Norwegian reports from TIMSS and PISA 2003

TIMSS Trends in International Mathematics and Science Study 2003

IEA

OECD - PISA

Short English versions

INSTITUTE FOR TEACHER EDUCATION AND SCHOOL DEVELOPMENT
UNIVERSITY OF OSLO

Preface

The present document is a short English version of the Norwegian national reports from TIMSS (Trends in International Mathematics and Science Study) and PISA (Programme for International Student Assessment) in 2003. This version contains two chapters from the TIMSS study, the first introductory chapter and the last final summary. In addition the report includes the final chapter from the PISA report summarizing the main findings and analysis.

The Norwegian TIMSS report is written by Liv Sissel Grønmo, Ole Kristian Bergem, Marit Kjærnsli, Svein Lie and Are Turmo. It is translated by Jorun Nylehn and Ann Kristin E. Cockroft Fiske. The Norwegian PISA report is written by Marit Kjærnsli, Svein Lie, Rolf V. Olsen, Astrid Roe and Are Turmo. It is translated by Therese Nerheim Hopfenbeck.

Both the TIMSS study and PISA study were completed by the Department of Teacher Education and School Development within the Faculty of Education at the University of Oslo as requested by the Directorate for Primary and Secondary Education.

TIMSS is an international study, at present covering pupils in the 4th and 8th grades in more than 50 countries. The main objective is to describe and compare the pupils' achievements in science and mathematics. One of the purposes of the national and international comparisons is to find out what factors promote learning and understanding. TIMSS is the most extensive comparative research project in educational topics ever conducted.

PISA is an international study, which in 2003 covered 15-year-olds from 41 countries. PISA assesses to what extent students near the end of compulsory education have acquired the knowledge and skills that are essential for full participation in society.

Please visit our web pages http://www.timss.no and http://www.pisa.no for more information.

Oslo, February, 2006.

Contents

What on earth has happened to science and mathematics?

An extract of the Norwegian report from TIMSS 2003
Short English version

TIMSS
Trends in International Mathematics and Science Study

What on earth has happened to science and mathematics?

How well do Norwegian pupils perform in science and mathematics?

In this report from TIMSS 2003 the achievements of Norwegian pupils in mathematics and the natural sciences are compared to the achievements of pupils in the other participating countries. In addition, the different countries' achievements are compared with the achievements in the 1995 TIMSS report.

How well do Norwegian pupils perform in mathematics?

Mathematics in the 8th grade

Results from the 8th grade mathematics are presented in figure 1.1, which provides an overview of the average level and distribution of the pupils' achievements in mathematics in each country. For an explanation, see text box 1.1.

East Asian countries dominate the top of the list in figure 1.1. The majority of European countries, both Eastern and Western, are situated above the international average. Below this average are primarily countries from the developing world, but also a few European countries, Norway being amongst these. When discussing these results, it is important to consider the significant age differences between the pupils in the different countries. Norwegian pupils are among the youngest, and they have attended school a year less than the majority. However, their achievements are still problematic. Compared to other European countries, Norwegian pupils are nearly the weakest in mathematics.

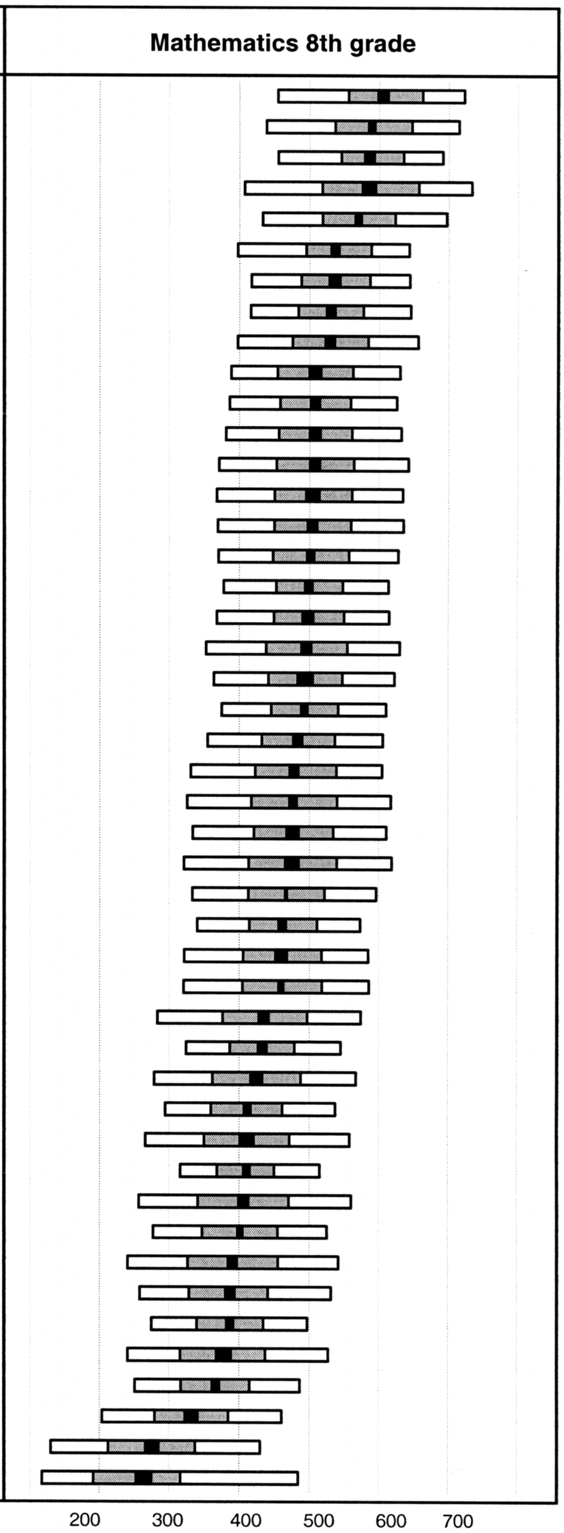
The results shown in figure 1.1 suggest that Norwegian pupils score slightly, but significantly, lower than the international average in 2003, as they did in 1995 as well. Since the actual countries participating are different in the 2003 and 1995 studies, a comparison with the

Text box 1.1 Explanations of figures 1.1, 1.3, 1.5, and 1.7

The average score is given as a three digit number. The scale is standardised by placing the average for all countries in TIMSS at 467 points, and the average standard deviation at 100 points. At the right end of the scale the distribution of the pupils' scores are shown as a diagram which indicates 5-, 25-, 75- and 95- percentiles in addition to a 95 percent confidence interval for the average (two standard errors, SE, in each direction from the average). In addition, the columns give the average age of the pupils, the number of years they have attended school, and the distribution in achievements by means of the national standard deviation.

Why standardise the scale at an average of exactly 467 points? Since a primary goal of the study is to compare the levels achieved in various years as well as to compare the different countries, this standardisation is used in order to give precisely the same scale in 2003 as in the TIMSS 1999 report, where the average for all students was placed at 500 points. A number of the tasks from 1995 and 1999 were also used in 2003, thus it has been possible to apply the same standard in 2003 as in the previous reports. Norway did not participate in 1999 but in 1995, and the standardised scale makes it possible to compare pupils' achievements in 2003 with pupils in the same age group in 1995. It is important to note that even if the international distribution of scores has a standard deviation of 100 points, the average national standard deviation is much lower.

Country	Age	Years at sch.	Score
Singapore	14,3	8	605
Korea	14,6	8	589
Hongkong	14,4	8	586
Chinese Taipei	14,2	8	585
Japan	14,4	8	570
Belgium (Fl)	14,1	8	537
Netherlands	14,3	8	536
Estonia	15,2	8	531
Hungary	14,5	8	529
Malaysia	14,3	8	508
Latvia	15,0	8	508
Russian Fed.	14,2	7 or 8	508
Slovak Rep.	14,3	8	508
Australia	13,9	8 or 9	505
United States	14,2	8	504
Lithuania	14,9	8	502
Sweden	14,9	8	499
Scotland	13,7	8	498
Israel	14,0	8	496
New Zealand	14,1	8 or 9	494
Slovenia	13,8	7 or 8	493
Italy	13,9	8	484
Armenia	14,9	8	478
Serbia	14,9	8	477
Bulgaria	14,9	8	476
Romania	15,0	8	475
Int. average	14,5		467
Norway	13,8	7	461
Moldova, Rep.	14,9	8	460
Cyprus	13,8	8	459
Macedonia	14,6	8	435
Lebanon	14,6	8	433
Jordan	13,9	8	424
Iran	14,4	8	411
Indonesia	14,5	8	411
Tunisia	14,8	8	410
Egypt	14,4	8	406
Bahrain	14,1	8	401
Palestinian N.	14,1	8	390
Chile	14,2	8	387
Morocco	15,2	8	387
Philippines	14,8	8	378
Botswana	15,1	8	366
Saudi Arabia	14,1	8	332
Ghana	15,5	8	276
South Africa	15,1	8	264



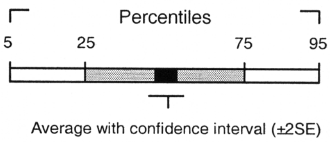


Figure 1.1
Main results in 8th grade mathematics for all countries. See text box 1.1 for explanation.

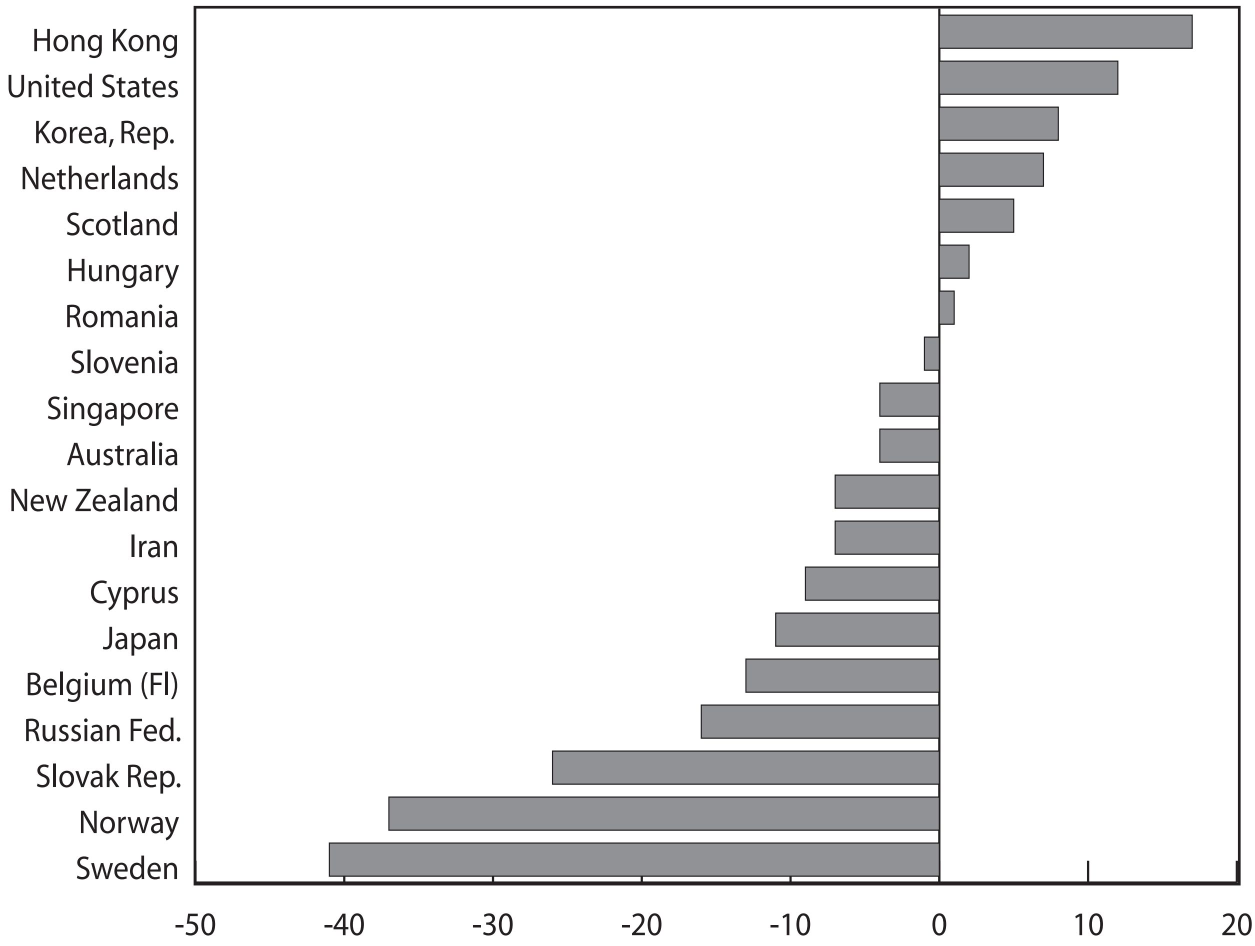


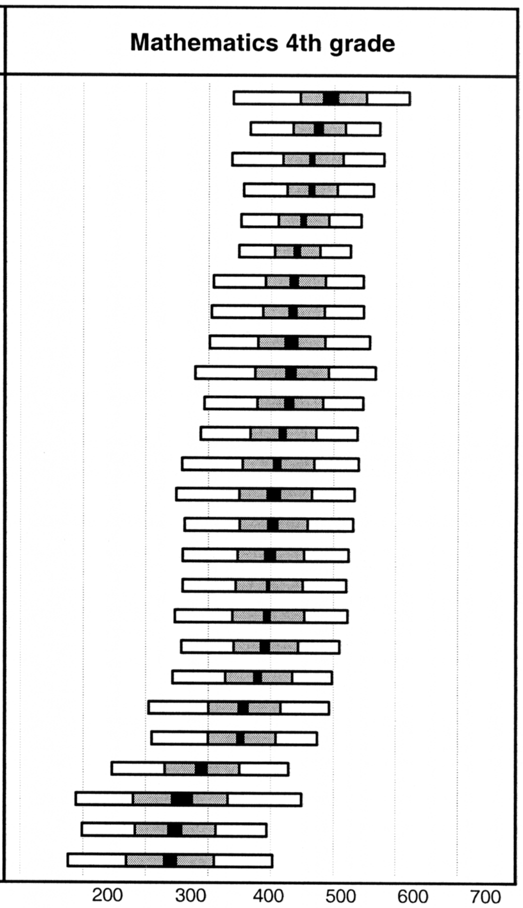
Figure 1.2
Changes in the 8th grade mathematic scores from the 1995 TIMSS report to the 2003 TIMSS report for the countries where the comparison is viable.

"international average" is inadequate. In 2003, there are more participating countries, especially developing countries, than there were in 1995. A more interesting task would be to study how well Norwegian pupils perform in 2003 compared to 1995. Pupils that are both the same age and have attended school the same amount of time were tested in the 8th grade in 1995 and 2003. (Pupils attending the 8th grade in 2003 are in their 7th school year, due to the 1997 Norwegian School Reform, where these pupils skipped a grade.)

Based on tasks included in both 1995 and 2003, it has been possible to provide reliable calculations for determining if achievements have changed and in which direction. These results are given in figure 1.2. Improvements from 1995 in pupil achievement are presented as a column pointing to the right, while a column pointing to the left represents a decline. The margins of error are between 5 and 10 points. Countries that tested pupils with more than a ½ year difference in the average age from 1995 are not presented.

