Abstract

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The Finnish Education Evaluation Centre assessed the learning outcomes of mathematics in the final stage of basic education in March 2015. The assessment is a part of the evaluation of education as required by Section 21 of the Basic Education Act (628/1998), and its aim is to get a reliable idea about the implementation of the goals specified in the curriculum and about the students' competence level at the end of basic education. There are other important aims for the education policy in the project evaluating mathematical learning outcomes. These include finding out about implementation of equality in education, about support received for education development and about improvement of learning conditions.

The sample selected for the assessment consisted of 140 schools representing all the schools in Finland. Of these, 124 were Finnish-speaking and 16 Swedish-speaking. The results were obtained from a total of 4779 students of 138 schools. There were 4287 Finnish-speaking and 492 Swedish-speaking students in the sample. Of the total sample, 51% (2446) were boys and 49% (2327) girls. In difference to earlier evaluations of learning results for mathematical education between1998 and 2004, this assessment included also the students who had received special intensified support or for whom an individual plan for the organisation of studies (IEP) had been drawn up for the study of mathematics in grades 7–9.

The structure of the assessment is based on mathematics exercises solved by students. In addition, traditionally a student survey, teacher survey and rector survey are added to the evaluations. Mathematical tasks were classified into four task types, namely *multiple choice, mental arithmetic, problem solution and "GeoGebra" tasks*, and into five content areas defined by the basic education curriculum: *algebra, functions, geometry, numbers and calculations* as well as *probability and statistics*.

For the first time in the assessment of learning outcomes for mathematics, all the students completed a part of the mathematics task types and a student questionnaire electronically on a computer. *Multiple choice* or *mental arithmetic tasks* were carried out either as a paper or electronic version and the *GeoGebra tasks* as an electronic version. The solution frequencies of the *GeoGebra tasks* were no taken into account when the total solution frequencies of this evaluation were

scrutinised. The *problem solution tasks* had not been designed into an electronic form. The purpose of the student survey was to obtain student background information and find out about matters related to teaching and study. The aim of the teacher survey was to get information about formal qualifications, work experience, practices and attitudes for teaching mathematics. The rectors in the rector survey told for example about their school's arrangements for mathematics teaching.

The average solution percentage for all the students' tasks was 43% of the total points given for the evaluation tasks. The average solution percentage for both boys and girls was, when rounded, also 43%. Boys dominated girls both among those who scored low and among those who scored high points. The average solution percentage for *multiple choice tasks* was 54%, for *mental arithmetic tasks* it was 52% and for *problem solution tasks* 34%. When the tasks in the 9th grade assessments earlier in 2011 and 2012 are used for comparison, it is fair to say that the level of competence has remained unchanged. The average solution percentages of boys and girls were approximately equal in the *multiple choice* and *problem solution tasks,* but boys were slightly more successful in *mental arithmetic tasks*.

The average solution percentage in *algebra* was 47%, in *numbers and calculations* 46%, in *functions* 43%, in *probability and statistics* 38% and in *geometry* 36%. The average solution percentages of boys and girls were approximately equal in *functions*, in *numbers and calculations* and *geometry*, while girls were more successful than boys in *algebra* and boys more successful than girls *in probability and statistics*.

In Finnish-speaking schools the average solution percentage was 43%, and in Swedish-speaking schools it was 44%. The difference is not statistically significant. The average solution percentages of the students in Finnish- and Swedish-speaking schools were nearly equal in *multiple choice tasks*, but in *mental arithmetic tasks* the Finnish-speaking schools did slightly better than the Swedish-speaking schools. On the other hand, the Swedish-speaking schools were somewhat better than the Finnish-speaking schools in *problem solution tasks*.

In *multiple choice tasks*, students using the paper version succeeded about 2% better on average than students using the electronic version. With the paper version, students' average solution frequency was 55 %, and, with the electronic version, it was 53 %. The difference is statistically significant. The difference between the paper version and the electronic version in case of boys was about 3% and in case of girls 2%. The difference for boys is statistically significant. In Finnish-language schools the average difference between the versions was slightly over 2% and in Swedish-language schools about 1%. The difference between the versions in Finnish-language schools is statistically significant.

In *multiple choice tasks*, students using the paper version succeeded about 4% better on average than students using the electronic version. With the paper version, students' average solution percentage was 54%, and, with the electronic version, it was 50%. The difference is statistically significant. The difference between the paper version and the electronic version in case of boys was about 3% and in case of girls 6%. The differences between the versions are statistically significant for both. In Finnish-language schools the average difference between the versions was slightly

less than 4%, and in Swedish-language schools the difference between the paper and electronic versions was up to 8%. As far as the teaching languages are concerned, the differences between the versions also are statistically significant.

In the *GeoGebra evaluation*, there were two tasks. The average solution frequency in the first *GeoGebra task* was 54%, and in the second it was 26%.

Among the evaluation participants were 95 students whose mother tongue wasn't Finnish or Swedish. The average solution percentage for these students was 41%. Students for whom Finnish was the second language in S2 syllabus and who participated in the evaluation numbered 48. The corresponding solution percentage for these students was 36%.

IEP was drawn up for 158 students at the schools participating in the evaluation. The average solution percentage for these students was 12%. As the number of those studying according to IEP was small, the effect of their results on the frequency percentages on the level of entire material was around one percentage point.

There was some variability in competence around the country, the average solution percentages varying between 40% and 46% regionally. The most successful in the evaluation was Southwest Finland with its 46% solution percentage and the least successful Eastern Finland with the solution percentage of 40%.

There was a clear connection between the student's primary study preferences and the average solution percentages in the evaluation: the average solution percentage for those whose aim was to apply for a secondary school to take a long syllabus in mathematics was 59%, for those choosing a short syllabus in mathematics it was 40% and for those intending to embark on vocational studies 32%. Also in relation to the parents' educational background, the differences in learning outcomes are statistically significant and large even in practice. For the students whose parents' highest education was that provided by a basic school, the average solution percentage was 20% lower than for students whose parents' highest education was provided by a university, higher education institution or university of applied sciences (known as polytechnic in the past).

In mathematics, the average school grade for girls was 7.9 and for boys 7.5. The difference is statistically significant. The correlation coefficient between the average solution frequency and the student's grade in mathematics was 0.73; thus it was fairly strong. The evaluation within schools seems fair, but that is not necessarily the situation between schools. From the viewpoint of becoming selected for further studies, it is alarming that the schools' evaluation practices differ from each other. The grades of students doing equally well but studying in different schools might have a systematic difference of up to two points. This problem has been repeatedly observed in the evaluations of learning outcomes. Based on these results, one should give serious thought to whether the students have an equal standing in joint selection procedures.

In Finland, the differences between schools have been among the lowest in the OECD countries for a long while now. In recent international studies and national assessments of learning outcomes in mathematics, slight increases in the variation between the learning outcomes among schools have been observed.

Most of the teachers (93.6%) had formal qualifications as a teacher of mathematics. Of the teachers, 96% were subject teachers and 3% were class teachers.

The students regarded mathematics as a fairly useful study subject, and their average idea about their own competence was felt to be somewhat positive by them. The boys' conception about their own competence was better, and of statistical significance, than that of the girls. Even though mathematics wasn't a liked subject, the trend nevertheless is more positive in this respect compared with the past evaluations. The differences among the average solution percentages in learning outcomes are statistically significant and in practice large when viewed from the perspective of the student's own idea about one's competence, of liking the study subject and of usefulness of the study subject. The more positive the attitudes towards studying were, the better were the learning outcomes.