spent in compulsory study of the subjects to be taught in school, and out of that approximately one tenth of the time is devoted to mathematics. In addition, students specialize in one or two subjects, which in the case of mathematics means that they will take courses that add up to half the mathematics studied by

subject teachers, or more. The major part of the theoretical studies is in pedagogy, including some research methods needed for the writing of the thesis.

Whereas class teacher education is the responsibility of the faculties of education only, subject teachers are educated in other faculties, with just the pedagogical studies placed in the faculties of education. The pedagogical studies take up less than one fourth of the total time, and they include both theory and practice, as for class teacher students. The mathematics studied by a subject teacher in mathematics is roughly equivalent to two years of full studies – the rest of the time is spent in the study of one or two minor subjects.

Associated with the faculty of education in those Finnish universities that are responsible for teacher education there is at least one “practice school”. These schools form the main basis for the periods of practice that are included in the studies, for class and subject teachers alike. The practice schools give the students ample opportunities to explore their personal style of teaching with the support of the experienced supervising teachers of the practice school. The practice lessons are also meant as opportunities to implement models of teaching encountered in the theoretical studies, and, vice versa, problems encountered in the practice lessons are meant to influence what is analyzed in the theoretical studies. All of this calls for careful cooperation between the teacher educators in the faculty and the practice school, and usually the practice school is located almost next to the faculty buildings. It should be mentioned that the studies also include short periods of “field practice” that are arranged in schools anywhere in Finland.

Clearly, the Finnish system of teacher education is a comparatively expensive one, but it is accepted as such by society. The system was set up in the beginning of the 1970s, and the faculties of education are now stable enough to function as teacher education institutions and research institutions at the same time. Very often individual faculty members are active in in-service teacher education and textbook production as well.

The new teachers are thought to be very competent from their first year of teaching, at least theoretically. They will have an ability to analyze the situations that come up in their teaching, they will have alternative ways of action ready to them, and they will have the ability to choose among the available alternatives. They will know what is expected from them in the way of assessment and support of individual students, and they will have a view of the subject that extends beyond the textbooks.

It is thought that this kind of teachers is the major asset of the Finnish educational system, and if they continue to be met by support from society, they will grow professionally as they add on experience. It is also thought that their influence must be visible in international studies of educational achievements like the PISA studies.

Conclusion

There is little in what has been brought forward that has been established with certainty.

There is no particular one reason for the good Finnish results in the PISA studies – they rather seem to be due to several different contributing factors. If, for instance, one had chosen other indicators of good achievement in mathematics, the result may have looked somewhat different.

The PISA studies are basically comparisons between countries, and so far very few systematic efforts have been made to find causes for the differences that have been found. Comparisons also tend to obscure absolute levels of knowledge, skills and attitudes – Finnish teachers, like teachers everywhere, are continuously disappointed with the achievements of their students.

And even in good results there will pop up indications of things that should be improved.

What about the level of interest in mathematics – what good are nice achievements in the comprehensive schools, if they are not followed up by efforts to go further? Is there room for an additional drive aiming at more inspiring mathematics in the schools, including challenges that are optimized for each student?