In a few countries the pupils score clearly better in 2003 than in 1995, especially Hong Kong and the United States (figure 1.2). In other countries the pupil's mathematic achievements have clearly worsened. Sweden and Norway are the two countries with the largest setback in pupil achievements from 1995 to 2003. Combined with the generally weak Norwegian results from 1995, a further decrease in 37 points is alarming. The TIMSS study in 1995 was carried out on two following grades, and the average advance during one grade was approximately 40 points. In other words, today's pupils are placed nearly an entire school year behind the level in 1995.

Country	Age	Years at sch.	Score
Singapore	10,3	4	594
Hongkong	10,2	4	575
Japan	10,4	4	565
Chinese Taipei	10,2	4	564
Belgium (Fl)	10,0	4	551
Netherlands	10,2	4	540
Latvia	11,1	4	536
Lithuania	10,9	4	534
Russian Fed.	10,6	3 or 4	532
England	10,3	5	531
Hungary	10,5	4	529
United States	10,2	4	518
Cyprus	9,9	4	510
Moldova	11,0	4	504
Italy	9,8	4	503
Australia	9,9	4 or 5	499
Int. average	10,3		495
New Zealand	10,0	4 or 5	493
Scotland	9,7	5	490
Slovenia	9,8	3 or 4	479
Armenia	10,9	4	456
Norway	9,8	4	451
Iran	10,4	4	389
Philippines	10,8	4	358
Morocco	11,0	4	347
Tunisia	10,4	4	339



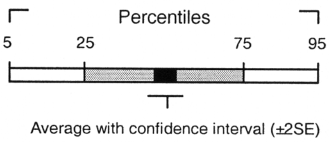


Figure 1.3
Main results in 4th grade mathematics for all countries. See text box 1.1 for an explanation.

Mathematics in the 4th grade

Equivalent results for the 4th grade are given in figure 1.3. As with the 8th grade, we have tested pupils with similar ages in 1995 and 2003. However, as opposed to the pupils in the 8th grade, the pupils in the 4th grade have attended school a year more in 2003 than the equivalent age group had in 1995. This means that pupils in Norway attend the same grade as pupils with the same age in nearly all the other countries.

Results for the 4th grade in each country are shown in figure 1.3. An explanation is given in text box 1.1. Norwegian pupils in the 4th grade are placed even lower compared to the international average than pupils in the 8th grade (figure 1.3). Even though the average age varies quite a lot from country to country, the number of years of school attendance is quite similar. Due to the situation in a number of developing countries, years of school attendance have played a more decisive role than age when selecting pupils. Still, age is the basis for the official definition in the TIMSS 2003 report. The international average for this school grade has declined from 524 in 1995 to 495 in 2003, while the average age for the pupils has increased. This is of course connected to which countries participating in 1995 and 2003.

As is the case for the older pupils, the East Asian countries dominate the top of this list. Similarly, the majority of European countries are situated above the average. Most noticeable in regards to Norway is that in the TIMSS report our country is associated with countries we

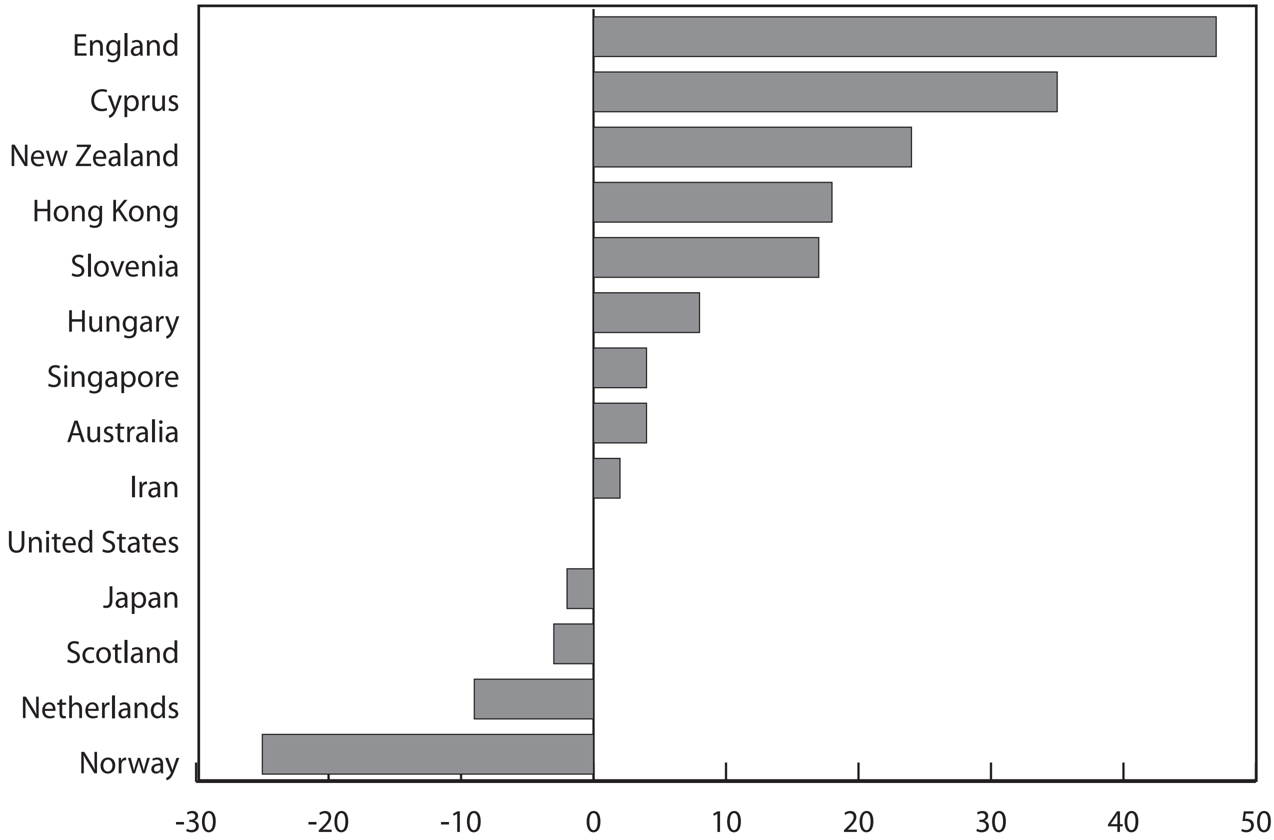


Figure 1.4
Changes in the 4th grade mathematics scores from the 1995 TIMSS report to the 2003 TIMSS report for the countries where such a comparison is viable.

don't usually compare ourselves to. There may be good reason to ask why this has happened. The Norwegian results seem sensationally weak. As with the 8th grade, it is natural to study how achievements in the 4th grade in the various countries have changed from 1995 to 2003. Figure 1.4 shows this development for the countries that have tested pupils at approximately the same age for both studies. The margin of error varies somewhat from country to country, but is roughly between 5 and 10 points.

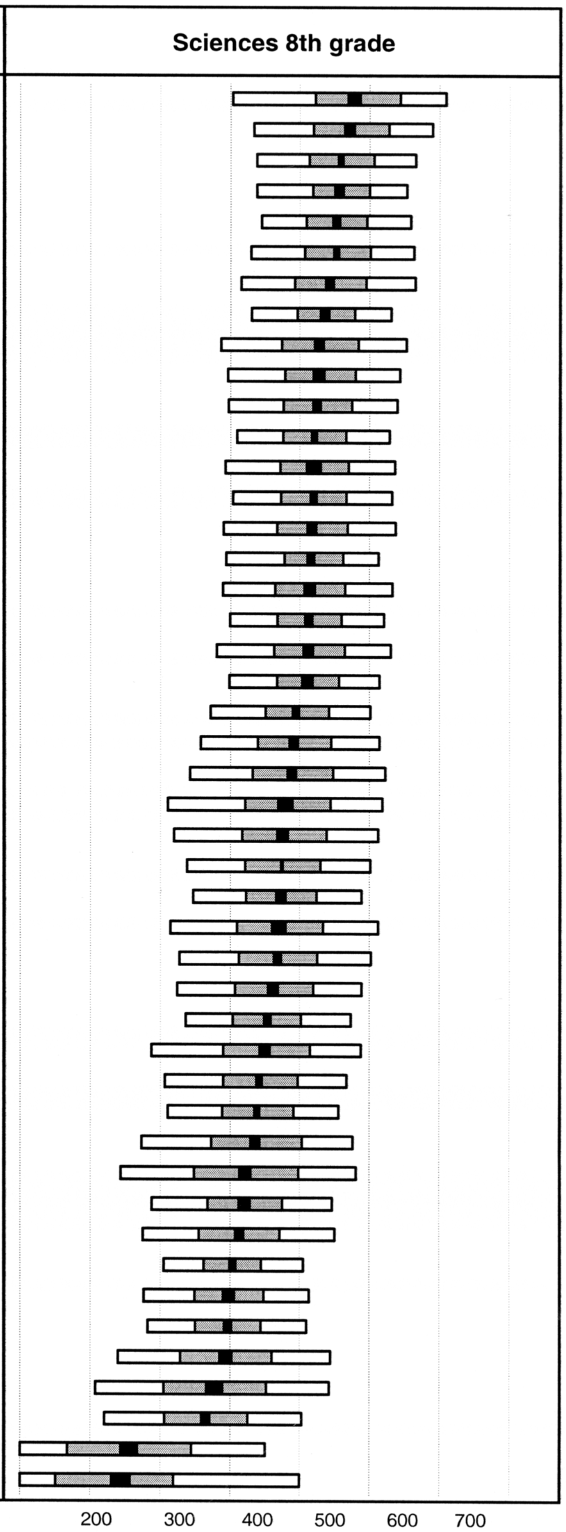
Clearly, many countries score better in 2003 than they did in 1995 (figure 1.4). Only two countries' achievements decrease significantly, the Netherlands and Norway. Concerning Norway the decline seems almost catastrophic, especially in connection with the already weak Norwegian results in 1995. A conclusion regarding 9-years olds at that time was; "*It seems as though Norwegian pupils suffer from having attended school one year less*" (Brekke et al. 1998, p. 121). In 2003 4th graders with the same age were tested, who have attended school one year *more* than the pupils tested in 1995. Thus the significant decrease is dramatic and unfortunate. To give an impression of how much a decline of 25 points actually represents, we point to the fact that in the 4th grade in the 1995 TIMSS report, one year's schooling equalled on average about 60 points in improvement on the same scale. Put simply, our pupils in 2003 have attended school one more year, but still lie approximately half a year behind in their academic development compared to the situation 8 years earlier.

How well do Norwegian pupils perform in the natural sciences?

The natural sciences in the 8th grade

Average scores for 8th grade pupils in the natural sciences from each of the participating countries are illustrated in figure 1.5. Seemingly the

Country	Age	Year at sch.	Score
Singapore	14,3	8	578
Chinese Taipei	14,2	8	571
Korea	14,6	8	558
Hongkong	14,4	8	556
Estonia	15,2	8	552
Japan	14,4	8	552
Hungary	14,5	8	543
Netherlands	14,3	8	536
United States	14,2	8	527
Australia	13,9	8 or 9	527
Sweden	14,9	8	524
Slovenia	13,8	7 or 8	520
New Zealand	14,1	8 or 9	520
Lithuania	14,9	8	519
Slovak Rep.	14,3	8	517
Belgium (Fl)	14,1	8	516
Russian Fed.	14,2	7 or 8	514
Latvia	15,0	8	512
Scotland	13,7	8	512
Malaysia	14,3	8	510
Norway	13,8	7	494
Italy	13,9	8	491
Israel	14,0	8	488
Bulgaria	14,9	8	479
Jordan	13,9	8	475
Int. average	14,5		474
Moldova	14,9	8	472
Romania	15,0	8	470
Serbia	14,9	8	468
Armenia	14,9	8	461
Iran	14,4	8	453
Macedonia	14,6	8	449
Cyprus	13,8	8	441
Bahrain	14,1	8	438
Palestinian N.	14,1	8	435
Egypt	14,4	8	421
Indonesia	14,5	8	420
Chile	14,2	8	413
Tunisia	14,8	8	404
Saudi Arabia	14,1	8	398
Morocco	15,2	8	396
Lebanon	14,6	8	393
Philippines	14,8	8	377
Botswana	15,1	8	365
Ghana	15,5	8	255
South Africa	15,1	8	244



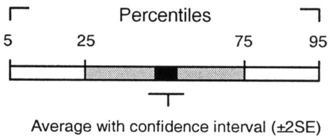


Figure 1.5
International results for 8th grade natural sciences. See text box 1.1 for an explanation.

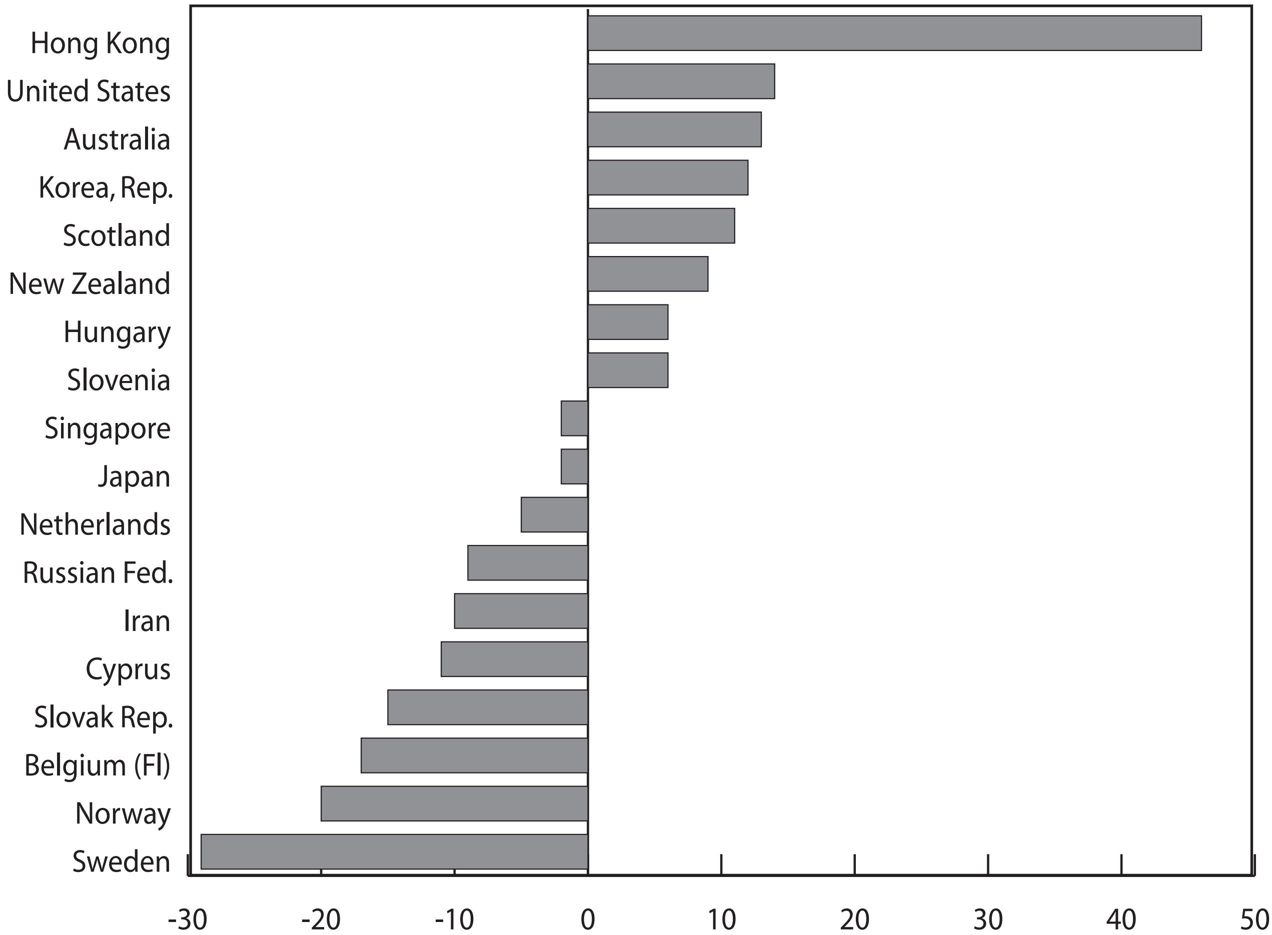


Figure 1.6
Changes in the score for 8th grade natural sciences from the 1995 TIMSS report to the 2003 TIMSS report for the countries where such a comparison is viable.

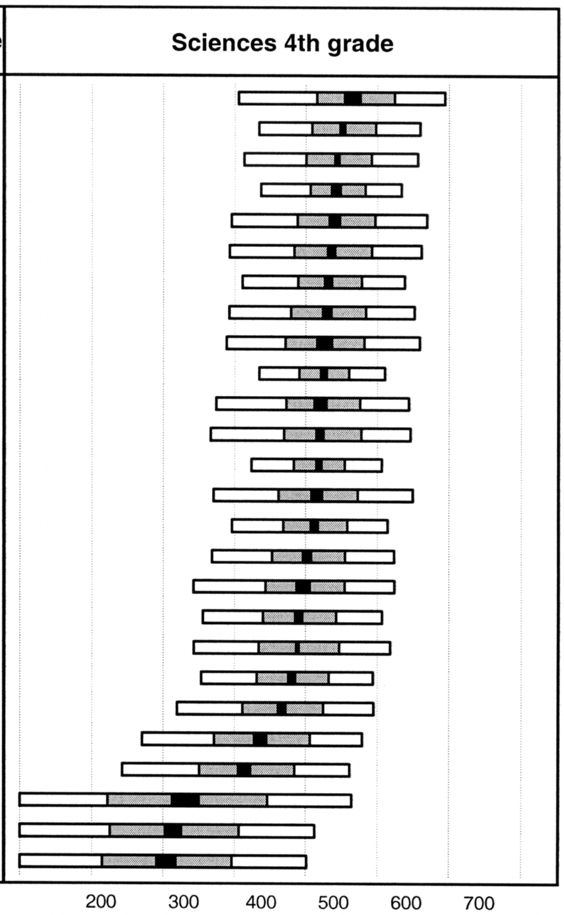
Norwegian pupils also show low performance in the natural sciences, though not as poorly as in mathematics. The Norwegian pupils score approximately 20 points above the international average, but nevertheless lower than those countries Norway would expect to be comparable to. It is important, however, to take into consideration age and number of years of school attendance. Norwegian pupils are relatively young, and as opposed to the majority, they have only attended school for seven years.

As with mathematics, East Asian countries dominate amongst the highest scores (figure 1.5). Singapore also had the highest score in the 1995 TIMSS report; Japan and Korea were also among the best at that time. Once again the majority of European countries score above the average, as they did in 1995.

In the following we aim to compare the results in the natural sciences from the 2003 TIMSS report with the 1995 results for pupils in the same age group. The differences between the average scores in the two reports are given in figure 1.6. Countries performing better in 2003 have columns pointing to the right. The countries are sorted by their progression, which does not reflect the average score of each country. The margin of error varies from country to country, but it is mostly between 5 and 10 points. Only countries that participated both years and where the pupils' average ages don't deviate with more than half a year, are included.

As is the case with mathematics, Norway and Sweden show the largest decline. However, the decrease in points is not as significant as with mathematics. In this particular case, the decline

Country	Age	Years at sch.	Score
Singapore	10,3	4	565
Chinese Taipei	10,2	4	551
Japan	10,4	4	543
Hongkong	10,2	4	542
England	10,3	4	540
United States	10,2	4	536
Latvia	11,1	4	532
Hungary	10,5	4	530
Russian Fed.	10,6	3 or 4	526
Netherlands	10,2	4	525
Australia	9,9	4 or 5	521
New Zealand	10,0	4 or 5	520
Belgium (Fl)	10,0	4	518
Italy	9,8	4	516
Lithuania	10,9	4	512
Scotland	9,7	4	502
Moldova	11,0	4	496
Slovenia	9,8	3 or 4	490
Int. average	10,3		489
Cyprus	9,9	4	480
Norway	9,8	4	466
Armenia	10,9	4	437
Iran	10,4	4	414
Philippines	10,8	4	332
Tunisia	10,4	4	314
Morocco	11,0	4	304



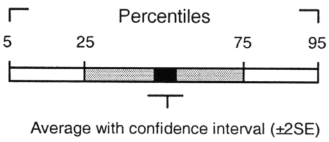


Figure 1.7
International results for 4th grade natural sciences, see text box 1.1 for an explanation.

indicates that pupils at present time are half a year behind the 1995 level. Hong Kong demonstrates great improvement, which is most probably due to their comprehensive study plan reform of the natural sciences. In Norway there has also been a comprehensive reform, but with very different results.

The natural sciences in the 4th grade

Equivalent results for the 4th grade are given in figure 1.7. As for the 8th grade, there is again a clear dominance of East Asian and European countries among the highest scores. Norwegian pupils did score significantly lower than the international average; in fact, Norway has the lowest score in Europe. As in mathematics, the Norwegian 4th graders' scores are dramatically weak.

The average scores of pupils having the same age in the 1995 and 2003 studies were compared, and the differences are given in figure 1.8. The countries are sorted by the extent of change; columns facing to the right indicate a positive progression. Countries with a large change in average age are not included in the figure. The first thing one notice is how the Norwegian results declined quite dramatically and by far more than any other country. Considering that pupils have attended school for one more year, the results are amazing. A decrease of nearly 40 points is more or less the equivalent to 4th grade pupils in 2003 being almost one year behind pupils of the same age in the 3rd grade in 1995.

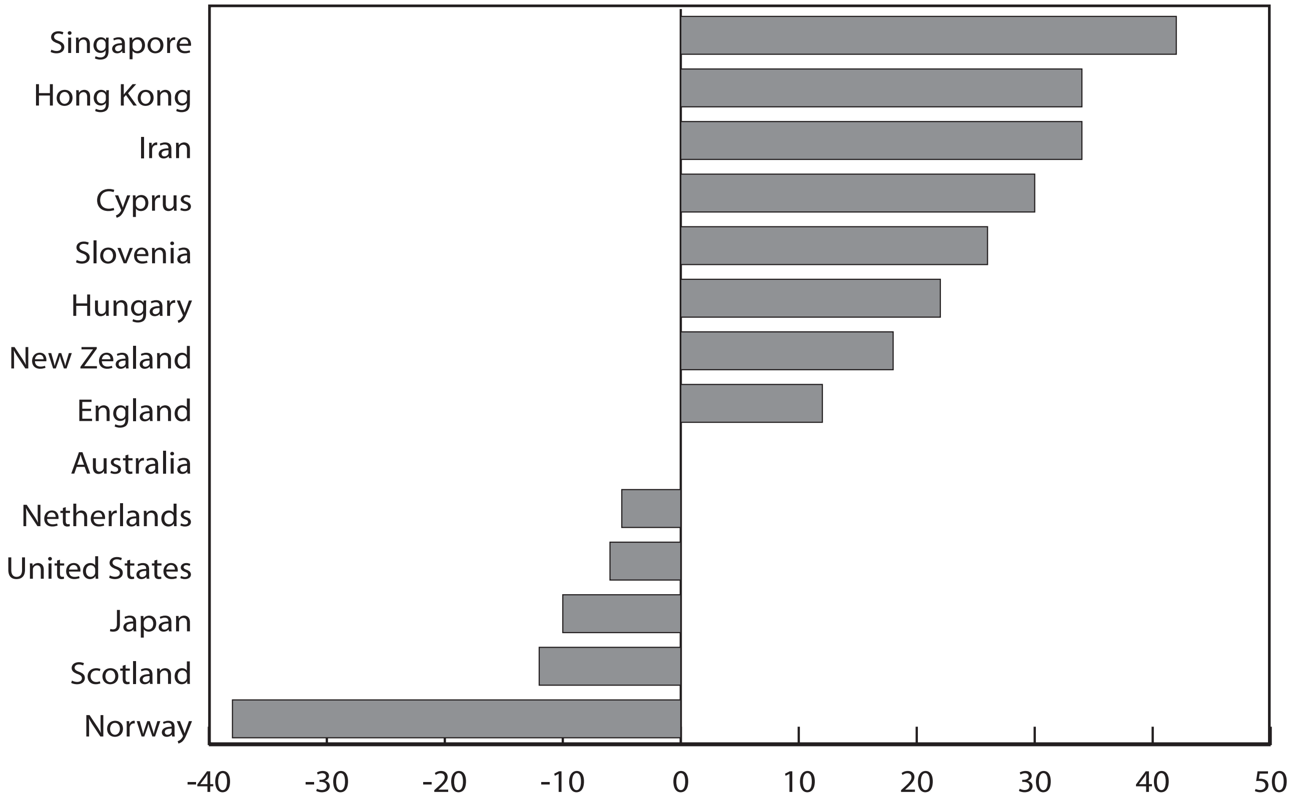


Figure 1.8
Changes in the 4th grade natural sciences scores for the from the 1995 TIMSS report to the 2003 TIMSS report for the countries where such a comparison is viable.

Summary

A worrying picture is presented concerning Norwegian pupils' knowledge of mathematics and the natural sciences in 2003. As we have seen, a number of countries score significantly better in 2003 than in 1995, while the pupils in Norway quite clearly achieve less at both grades and in both subjects. However, there are other relatively high achieving countries that also experience a decline. For a high achieving country a small decline in one of the grades is not especially problematic. Norway appears to have a far greater problem, where the results are clearly negative at both levels. In addition, this represents a decrease from a level that already in 1995 was considered weak when compared to other countries (Lie et al. 1997 a, b). This has happened in spite of the fact that our 4th graders have spent one more year in school in 2003 than in 1995. The same negative tendencies are found in the PISA 10th grade report (Kjærnsli et al. 2004).

Another characteristic indicated by the international results concerns the distribution of achievement in each country. This is illustrated by the width of the columns at the right of the figures and of the column with standard deviations. In our country, the achievement distribution is average in the 4th grade, while it is a little below average in the 8th grade. Since equality in education is a major goal in Norwegian school politics, we might have expected the distribution to be significantly lower than the international average. However, the results of the present study is not much different from the 1995 TIMSS results (Lie et al. 1997a, b) or from the natural sciences in the 2000 PISA report (Lie et al. 2001) and the 2003 PISA results (Kjærnsli et al. 2004).

Most striking for Norway is the clearly negative picture we are presented regarding the pupils' knowledge and skills in the natural sciences. We need an in-depth debate concerning this issue. There may have been many contributing factors, and we warn against drawing too categorical conclusions. We have already mentioned that Norwegian pupils are younger than pupils in many other countries. This argument is, however, irrelevant when comparing the Norwegian results in 2003 with the results of 1995. Both times we have tested pupils in similar average age groups, and the only difference has been that the pupils in 2003 had attended school for one more year in the 4^{th} grade. Our pupils' achievements and international placing is reason for concern, but it is the clear decline in achievements in both grades from 1995 to 2003 which is most problematic. The fact that Norwegian pupils perform markedly worse in both grades and in both subjects in 2003 than they did in 1995, illustrates a considerable problem, well worth considerable efforts in our attempts to understand why.

Summary, conclusions, and interpretations

Initially we will provide an overview of the most important results. This overview will serve as a prelude to the following discussion.

Summary of results

Our main findings are summarized as the following:

Chapter 1

In mathematics, Norwegian pupils in the 4th and 8th grade achieve less than the average and perform far worse than the countries we like to be compared with. In the natural sciences our pupils in both grades achieve an average score, but still performed worse than those countries we would like to be compared with.

Since 1995 there has been a significant decline for both age groups and in both subjects. We could claim Norwegian pupils at present lie between six months and a year behind the level of pupils at the same age in 1995.

Chapter 4

We find no significant gender differences in Norway in regards to achievements in mathematics. This varies internationally, with the average gender difference for all countries being approximately equal to 0.

Norwegian pupils, in both the 4th and 8th grades, are ranked at the top in data representation and at the bottom in numbers and algebra/patterns. This corresponds well with the results of the 1995 TIMSS study.

The results from the task examples support the fact that it is especially in formal mathematics that Norwegian pupils do poorly. This is true for being capable of using the four basic arithmetical operations on whole numbers in the 4th grade and decimal numbers in the 8th grade.

Chapter 6

In the 8th grade there are small, although significant, gender differences in favor of boys, both in the natural sciences in Norway and in the international average. In the 4th grade the differences are less and favor the girls, but they are not significant in Norway or for the international average

In the 8th grade Norwegian pupils perform relatively best in the earth sciences but they are ranked at the bottom in physics and chemistry. In the 4th grade they perform relatively best in life sciences and worst in physics/chemistry, which in the 4th grade is a combined subject.

There is ample variation between the various subject areas. In the 8th grade the largest variations in gender are in the earth sciences, where the boys score better than the girls. The Norwegian boys also score better in chemistry, physics, and environmental sciences, while girls score better in life sciences. In the 4th grade the differences are less, and Norwegian girls score better than the boys in all three subject areas.

Chapter 7

Norwegian pupils are represented by almost average positive attitudes towards mathematics and the natural sciences in the 4th grade, but they rank considerably below the average in the 8th grade. In the 8th grade one can trace more positive attitudes towards the natural sciences and less positive towards mathematics than those found in the 1995 TIMSS study.

Pupils mark a higher interest in the natural sciences than in mathematics, but mathematics is considered a subject that is more important to master than the natural sciences.

Seen from an international perspective Norwegian pupils demonstrate a high degree of self-confidence in the natural sciences. Considering the results of this report, this may be characterized as being quite unrealistic, and is most likely a result of the fact that these pupils have not been subject to academic challenges.

In the 8th grade the boys are more positive towards, and more confident of their abilities in the natural sciences than the girls. In the 4th grade the girls are more positive towards the natural sciences, while the gender differences regarding self-confidence are minimal.

Chapter 8

Norwegian mathematics teachers maintain a generally high level of education, but their academic training in mathematics particularly is low. It is striking how few Norwegian mathematics teachers participate in continuing- and further education courses of relevance to the teaching of mathematics.

In Norway, 8th graders have the same amount of average teaching time dedicated to mathematics as is the international average. 4th graders in Norway receive considerably less than the average.

The teaching of mathematics in Norway is not characterized by a few thorough themes. In Norway, mathematics is to a lesser extent associated with daily life than is the international norm.

The teaching of mathematics in Norway is characterized by pupils, to a large extent, working individually with tasks. Norwegian pupils spend less time listening to the teachers' explanations than the international average.

Access to computers for the teaching of mathematics is good in Norway; however, they are seldom used.

Chapter 9

Norwegian natural science teachers maintain a generally high level of education, but their academic training in the natural sciences particularly is low. It is striking how few of the Norwegian natural science teachers participate in continuing- and further education courses that are relevant to the teaching of the natural sciences.

In Norway, 8th graders have the same amount of average teaching time dedicated to the natural sciences as is the international average. 4th graders in Norway receive considerably less than the average.

In the Norwegian teaching of the natural sciences a relatively large amount of time is spent on earth sciences and a relatively small amount of time is spent on physics compared to what is the international norm.

There is less experimental teaching conducted in Norway than the international average.

From an international perspective, Norwegian teaching of the natural sciences is characterized by pupils working individually with problem solving to a much greater degree than is the international norm.

Chapter 10

The results from the TIMSS study regarding the connection between family background and academic scores comply with the results from both the previous TIMSS and PISA studies.

Considering the connection between cultural resources and academic achievements, Norway is not portrayed as being especially weak in relation to the international perspective.

Norway is characterized by weak connections between a pupil's academic performance and his or her economic background.

Connections among results, teaching, and curriculum

Intended, implemented, and attained "curriculum"

In each subject area, results from the 8th grade are compared with how well this subject area is covered in L97, and with how thoroughly the area is treated in the actual teaching.

The framework for TIMSS (Mullis et. al., 2003, p. 3) describes these three aspects of a curriculum:

- The intended curriculum: What pupils are supposed to learn, based on the wording in the formal curriculum, in our case L97.
- The implemented curriculum: What pupils are "offered" in the way of teaching.
- The attained curriculum: What pupils actually learn.

TIMSS compiles data from all three levels, and here we would like to compare them based on the 8th grade data. For each of the subject areas where there is data, the Norwegian results are compared with how much emphasis L97 puts on that particular subject and how much time is spent in the actual teaching of it in schools.

The international TIMSS framework offers for each subject area a detailed description of the topics included in that area. As a measurement of the intended curriculum, the national project groups investigated which of the subject areas in the overall framework that were covered by the country's formal curriculum up to and including the given grade. Concerning the implemented curriculum, teachers have indicated which of these subjects have been taught during the 8th grade (including a stipulation of the remaining school year).

A comparison of the three levels

Connections among the three levels of the 8th grade curriculum are illustrated in figures 11.1 and 11.2. These figures are only meant to illustrate correlations. The actual numbers must not be read literally, since they do not represent quantities. It only makes sense to investigate the form of the three graphs. Results are indicated by the national score minus the international average in each subject area. As for the intended and the implemented level, the percentages of the given topics in TIMSS which are covered by L97 and taught respectively, are represented. Since there are so few topics in environmental studies, this percentage is not especially noteworthy and we have therefore chosen not to provide curricular data for this topic.

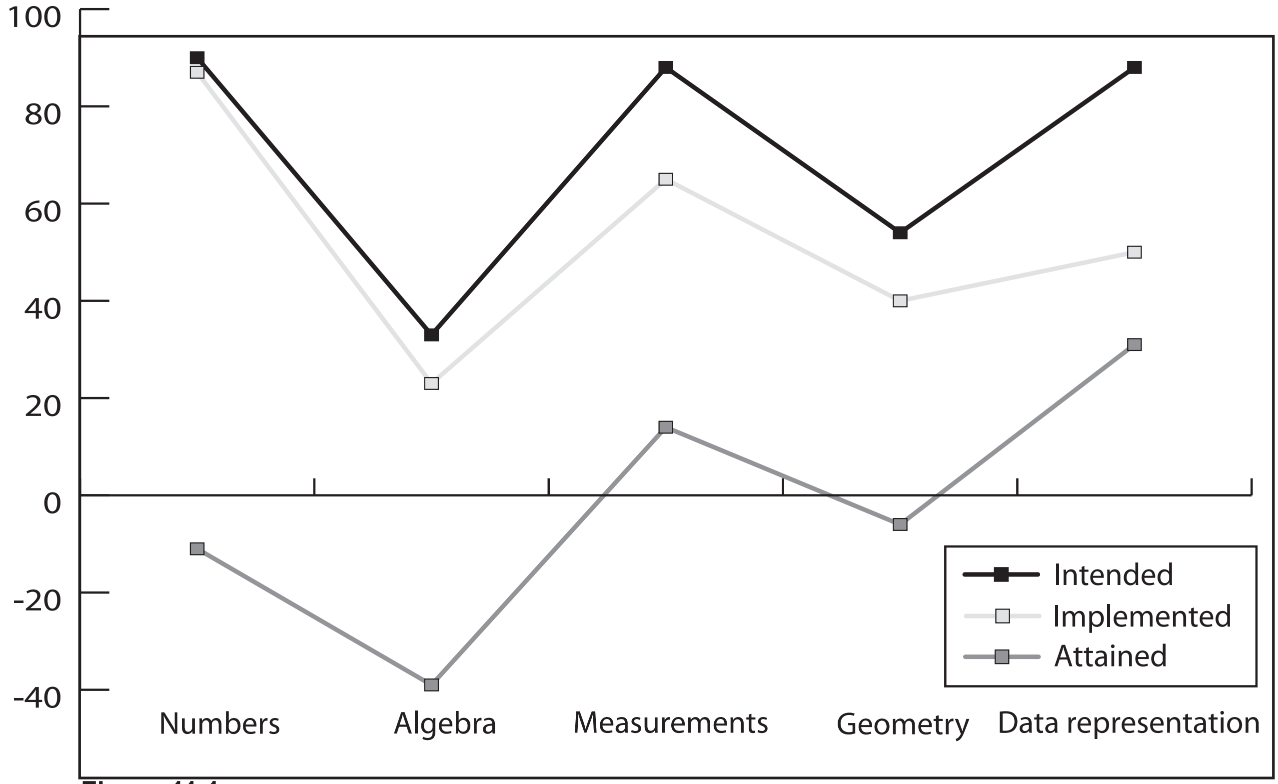


Figure 11.1
A comparison of intended, implemented, and attained curriculum for 8th grade mathematics. See text for an explanation.

Figures 11.1 and 11.2 illustrate a number of interesting points. First and foremost it is clear that Norwegian pupils score relatively well in subject areas where a lot of the topics are covered by L97, and are given a lot of teaching time in the 8th grade. It might seem odd that teaching in the 8th grade is of such importance, but to a certain extent the distribution between subject areas also mirror typical tendencies in the 6th and 7th grade. However, it is not unexpected that pupils score relatively well in subjects that are emphasized the most. This confirms a few rather obvious facts – namely that teaching is beneficial, and that one improves in the areas one works at. We are, however, not given a solution for how to improve the academic level as a whole.

The academic priorities forming the graph's representation are based on a view that the natural sciences are especially directed towards perspectives and applications in day-to-day life and society; this is in line with the general part of L97. The only facts that seem to contradict this, are the low scores Norwegian pupil receive in environmental studies. Even the name of the course in primary school, natural- and environmental studies, seems to indicate that Norwegian pupils should be at an advantage. When this appears not to be the case, the explanation given is that environmental studies are quite simply not prioritized, neither in the academic aims of the subject or as a specified main point in the plan. In an international context, the name of the subject is simply deceptive.

Another clear signal provided from the figures is that in Norway mathematics is obviously in a worse position than are the natural sciences. The mathematics tests do not seem worse than those of the natural sciences, if judged from how well the tests correspond with the emphasis put in the curriculum and in teaching. Such a correlation

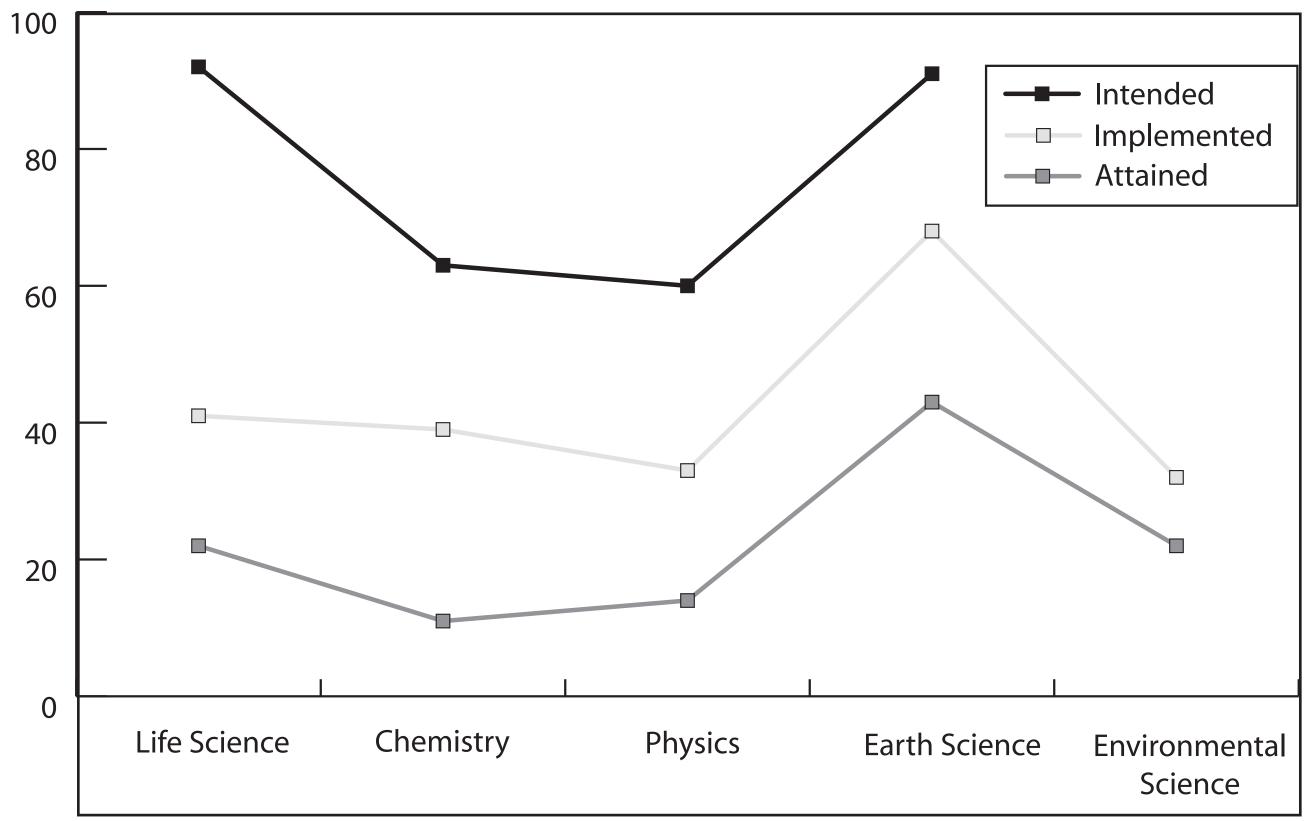


Figure 11.2
A comparison of intended, implemented, and attained curriculum for 8th grade natural sciences.
See text for an explanation.

is nevertheless rather superficial, since each subject may be treated on different levels, and it is obvious that pupils have low scores in important areas despite the fact that many of the areas have been taught. In many contexts they are prioritized at a lower level than a number of the tasks would presuppose. Further, the capability of analytical reasoning is an underlying factor that is challenged by a majority of the TIMSS-tasks; this is not particularly related to a specific topic. The data presented in the figures do not offer an explanation as to which extent teaching manages to encourage this factor.

In mathematics, the weakest results are in algebra, the most formal part of the subject, which is a clear consequence of deliberate prioritizing. Results in the subject of calculation are certainly better, but nevertheless it is here that the gap between intentions and results seems to be the largest. The relation between formal knowledge and the use of mathematics will be a topic in the closing discussion of this report.

The data therefore demonstrate the fact that the implemented and the intended curriculum to a large extent explain the *structure* of the Norwegian achievements. But they do not offer a good explanation as to the general achievements in each of these two subjects. Norwegian schools do not have a low teaching ratio in the natural sciences in the 8th grade. We are not able to explain why Norwegian pupils do not score higher than they do in total by studying the distribution of the subjects that are taught. It is therefore necessary to focus on the type and quality of teaching in the following chapter, more specifically, how it is conducted, and the learning conditions created.

TIMSS as an assessment of Norwegian schools

It is impossible to assess whether many of the numerous goals in L97 are accomplished or not, or to which extent. In an international study the comparative perspective will be central, thus some of the focus will naturally move away from whether or not the goals in the L97 have been met. But the international perspective gives us the possibility to discuss national goals and operations in a meaningful context. Similarities and differences with other countries might provide guidelines for our country. The TIMSS results create a background for discussions about the degree to which goals have been fulfilled to a satisfactory level. By looking at how other countries' pupils are expected to perform, it is easier to judge what we should expect of our own. In a comparative perspective it is also meaningful to discuss how relatively "large" the variation is among our pupils' achievements, and how relatively "strong" the connections are between a pupil's level and his or her home background.

How well L97 covers competencies in mathematics and sciences as defined in the framework for TIMSS is also reviewed in the present study. Evidently there are topics in which Norwegian pupils still have not received instruction, but this occurs in all countries. It is evident in the international report (Mullis et al. 2004, Martin et al. 2004) that Norwegian pupils would not have performed better even if only the exercises that correspond with L97 had been used. A Norwegian set of "favorite tasks" was constructed with only the TIMSS exercises that are clearly covered by the L97. Similarly, people in all the countries prepared sets of favorite tasks, and studied how the comparisons between countries worked out for each of them. This showed that the individual countries would not have done better if they had chosen their own exercises. Thus the comparisons of subject performances between countries in TIMSS are robust regarding the precise selection of tasks.

The framework in TIMSS should be regarded as an internationally intended "lesson plan" in the sense (and *only* in this sense!) that it provides a realistic description of intensions for the schools' instructions in mathematics and science around the world. It covers more than what is common for all countries, but as much as possible, no countries or groups of countries are favored in the weighing of themes or perspectives.

Following from this, the TIMSS study is a well suited tool for comparing the results before and after our teaching reform. Since the TIMSS study design fits almost equally "well" to M87 as to L97, a comparison of the results in TIMSS 1995 and

2003 will give relevant information concerning consequences of L97. A large part of the exercises from earlier studies are confidential and reused each time, so the comparison of the performance is done with great belief and precision. In relation to Norway's dramatic decline, it is important to understand the background of this change. Clearly, this set back cannot be explained by the selection of themes in the education.

Together with PISA on the track of the lost knowledge

The PISA study took place at the same time as TIMSS in 2003, with quite similar results. The TIMSS and PISA studies supplement each other in many respects; both in subject didactic perspectives, grade levels, selection criteria, and focus in the questionnaires. We want to discuss the situation of mathematics and sciences in our country based on the information from both studies. Therefore we will briefly mention what PISA has concluded to be the most important and problematic findings (see Kjærnsli et al. 2004, chapter 11):

- The subject performance in mathematics and sciences in our country are weak and below the average in OECD. The pupils' performance are weaker than in PISA 2000. The decline is most tangible in sciences.
- Norwegian pupils score conspicuously poorly in the new multiple subject "problem solving" which concerns pupils ability to analyze rationally.
- Our pupils seem to have a minimal repertoire of good learning strategies, for example metacognitive accomplishments, awareness, and control over their own learning. This lack of understanding is a particularly large problem in schools with great emphasis on pupils' work ethic.

In Norwegian schools there is little emphasis on practice of elementary concepts in mathematics. On the other hand, no country in the PISA study has such a high correlation between extensive practice and results as in Norway. Practicing of elementary skills is also something that characterizes our good pupils to a greater degree than in most other countries.

Norwegian classrooms are rather loud and restless, both principals and pupils attest that the work environment is problematic, actually to a larger extent than in any other OECD country.

The pedagogical atmosphere also seems in other respects to be worse than in other countries, both regarding the relationships between the teachers and the pupils, and how the pupils realize the benefits of the instruction.

In the report from the PISA study these points do not depict the isolated problems, but give a uniform interpretation. This superficial description of the PISA results is to a great degree in accordance with the results from TIMSS, especially the comparisons with earlier studies. Now we want to conclude our report with a summarized description of the situation in mathematics and science in Norwegian schools; our description builds upon data from both TIMSS and PISA.

What on earth has happened to mathematics and science in Norwegian schools?

A uniform and subjective description based on TIMSS and PISA

TIMSS and PISA together provide an extensive amount of data about the situation in mathematics and science in Norwegian schools. The main observations about the pupils' achievement levels are similar, thus the credibility of both studies is strengthened. The two studies complement each other in many ways, and thus in combination offer a better understanding of the situation. The rest of this report is dedicated to our subjective interpretation of this situation. Obviously, others might interpret the empirical data differently. Thus, it is important for us to emphasize that the following goes beyond the direct results and implications of the data.

In our attempt to clarify this situation we often refer to perspectives and view points from the PISA report and we frequently quote from that report. These quotes will be connected to the new and expanded findings from TIMSS.

Where has all the knowledge gone?

The most conspicuous thing about the Norwegian results is that they are weak all the way through. Norwegian pupils in primary school seem to have sensationally poor knowledge and proficiency both in mathematics and science. Pupils in countries we usually like to compare ourselves with, score better than Norwegian pupils. Even more significant is the unambiguous decline when compared to earlier studies. In every topic with meaningful and precise comparisons, an apparent weakening of pupil knowledge and proficiency is demonstrated. This is valid in 4th, 8th and 10th grades and in both mathematics and sciences. Since the two studies complement each other so well, we can say that the general picture of weakening is valid for basic knowledge and proficiency as well as with realistic applications. Thus the title of this report is justified: What on earth has happened to mathematics and science?

The decline shown in the PISA results was not as profound as in TIMSS. The PISA study, of course, considered a shorter time span, only between 2000 and 2003. In TIMSS, on the other hand, the time period is longer and the comparisons are more precise since so many of the exercises were the same in both 1995 and 2003. The joint message is unavoidable: Norwegian pupils perform steadily worse in mathematics and science. The most interesting is not the decline itself, but that it is so great and found in every topic and grade considered. Especially marked are perhaps the fourth grade classes that perform lower than the third grade classes did in 1995. The weak foundation these pupils have in mathematics and science is not easily retrieved in years to come.

We have tried to illustrate *how* large the decline from 1995 has been. The average progress for all countries from one school year to the next was used for this purpose. We can do this because each population in 1995 consisted of two subsequent grade levels. With this measurement we can, for example, say that the present fourth grade classes in mathematics lie half a year behind the third grade classes in 1995, in spite of one extra year of school. Following the same line today's eight grade classes (actually in their seventh school year) score approximately a whole year behind the seventh grade classes of 1995. Science is proportionally declining a whole year in the fourth grade and half a year in the eight grade. The same measurement is also valid in comparisons between countries. A realistic impression of the differences in performances is provided with a comparison with the levels in the best eastern countries for the eight grades, which shows that these countries have a three year head start on our pupils in mathematics and nearly two years in science. At the same time it also appears to be true that the head start the Swedish pupils have in the eight grade, is approximately as expected since pupils in Sweden are one year older and have attended school one more year. Thus the pupil performances are rather similar in Sweden as in Norway. Pupils in the Netherlands, however, who are one of the reference countries, seem to have eight grade scores about two years ahead of Norwegian pupils in mathematics and one year ahead in science.

The negative tendencies in both short and long term are obvious and a thorough discussion of the background seems necessary. The influence from L97 is not obvious. There are many tendencies of the times and school is only a part of it. However, in the designing of new teacher plans, we sincerely hope that the PISA and TIMSS results remain important premises for a discussion about changes, which are necessary in order to come "back on track" and lead to improved teaching of mathematics and science.

Instruction forms

We will begin this chapter by quoting some thoughts from a newly educated teacher:

> "Another thing I have thought much about this year is instructional methods. I think this has been depicted as either or. Not only in lectures with practical pedagogy education, but also in debates in the newspaper and others alike. I now wonder about it and I wonder if I am odd thinking the middle road is the way to go. Take project based work for example. Yes, I said that it does much for itself. Project based work exercises the pupils on

another level of proficiency than instruction from the chalkboard, for example. They learn to work together, they must define and see the problems concretely, they must seek out information and they must discuss, assess, and come to a compromise. But it is not like project work does not have any negative sides, and it is not suited for all pupils. It is common knowledge that what you learn in a period of time, if regarded as an interesting quantity, is less than in other education methods. (…) Sometimes I think that maybe our schools were not as dumb before. Is there anything crazy about learning by memorization? Not always, and not as a basic principle. Rote learning seems to be an insulting term in Norwegian schools, and now and then you get the impression that instruction from the chalk board will end up in the same category. Sometimes is it alright to learn by rote a little? Something one must learn." (Paulsen 2004, p. 68).

Evidently, with L97 there has been a change in instruction forms. L97 is highly influenced by the constructivist teaching perspective: "*The pupils attain a large degree of their own knowledge, build upon their own accomplishments and develop their own opinions*" (L97, p. 28). We call attention to the fact that there is not a distinct line from constructivism to those methods that are used in classroom instruction. This also became a debate within the PISA report:

"There is no distinct line from emphasizing the pupils' independent construction of their own understanding to "pupil centered" work. Active learning happens in the brain and brain activity is not dependent on a chosen work form. The decisive point is whether the learning efforts are able to "provoke" this activity. Thus it is neither according to the noticeable activities, nor about the work does being independent or self initiate. Considering learning, formal instruction is by far irrelevant. A good supervisor may lay the ground for independent project based work to facilitate efficient learning. This demands that the teaching goals are in focus for both the teacher and the pupil, and that the project based work promotes the learning goals. On the same line, a good lecturer can clearly promote good learning activity to the audience while going over new teaching material. This demands, however, pupils' alertness and participation, and not the least precise assumptions concerning the pupils' prior knowledge" (Kjærnsli et al. 2004, p. 255).

In our opinion, this is a main point. In L97 it is underlined: "(…) *the pupils shall be active, pro-active and independent. They shall learn by doing, investigating and testing new concepts actively against their prior knowledge and understanding*" (L97, p. 75). Pupils being active is usually interpreted as different activities such as working in groups, project based work, playing games, and experiments. The strong focus on specialized work methods might lead to the subject's learning objectives being made lower priority. The use of different learning activities is often presented as being an independent goal without having any relation to clear learning objectives:

"The general impression is little systematic and summarized reflection around the learning potential in the different activities. Pupils are not given the opportunities to accumulate knowledge based on systematic experiences. The fact that little time is used for closure and summarizing of the different activities contributes to a situation where the different activities and intentions become diffuse for the pupils and a weak relation between doing and learning is established" (Klette 2003, p. 73).

"Learning by doing" is an expression that L97 has tried to carry out. Klette, however, points out the obvious problems arising when pupils are left alone to construct their knowledge from a multitude of experiences. The problem seems to be that different activities often take place in isolation from other instruction and without connection to the subject matter or the defined teaching objectives. The lack of explanations concerning the objectives can result in much "doing" becoming "confusion" instead of "learning".

We are sceptical that some teaching objectives on their own are seen positively while mediating and explaining by the teacher seems to be regarded negatively. The video study connected to TIMSS in 1995, where mathematics instruction in the USA, Japan, and Germany were compared, showed to some extent large differences in education (Stigler & Hiebert 1999). The difference was not about whether or not the pupils listen to the teacher, rather more about what type of reflection their teacher required of the pupils; how the activity's objectives were integrated into the lesson. Also how the teacher used the conclusions that the pupils had come to. In our opinion, these subject didactic sides of the lessons in mathematics and science are decisive for good learning. In this context good instruction places a great importance on the teachers' competence, both regarding the subject matter and didactics. To a certain extent, Norwegian teachers have little competence in mathematics and science. In particular, teachers in mathematics have a superficial knowledge of the subject.

According to Klette (2003), a summary from the teachers' side that structures the learning material from a pupil activity, is often lacking. The same tendency appears when considering the pupils' assignments. The TIMSS data reports that assignments in both mathematics and science are seldom followed up and discussed at any length.

Changing pupil and teacher roles

In the description of the PISA results the changing pupil and teacher roles are brought in as essential factors for understanding the situation. The following is stated in the PISA book:

> "The strong wave of democracy in the schools is a sign of the times that a strong authoritative position is not in place, neither in the educational sectors nor in other sectors. The democratization in schools has given us much more independent pupils, pupils that know their privileges and pose demands. (…) Satisfying the pupils, even giving priority to their wishes and needs in a short time span perspective, is to a large degree taking a toll on work in school (…) The changing pupil role has consequently caused a new teacher role. In line with the focus on the pupils' independent learning, the teachers are being assigned to arrange for learning to take place. Simplified, the teachers' role is changed from a lecturer to a facilitator.
>
> Many teachers declare uncertainty about how they shall act as a guide in helping the process of learning. Teachers that earlier were strong in mediating, are often uncertain whether they can completely go through the teaching objectives in an instructional teaching form without being out of date or old fashion" (Kjærnsli et al. 2004, p. 254-255).

In as far as this description is correct; it is not so strange that the teachers' summarizing and explanatory lecturing seem to be losing ground. From the constructivist perspective this absolutely gives the pupils a weaker background as they try to structure isolated pieces of knowledge into a meaningful whole. Mathematics and science are, because of the logically structured subject matter, especially vulnerable.

The new pupil role poses greater demands upon the pupils' self regulation of learning. The results from PISA showed a relatively stronger connection between the degree of self regulation and one's performance in mathematics in Norway than compared to other countries. In schools where this is, to a greater degree, left to the pupils own initiative, it is not a surprise to find such a connection. In TIMSS 2003 we have seen weak tendencies towards a stronger connection between pupils' background and their performance in school as compared to 1995. The project based work and responsibility for their own learning can favor the pupils that have more attention from their parents. Possibly, parents with a higher education are more able to support their children in school.

Teacher authority and noise

Another side of the changing pupil and teacher roles considers the work atmosphere in the classroom. The PISA studies both in 2000 and 2003 paints a dismal picture as to the possibility for concentration and learning atmosphere in Norwegian classrooms. Pupils and school directors were to an astonishing degree concurring in the negative description. The PISA report contains some reflections on this:

> "Noise, disturbance and waste of time turns out to be a big problem in Norwegian schools. (…) Improving the work environment in the classroom seems to be a considerable challenge. (…) If "the negotiating pupils" dominate the classroom, it might be difficult for the teacher to be an authority

> figure. A teacher who deviates from their role as an authority figure is in danger of surrendering pupils to the so called "group tyranny". From our data there is reason to believe that the pupils certainly want to have some influence, but in a structured form where the teacher draws definite lines and is clear about what the pupils are expected to learn. (…) A restoration of teacher authority seems to be a formidable challenge for the Norwegian schools. (…) We interpret from our data that the pupils want a teacher that dares to project themselves as a clear authority in both pedagogical and social contexts. It is not a question about who has the authority, but about the natural authority built upon the subject matter and good leadership to support the pupils in their learning and social development." (Kjærnsli et al. 2004, p. 258-259)

The agreed description from pupils and principals about the amount of noise and unruly behavior is supported in TIMSS with data from the teachers as well. In both the investigated grades the teachers were asked about factors that hampered instruction. The teachers' view was in line with the description above. Norwegian classrooms appear to be characterized by unusually interruptive and unmotivated pupils.

It is not difficult to see the connection between the many interruptions in the classroom and the teacher being a weak authority figure. Sometimes a bit of noise might be a sign of creative activity, but here we are only discussing distracting behavior. Mathematics and science are clearly subjects that require a great deal of attention and concentration, and this demands silence and motivation. These subjects, especially mathematics, have a hierarchical structure – this means that a good understanding of a new concept often depends upon prior knowledge of basic concepts. Without any doubt, silence and concentration are essential.

Efforts and demands

The TIMSS study does not contain any questions that directly illustrate the pupils' and teachers' "drive" during instruction. This was, however, an important theme in PISA, and we have borrowed from some of their results:

> "Increased pupil influence is naturally accompanied with what the pupils' think is fun, not to say "cool", to play a larger role. Young people today live in a time of impressive entertainment, especially TV media has contributed to the feeling even information shall first and foremost function as entertainment. "Infotainment" is the English expression for this phenomenon. The school is in danger of following blindly after this tendency of the times if it does not risk standing in opposition. There is no "cool" shortcut to knowledge. Good subject advancement is determined by work with definite goals. (…) A general impression of Norwegian schools is the relaxed effort seen in comparison to other countries. Again, there is obviously a need for a more apparent teacher authority that dares to set demands. (…) To let the pupils decide their study methods implies a danger of lowering the priorities of efficient study methods. To let the pupils' "interests" have priority before work habits and material selection might result in good motivation, but not necessarily good learning in important topics." (Kjærnsli et al. 2004, p. 259-260)

In mathematics and science, especially, it is necessary to "roll up our sleeves". As pointed out in the last part of the quotation, many of the subject challenges demand that the pupils engage themselves in analytical reasoning. This mental activity is demanding, and becomes further distorted if the elementary principles are not automated through comprehensive skill training. In the next section we will take a closer look at the meaning of this in mathematics.

The results from TIMSS show that Norwegian pupils are among those with the highest self-confidence in mathematics and science, in contrast to their actual low achievements. The evaluation of Reform 97 pointed out that much of the feedback given to the pupils in Norwegian schools, especially in the lower grades, is mostly positive and more or less independent of the actual quality of the pupils' work. Again, this seems connected to the low subject material demands unveiled by the PISA data. It is doubtful whether creating an unrealistic high self-confidence among pupils is a favorable objective for additional learning. Rather, there is reason to believe there is the need for precise feedback that can form a starting point for further development.

An old Norwegian song for children

Smile and be happy wherever you go
Then many friends you will see
Even if you forget that one and one are two
Nice you must never forget to be

"If you forget that one and one are two…"

There are a multitude of goals lined up for Norwegian schools, one of them is named in an old Norwegian children song: "Nice one must never forget to be" (see the small text box for the whole poem). Good goals are important, however, the situation in school does not easily promote or allow for the concentration and engagement necessary for mathematics and science. In particular, mathematics is a subject with a high degree of abstraction, and thus requires concentration and systematic work. In addition, this subject demands that some proficiency is automated, to "free attention" when mathematics is applied to a concrete problem. Practicing proficiency, often called "drill" or "rote" which has some negative connotations, is of conclusive importance in mathematics, but there seems to be little understanding of this in the present day schools. Maybe the pupils still have not forgotten "one and one", but obviously most of them have forgotten "9 times 15". Clearly, the pupils are not becoming more kind from a lack of knowledge.

The international TIMSS report points out how important basic proficiency is for successful problem solving in mathematics:

> "The TIMSS 2003 results support the premise that successful problem solving is grounded in mastery of more fundamental knowledge and skills." (Mullis et al. 2004)

"Mathematics for everyone" is a central theme in mathematics in elementary school as well as in parts of secondary school in Norway. Mathematics is to a large degree justified by and related to functioning as an active member in a democratic community. At the same time, the importance of knowledge in pure mathematics has been devalued. The argument that a living democracy needs competent citizens has had a large impact in all the Scandinavian countries. The close connection between mathematics in day-to-day life and learning in school is emphasized in the introduction of the mathematics teaching plan:

> "The teaching plan highlights the importance of making a closer connection between mathematics in school and mathematics in work outside of school. Concepts and subject vocabulary are built upon from life experiences, playing games, and experiments." (L97, p. 153)
>
> Knowledge and proficiency in mathematics is an important foundation for active participants in work and free time as well as being able to understand and to influence the processes in the community. Mathematics can be a tool to master challenges for the individual. (L 97, p. 154).

Also, "Mathematics in daily life" is the first of the subject's five goals. Furthermore, this shall be a thorough theme, to give "the subject a social and cultural explanation and (…) take care of the *applicators aspects*" (L97, p. 156). But an open ended question is whether or not "realistic mathematics" in connection with day-to-day life experiences really makes mathematical comprehension more attainable for everyone. In any case, it is hard work acquiring mathematical skills. Listening to a qualified teacher and exercising important basic concepts is a part of this. The data depicts that Norwegian pupils generally have strikingly weak qualifications in elementary proficiency in arithmetic. In PISA it is apparent that fundamental skill training is rare as a learning strategy. In addition, elementary arithmetic proficiency is, to a large extent, a characteristic of schools performing well in mathematics in grade 10.

Perhaps more important: Stressing problem solving and mathematics in daily life might be a bad strategy if it becomes an alternative to the basic proficiency training. If lacking a basic understanding of numbers, application in daily life and in algebra becomes difficult for the pupils.

We claim that something must be completely and fundamentally wrong when the results of TIMSS can be as bad as they are. Norwegian pupils perform weakly and weaker than previously in all the areas of study. This is true in algebra, which is devalued in L 97. This is also the case for numbers and arithmetic, which form the basis for applications in realistic contexts. Finally, this is the case when pupils are solving problems arising from such contexts. In addition, it is worth mentioning again that the pupils in the tenth grade scored especially weak in PISA on the so called multi-subject “problem solving” tasks, which concentrated upon testing the pupils’ ability to analyze logically.

Conclusions

Some will, perhaps, claim that it is not so bad that the pupils do not learn mathematics and science especially well in primary school, which is an honest opinion. But for all of us who are concerned with strengthening mathematics and science in Norwegians schools, in our view it follows from the PISA and TIMSS results that a thorough debate about a change of course is necessary. Many have, for the time being, warned against the systematic deterioration of knowledge with L 97. Through the two studies PISA and TIMSS this warning has been significantly strengthened. Of course, these two studies have not been able to measure all of the knowledge and proficiency that is important. However, with the well documented qualitative information and a subject perspective in accordance with L97, it does not seem appropriate to discuss possible failings with the studies which have come up with these results. The truth is that these two sets of data, to a large degree, both confirm and supplement each other, and thus give a consistent picture of a problematic situation for mathematics and science in our country.

Some bells are ringing, and we hope they are being heard!

Right on track or going nowhere?

PISA
Programme for International Student Assessment

An extract of the Norwegian report from PISA 2003
Short English version

Summary and Conclusion

In this final chapter we would like to summarize some of the most important findings from the results chapters (3-10). Then we would like to present some of the results across the different subjects to be able to give a better understanding of the Norwegian students in a Nordic and international perspective. Finally, we would like to consolidate all the results in one interpretation for an overall message. The central issue will be what this message has to say about Norwegian schools, and not at least how can we, or should we relate to this.

Summary of findings from the results chapters

First in this chapter, we would like to summarize in bullet points what we believe are the main findings in each of the chapters (3-10). The overviews will serve as a starting point for the rest of this chapter and guide for the readers to see where the different subjects are discussed.

Our main findings are shortly summed up as the following:

Chapter 3 Mathematics

- Norwegian students perform near the OECD average, but significantly below all the Nordic countries.
- Norwegian students are quite good in the issue Uncertainty, but relatively weak in Change and Relationships and Space and Shape.
- Norwegian students have had a minor fall of performance in PISA 2003, compared to PISA 2000, in the two subjects that can be compared directly, Space and Shape and Change and Relationships. In Change and Relationships, we are falling behind because nearly all the other OECD countries have improved their performance in this issue.
- Males perform better than the females in almost every country, but in Norway these differences are very small.

Chapter 4 Science

- Norwegian students perform significantly lower than the OECD average in science.
- Norway is among the countries which showed the largest significant decline in performance.
- There are small differences between males' and females' performances and these are mostly in favor of males. In all the countries females perform better on tasks which measure process skills, while males perform best on tasks which measure conceptual understanding.

Chapter 5 Reading

- Norwegian students perform, as in PISA 2000, just above the OECD average. Norwegian students have had a minor decrease in their performance compared to PISA 2000, but the decrease resembles the decrease in the OECD average.
- The gender difference in reading in favour of females has increased. This is mainly due to the decrease of male performance.
- Norwegian girls perform relatively high on tasks which demand reflection and evaluation.
- The results show a weak, but clear tendency of more positive attitudes to reading activities among Norwegian students and they read more in their spare time than in 2000. The percentage of males who never read literature has declined considerably.

Chapter 6: Problem solving

- Norwegian students perform below the OECD mean, and it is also significantly lower than the rest of the Nordic countries.
- Norwegian girls perform slightly better than the Norwegian boys, but the difference is relatively

small. In some tasks we find relatively high gender differences, and the results seem to reflect the stereotyped gender pattern.

Chapter 7: Self-regulated learning

- Norwegian students report that they use learning strategies in Mathematics less than the OECD mean. This is found both in rehearsal strategies, elaboration strategies and especially control strategies in mathematics.
- Regarding motivation for the subject mathematics, Norwegian students report that lower interests for mathematics than the OECD mean, but they report above the OECD mean when it comes to the importance of mathematics for future education and work. Boys report a higher motivation than girls in both these areas.
- Norwegian boys have significantly better self-efficacy in mathematics than Norwegian girls, despite the fact that there are small differences in the achievement level.
- There are relatively strong relationships between students' degree of self-regulation and their performance in mathematics in our country. No other country has a stronger correlation between the reported use of rehearsal strategies in mathematics and the achievement level than Norway.

Chapter 8 What is the importance of home background?

- The correlation between the mathematical competence and socio-economic background is smaller in Norway than the OECD mean.
- Norway has the highest correlation between the students' expected educational level and home background of all the Nordic countries.

Chapter 9: School factors

- In Norway there are small differences between the schools when it comes to the learning outcome, compared to other countries.
- In an international perspective, Norwegian students report a strong sense of belonging to their school.
- Norwegian students are generally less positive to the learning outcomes of their schooling than the OECD mean. They also report that they have less positive teacher-pupil relation, and less supportive teachers.
- Both students and principles describe a more problematic school climate in our country than other countries. Norwegian students report more noise, disturbances and wasted time than the rest of the OECD countries. Norway has the highest percentages of principals who report that the students' learning is disturbed by disruptions of classes by other students.

Chapter 10: What characterizes Norwegian schools that perform high in Mathematics?

- A "good" school is defined as a school which performs higher than expected, regarding the students' socioeconomic background. "Good" schools in Norway are known for having positive teacher - student relations, supporting teachers and relatively good work environment in the classes. Students in "good" schools have also higher motivation for mathematics.
- In "good" schools students practice more rehearsal and use of control strategies when they are working with mathematics.

Some results across the subjects

Nordic performances in each subject-domain

Some of the results are interesting in a cross-curriculum perspective. This is why we would like to study some cross curricular patterns in the Nordic countries, as Nordic profiles. Figure 11.1 shows the performance in mathematics, science, reading and problem solving for the Nordic countries relative to the OECD mean. The results in each subject domain are discussed earlier, but here we would like to focus at the pattern that emerges. The first we notice is the Finnish students' performance. They are far above their Nordic students in all the subject domains. There seems to be more general than subject specific reasons why Finnish students perform so high. We can suggest a way of describing the differences between Norwegian and Finnish students by comparing how much improvement each country has during a year. TIMSS 1995 had data for 6th

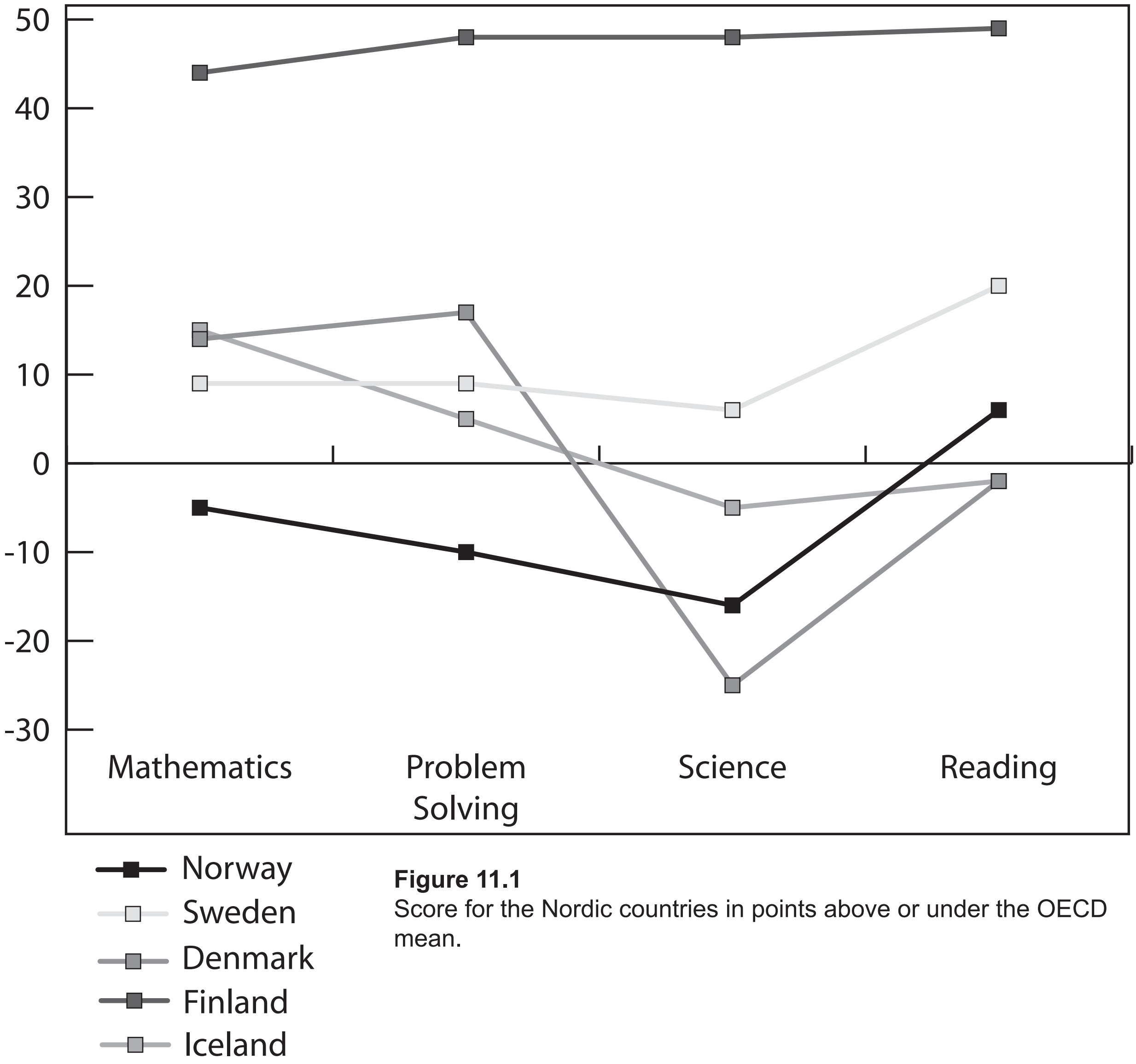


Figure 11.1
Score for the Nordic countries in points above or under the OECD mean.

and 7th grade, and the improvement from 6th to 7th grade was 30 points, and the points were calculated in the same way as in PISA (Lie et al. 1997). This suggests that the differences between the Finnish and the Norwegian students in each subject domain resembles almost two years of schooling. Without interpreting this too literary, it clearly demonstrates that the Finnish students have knowledge and intellectual abilities that make them well prepared for further education and "lifelong learning".

The differences between the other Nordic countries are smaller, but with some interesting patterns also. The Swedish profile resembles the Norwegian one, even if it lies 10 to 15 points higher. The Swedish students are slightly better than the Norwegian in all the domains, which was also a characteristic finding in earlier TIMSS and PISA-data (Lie et al 1997, 2001). When it comes to Denmark and Iceland the profiles are different, but with a considerable strength in mathematics. The new domain in PISA 2003, problem solving, stands out as the most cross curricular competency. As earlier mentioned in Chapter 6, this domain represents an area which mainly focuses on intellectual ability such as analytical reasoning. Such cross-curricular competencies are similar to reading strategies in that they are of great importance in all subject areas, and the relatively weak Norwegian performance may give us the key to understand some of the results also behind the other domains. Nevertheless have we consciously placed problem solving next to mathematics, because these two areas exhibit the highest correlation and seemingly have most in common.

Changes since PISA 2000

We can summarize the subject performance in Norway by saying that they are at and under the OECD mean in all subject domains, and as a whole our country appears as the weakest of all the Nordic countries. In PISA 2000, the Norwegian results as a total were closer to the OECD mean, so there are reasons for looking more closely at what characteristic changes have happened since last time. Figure 11.2 shows some changes from 2000 to 2003, here presented as the difference between the two scores for the two assessments. It is important to notice that the point differences represents the same in these two years, so the changes in the figure, as far as possible, represent real changes and not only increases or decreases performances compared to other countries. This opportunity is not present in mathematics, for

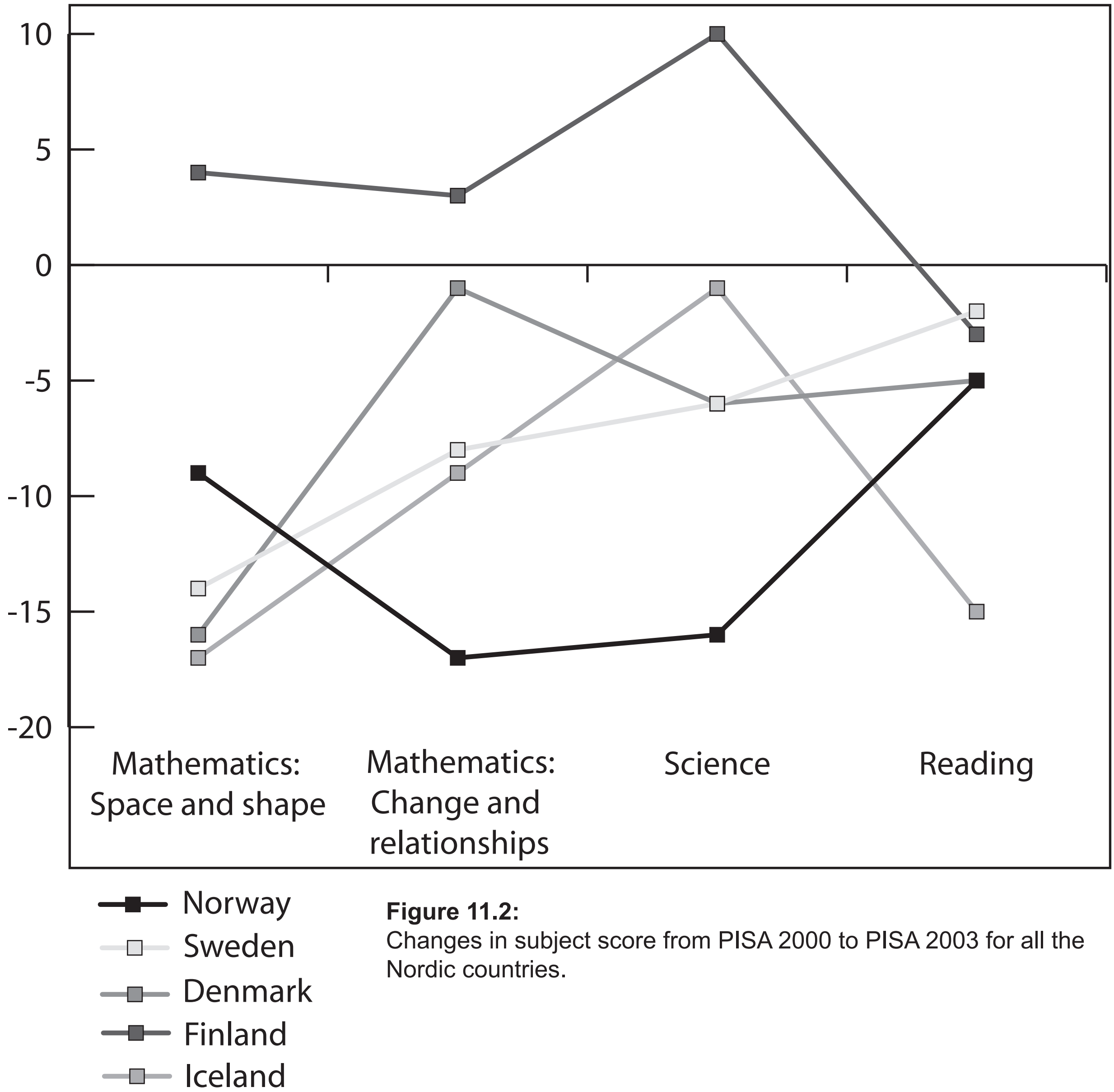


Figure 11.2:
Changes in subject score from PISA 2000 to PISA 2003 for all the Nordic countries.

several reasons which are explained in chapter 3. Instead we have showed the changes for the two scales in mathematics where this is possible.
In figure 11.2, the Finnish results are again what stand out. Finnish students have consistently improved their performance since 2000, and this is especially remarkably when they already in 2000 achieved highly. For the rest of the Nordic countries this figure gives a slightly dark picture of the decrease of performance in almost all the areas. In an international context, these countries stand together as a group with significantly decreased performance. Even though our country's data together with Iceland as a whole show the most disturbing results, there are still reasons to discuss the situation in a Nordic perspective.

Gender differences

In PISA 2000 there were two noticeable patterns in gender differences in the Nordic countries:

- In OECD as a whole, there were high differences in favor of the females in reading, almost none in mathematics, and minimal differences in favor of the females in science. As a general tendency, this was also the case in the Nordic countries.
- The gender differences in the Nordic countries were generally more in favor of the females than in OECD as a whole, but with significantly differences among the Nordic countries. The Finnish females showed specifically strong performances, while the performance of the Danish females were weak in all subject areas.

The results this time are shown for every subject domain in figure 11.3. The figure shows some patterns similar to those from PISA 2000. Also this time the Danish females perform noticeably weak, as a consequence the performance favors the males more than in the other countries. In Iceland we see the opposite results in all the subject domains, having increased the female performances since 2000. Iceland has the highest gender differences in reading of all the OECD countries. The gender differences in reading have increased the most in Norway, and as in Iceland it is the males who have decreased their performance. In the new area problem solving, the pattern is close to what we find in mathematics, except that we conclude with stating that problem solving seems to be more "girlfriendly" than mathematics in all countries.

What has happened in the most problematic areas?

We have in 11.1 and 11.2 given a brief summary and overview of what we think is the most important findings. Some of these results are closely related to similar problems in PISA 2000. It is therefore natural to ask which changes we can see, and what we can conclude regarding the direction Norwegian schools is headed.

The following Norwegian results from PISA 2000 were regarded as particularly problematic:

- The Norwegian results in the subject domains were only average, something which was regarded as bad, given the Norwegian context.
- The gender differences in reading in favor of the Norwegian females were among the highest in OECD.
- Norwegian students reported a low use of learning strategies.
- Norwegian classrooms were reported by principles and students to be noisy and disruptive.

If we are going to ask which changes have occurred since 2000 in all of these areas, we must conclude that what was problematic in 2000 now appears to be even more problematic:

- This time, Norwegian students perform even weaker than in 2000 in all subjects' domains where we can compare the results in detail. The decrease in performance has been especially large in science.
- The gender difference in reading has increased.
- There are no signs of better use of learning strategies.

These data suggest that the school climate is even worse. Our country appears to be the country in OECD where you find most noise and disturbance.

PISA 2003 has given us some information which we did not have in 2000. In the new area problem solving the Norwegian perform unexpectedly low and lowest of all the Nordic countries. Problem solving is not a subject, but as reading it is basically the ability to use analytic reasoning. As for reading, it is easy to admit that being week in this skill, might give students problems in other subjects, especially in math and science. Another new insight from PISA 2003 is that the Norwegian students report that they do not think of their school outcome, as very positive.

On one hand what seem to be the main problems in Norwegian schools are confirmed, and on the other hand, it looks as though these problems are increasing. We cannot expect large changes over a period of three years; PISA 2003 was carried through only one year after the results from PISA 2000 were published. In this light, even small changes are important, because they tell us about certain lines of development. Norwegian schools seem to be facing a considerably remarkable challenge which should give the school politicians important tasks in deciding what changes are necessary. It seems to be time for fundamental changes in order to find a path towards positive development.

Some few positive signals

It is not easy to point to positive signals in the Norwegian results. Some positive aspects are however worth mentioning and commenting:

- Norwegian students stand out positively when it comes to the sense of belonging to school. It is important to remind the reader that this does not include the teaching, but primary the relations to other students.
- There are few differences between the schools in our country, in the sense that in an international perspective it doesn't matter for the mathematical achievement where in the country and in which school the student is. This might signify that new strategies might be carried out systematically and successfully at a national level across the country.
- Norwegian students perform relatively well on the mathematics uncertainty scale.
- We interpret this result as a direct result of the Norwegian curriculum which stresses the issues statistics, and interpretation and representation of data.
- The Norwegian boys report this time slightly better reading habits, both when it comes to attitudes and frequencies of reading.
- If this trend continues, there is reason to expect a gradual improvement of the boys' reading literacy.

PISA as an assessment of the Norwegian school

Premises for the evaluation

We are now at the end of presenting the results, and it is time for a few comments of a different kind. So far we have discussed the results in both a nationally and international perspective, and we have also referred to and compared the results with other research. We would now like to look at our results in a more educational politics context. We are not educational politicians ourselves, but we realize of course that our results might come to give important premises for the political debate in the years ahead.

PISA is related to a mode of knowledge production we call evaluation. Evaluation or evaluation research usually starts were researchers are commissioned to assess the results of a reform. One example of this is the research around the evaluation of Reform 97 (Haug 2003). The task we were given has not had specific formulations related to the Norwegian school reality. This task can therefore not be interpreted as an evaluation of the Norwegian schools on it owns terms. Instead, PISA has developed definitions of competencies based on international consensus in terms of their being central in the future, both in a professional carrier as well as in the society. PISA might therefore be said to evaluate the Norwegian school on external premises. To which degree does the Norwegian School System succeed in cultivating some general competencies of which there is broad, international consensus regarding their importance for young students in a lifelong perspective?

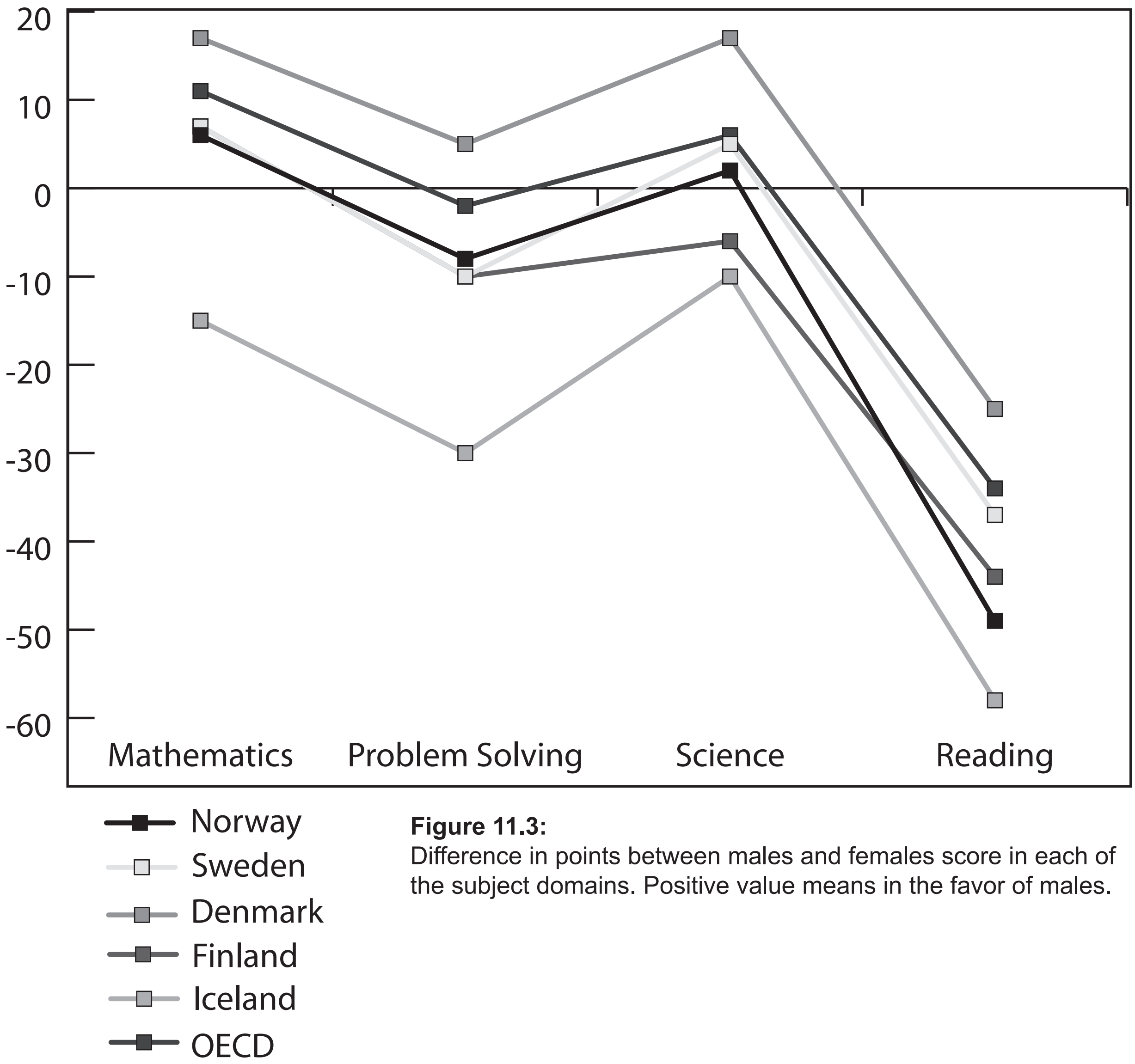


Figure 11.3:
Difference in points between males and females score in each of the subject domains. Positive value means in the favor of males.

The goals of L97 are multifaceted, and a lot of them of such a character that it is impossible to measure to what extent the actual goal is reached, or even to judge whether one is headed in the right direction to reach it. In an international assessment, the comparative perspective will of course be essential, something which also moves the focus away from the discussion regarding to which degree the goals in L97 are reached. An international perspective gives us the possibility to discuss national goals and operational the goals in a meaningful way. To see what other countries succeed and not succeed in might be important premises for our own country. Based on the PISA findings, one might discuss whether the goals are reached to a reasonable degree. By looking at what other students are able to achieve, we might easier judge what we can expect from our own students. In a comparative perspective, we can in a meaningful way for instance talk about whether results show relatively "large" variation and relatively "strong" relation to the students' home background.

We have in the earlier chapters given our evaluation of to what degree L97 seems to cover the competencies in mathematics, science, and reading, problem solving and self-regulated learning the way these areas are defined in PISA. In one domain, reading, we have clearly ascertained that our curriculum does not have clear goals for what is known as "the second reading training". Accordingly it is difficult to find general goals which cover what is measured in the domain problem solving, even if some of the current skills are partly covered in mathematics. In the domain of mathematics and also partly in science, we have showed that the overall goals in our curriculum coincide well with PISA's definitions of the competencies which are measured.

Regarding Mathematics, we have also used some of the results from the Evaluation of Reform 97, related to the subject Mathematics (Alseth et al 2003) to draw a picture of the Norwegian curriculum and the Norwegian classrooms. Through this it is, as far as we can see, difficult to explain the weak results in Norwegian performances in Mathematics with the argument that the Norwegian curriculum differs from what is measured in PISA. It is therefore fair to say that the mathematic results show a relevant goal of the outcome quality in Norwegian schools. Generally the same might be said about science, even if it is obvious that important aspects of this domain are not measured in PISA. If the government perceive the performance level which is documented here as "too weak" and wish to do something about the situation, it will not be natural to do something with the curriculums' overall statements and listed issues. A better strategy would probably be to develop more precise and concrete descriptions of what it means to reach the competence goals.

As we have shortly described in chapter 1, PISA is under quality control. Detailed reports are published where these quality controls are documented (see Adam and Wu 2002). From our own experience and from the documentation in other countries, we are convinced that the data holds a high quality and gives a reliable picture of the situation in each participating country. In one area, however, we are not so certain, and this concern to what extent is it possible to motivate the students to do their best in the test situation. At the worst, if some of the few measured differences between countries and between genders should be influenced by different test motivation, this would only show that the will to make an effort and the perseverance for schoolwork are the most important factors in achieving good results.

Is the Bildung aspect forgotten?

Some might argue that the PISA study emphasizes too much measures of knowledge in a narrow area, and that especially the subject domains are colored by "back to basic" and the education on the premises of business, and that there is not enough focus on the Bildung aspect. This is of course legitimate to claim, but we would like to point at some important moments in this respect. First of all, we can hardly understand that the basic skills which are in the center in PISA are not also important aspects of Bildung. Being able to read, understanding quantitative information and reasoning, analytical reasoning and basic skills in science are important factors for being able to acquire new knowledge and to be able to use these in concrete situations whether this is in education, in a job career or in the search for a meaningful leisure time and a deeper understanding in life.

Of course there are other important areas which PISA does not measure. The PISA results can therefore not alone give a valid measurement of the quality in a broad sense. But we may state that what is emphasized in PISA of knowledge, skills and attitudes in many ways represents the overall goals which are stressed in L97. This can easily be seen in the slogan of PISA, "Learning for life", which refers to knowledge which is important in real life, not only in schools and higher education. This slogan also reflects other aspects than the cognitive ones. Motivation, positive self-efficacy and use of good learning strategies are not only important for succeeding in school, but are also an important part for learning in a life long perspective. We will therefore claim that the PISA results give a balanced picture of the Norwegian school system and to what extent certain goals in central areas have been reached.

Right on track or going nowhere?

An overall description

Our task will now be to point at some general patterns and tendencies and some possible options and eventually consequences of following these. Our work as researchers in PISA gives us the opportunity to do this, but we also realize that this role does not give us privileged positions when it comes to clear normative statements about what one should do in the Norwegian schools today. What kind of school we want and what kind of values should be the basis for the Norwegian school are questions which cannot be answered by research.

Let us list some of the problematic areas in the Norwegian school based an international perspective from the PISA results: low and decreasing achievements (compared to PISA 2000), larger variation between students than expected, little use of learning strategies, a lot of noise and disturbance in the classrooms, problematic relations between teachers and students, big gender differences in reading, students do not think they got much of their schooling. This is not only a list of isolated problematic areas. There are obviously some connections here, and we will try to understand some of them.

Changed student- and teacher roles

There have been a number of changes in the Norwegian school system in recent years, but a lot of these changes are connected to society as a whole. The changing student and teacher roles have many of their qualifications outside school. The changes have particularly involved an increase of student participation. Their voices are important and adults have spoken for them, like in a report from 1999 by The Children Commission and "The Pupil Inspectors", which are net surveys where the students anonymously report about their school situation at a national level. The strong democratic influence in school is a part of the changing times, where there are fewer acceptances for strong authorative attitudes both in school and in workplaces. The democracy of school has given us more autonomous students, they know about their rights and are able to set their expectations. Norwegian students do not only stand out as conscious about their own rights, they also have considerable knowledge about democracy and good "democracy preparedness and involvement" (Mikkelsen et al 2001, 2002). In contrast to students a generation ago, our students seem to be outspoken and capable of presenting their subject results or argue in social situations. The students have influence when it comes to how the school year is planned according to the curriculum, choices of issues and choice of assessment. Through "The Pupil Inspectors" they have got a medium where they can freely speak about what they are not satisfied. Some will even claim that this place indirectly encourage to find areas where they are not satisfied. The satisfaction of student felt needs, even in a short term perspective, are now influencing the schoolwork.

The slogan "from teaching to learning", involves in light of new learning theories a shift of focus from the teachers' teaching to the students' learning. In the tradition of Piaget we have what we can call a constructivist idea, that learning implies an active act where the students themselves construct their understanding and these ideas are influencing our schools. We see a strong emphasize of "responsibility for their own learning", student centered teaching, self-regulated learning, project work and self-evaluation. Change in student roles changes the teacher role. In line with the new learning approach where students are active and independent, the teacher role is to make sure that learning can take place, by supervising the student. In short we can say that the teacher has changed from being a disseminator of knowledge to being a guide.

We believe that there is nothing to gain by having a pedagogic debate where different teaching strategies are described as opponents. A lot of teachers express an uncertainty about how they are suppose to behave as guides to enhance student learning and teachers who earlier had their strength in lecturing, are now unsure of to what extent they can go through the curriculum in lectures, without being seen as old-fashioned and out of date. In the rhetoric we see that teaching and learning are set up against each other in a very unfortunate way.

From teaching to learning or to activity?

We will claim that only stressing one specific method does not necessarily follow a constructivist view, which has to do with a certain learning theory and not a theory for teaching. Having one view of learning, doesn't necessarily mean that there is a specific teaching method following this view. There is no straight line between students constructing their independent understanding and student centered methods. Active learning happens in the brain, and brain activity is not dependent of a certain pedagogical method. The important factor is to which degree the method is able to "trigger" this activity. This does not involve visible activity, neither to which degree is the activity independent or self-initiated.

Rather it is a matter of in which degree the learning activity in itself is able to "trigger" this activity. A good teacher may be able to act as a guide in a way so learning might occur. But this demands that the learning goals are in focus for both the students and the teacher, and that the project work is carried through in a way that enhances the learning goals. In the same way, a good teacher might be able to give a lecture which can enhance the learning activity among the audience when going through new domain material. But this demand being able to see the students attention and reactions, and not at least, it involves knowing what the student already knows.

L97 changed the student and teacher role, even if to some degree L97 continues the pedagogy from M87 and M74. Pedagogical changes are something which normally does not happen because of research that show that something works better than other things. This was also the case with L97. Big changes have been implemented, but perhaps there has been little understanding of the difficulties in acting out these changes in the classroom according to the intentions. Perhaps it is also difficult to understand what these intentions were in the first place.

Teaching strategies develop over time, based upon the teacher herself and in relation to the context, and as a result of experience. We might call this a sort of "pedagogical evolution". In this aspect implies that even teaching methods change in an adaptive process for good goal achievement and the specific learning goals. Similar as evolution in biology depends on mutations, the development of new teaching strategies demands new ideas. Some of them are useless, but others through experience, trying and failing, will stand out as adequate repertoire as fruitful procedures for good learning. Evolution demands time, and when it comes to implementing new curricula, this is well known. In line with this, there are reasons to point at the fact that there seems to be a mismatch between the intentional changes from L97 and the weak attention about the suppositions and time it would take for the changes to lead to good learning.

There may be reason to ask basic questions about the new teaching methods and the way the school day is structured. Rhetorically, changes are often presented as good in themselves, and changes are made without always having the empirical knowledge about whether it will work out better or not. A typical example of this, are the new schools which are built based upon certain pedagogical ideas, or schools which tear down their blackboards in all their classrooms. Another example is the appointment of the so called "Demonstration schools". These are schools which have been evaluated as excellent, even though criteria regarding student learning have not been part of the evaluation.

Mathematics may be a subject domain which more than any other subject are targeted by new teaching methods. Being able to connect mathematics to what is known and familiar, is the overall goal in the curriculum; including showing that mathematics is the important tool for describing and solving problems in many situations. Cross curricular methods and working with specific questions may be of relevance for learning mathematics, especially learning mathematics as it is defined in PISA. Nevertheless, we are concerned about the new methods in mathematics. A central issue here is not only whether the project, roleplay, game etc. are experienced as fun for the students, but rather to which degree the student are able to learn something of it. We hardly see any evaluation of the innovative changes based upon learning outcome. One reason for this is probably because it is difficult to measure the effect of teaching program. One example which shows the uncertainty around a too concrete approach to mathematics is the description of the innovative school in the report to the Storting "Culture for learning" (white paper, UFD 2004, p. 3), where it is emphasized that students put puzzles together of geometric figures, calculate the average speed of cars passing by, throw dice or "run around with measuring wheels or doing something else strange and funny". It might be that this school has a plan for the learning of mathematics in all these activities. It is still legitimate to point out that the way this example is presented in the report to the Storting, it is the activity which is at the center and not the positive learning outcome. In the evaluation of teaching of mathematics in Norway, Alseth et al (2003) pointed out that the main challenge with new methods is to be aware of which mathematical conceptions and processes the activity is meant to enhance. This puts great demands on the teachers, both when it comes to their own command of the subject matter and their ability reflects on the didactics.

Aimless wandering going nowhere?

If we study the learning goals in L97 in detail, we notice a remarkable thing. The curriculum for the different subject domains in Norway has a lot of different statements like the students are supposed to "read", "do", "experience" and such. It seems to be filled with descriptions of activities and learning material, but it is hardly any description of what they are going to learn from what they have been "doing" or "experienced". A curriculum which is supposed to include absolutely all the students in Norway, it is easy to understand that it cannot describe concrete learning goals which we know many students will not be able to reach. On the other hand, with no clear learning goals to reach after, there is a danger that the activites in themselves will be the goal. With no clear goals, it is of course also easier to lose track and go in the wrong direction, all the activities will then be equally important. Thinking about subject domains and expectations, these activities might seem to be without any specific purpose, accidently, "aimless wandering going nowhere".

The evaluation of Reform 97 showed that there are many and varied activities going on in the Norwegian classrooms in all grades. But the purpose of all the changing activities may seem to be a little unclear. It seems to be more important to do something, to be active, than to learn something. Rapid change of activities might prevent students from studying in depth and being able to concentrate. Instead the endless changes might enhance superficial learning. The researchers of the evaluation program noticed unclear goals and unfocused subject expectations from the teachers. It seemed overall as if the teachers where afraid of asking the students to do something, especially in the comprehensive school (Klette et al 2003, Haug 2004).

We have deliberately avoided using words such as "progressive" and "traditional" pedagogy in the descriptions above. We don't see those kinds of dichotomies as fruitful, since they in many ways give a false impression of the situation. We think there is an obvious truth in the perspective that it is not what kind of teaching method which is used, but rather the quality of the work carried out by the teacher, no matter what method is used. Not at least we believe that independent of teaching method the teacher's insight and effort will determine the student's subject domain learning outcome and progress. The teacher and writer Jon Severud has described his ideas about knowledge and teacher roles as the following in his book "School and It's Discontents": "It is an illusion that one might (put the teachers in brackets as pedagogical consultants and) conceive of students as grown ups, independent self-motivated learners with flexible time in school and self-prepared individual plans for the day" (2003: 222).

Much could be said about the teacher role and the change from lecturer to guide. With no doubt, the new teacher role as a guide is highly demanding for teachers. There is little tradition in using learning goals in a good way as a part of project work, and therefore it is not so strange that teachers do not find themselves comfortable in such a teaching role. This type of teacher role, also demands even more subject knowledge from the teacher, since there is no clear path from activity to learning. In an international perspective, the Norwegian teachers seem to be class teachers more than teachers of a specific subject, teaching several different subjects, and therefore they have relatively low competence in certain subject domains. Lack of subject competence will make it particularly difficult to meet new challenging pedagogical changes. In a subject such as Mathematics this is easy to see.

A generation ago some might have thought of teaching as the same as learning. A teacher could give his lecture and teach his curriculum, and it was the student's job to "receive" the teaching as it was given to him. This could lead to learning, especially if the teacher was a great storyteller and the students had the motivation for active listening. Obviously, little is learned in a lecture if the student is only physically present, but fails to listen and take part.

Today, one might say that there is a similar tendency to confuse independent learning activities with learning. For example, project work might be an excellent way of learning, based upon the condition that the learning goals are focused. If not, project work might be a typical method for not learning anything specific at all. The same might be said about using ICT as a part of the learning activity in the classrooms. It might enhance learning, in addition to enhance the competence of using ICT as a tool for learning. But surfing around on the internet and downloading from the internet, might also be a way of learning nothing at all.

About noise and disturbance

Noise and disturbance seems to be the biggest problem in Norwegian schools. It is important to point out that neither students nor the headmaster are asked what they mean about noise and disturbance, something which might heat up the public discussion of this. It is rather noise and disturbance which prevent the students from learning. The results show that schools which perform well according to their assumptions, have less problems with the learning environment then schools which have low performances. A better class environment looks like one of the major challenges in Norway.

What's behind this problematic situation in Norwegian classrooms? Letting students participate more, might positively influence the school and make it more democratic. However, this demands a structured teaching of what it means to participate in planning and evaluating his or her own work, and the students can only do this eventually, and not until they are ready for the responsibility for their own learning. But it is also necessary that the teacher stipulates clear commands and holds high expectations for all students. "Being responsible for his or her own learning" has been a well known slogan, but you cannot give a student this challenge without making sure that the student is capable of having it. Student participation demands a guiding teacher who is able to have strong expectations and "stipulate demands". In schools where teachers are not sure about how they may do this, teachers might experience that students are taking control and are in charge of the teaching, and we can see a mismatch in student participation where the teacher has problems being seen upon as the authorative teacher. If the teacher tries to hold high expectations for the students in such a classroom, he or she is risking being unpopular and exhausted. Tendencies like this, lead to problematic pedagogical climate. And if the "negotiating students" are left to dominate the classrooms, it might be difficult for the teacher to act as the authorative leader.

A teacher, who abdicates from the role as authorative, might leave the students into what is known as the "tyranny of the group". From our data, there is reason to believe that the students do want to participate, but in structured ways where the teachers create clear demands and act as models by showing what it takes to learn a specific subject domain.

A restoration of the teacher role is needed and seems to be a huge challenge for the Norwegian school. There are reasons to believe that there are some basic conditions for a good learning environment and for better learning, and perhaps also for better relationships between students and teachers, then what is reported from our data (see chapter 9). We interpret our data in such a way that the students actually prefer teachers who dare to stand out as leaders with clear goals both in pedagogical and social settings. This is not about bringing back authorative attitudes, but more about being the leader of the learning environment, built upon the subject knowledge and good leader management to support the students in their learning process and social development.

Getting down to work

The increase of student participation has probably also influenced what kind of learning the students find "fun" or "cool". Young people today live in an age where even information should entertain; this is what is known as "infotainment". Schools are in danger of follow this pattern if there is no discussion about this and if schools don't dare to be an opponent to the popular culture. There are no short cuts to knowledge. The secret behind subject improvement lies in hard work and clear goals. This might seem to be a secret in the Norwegian school system despite that this should be well known. It is probably related to the fact that goal oriented work actually can be quite a lot of hard work.

Data from PISA 2000 shows that Norwegian students have low values when "Work investment and perseverance were measured, at the same time this correlated highly with performace. We do not have any information about the student's achievement motivation in 2003, but there is no reason to think that it is particularly different now. That's why there is reason to emphasize the danger in students' natural avoidance of "getting down to work". From PISA 2000 our country also had low values on the construct "Teacher with high expectations", but we have no data from this construct in 2003. We note that there are many things which seem to point in the direction that the Norwegian school has low expectations to their students compared to other countries. Again, it is easy to see that there is a strong need for teachers who are able to hold high expectations for all their students.

Letting the students choose their learning method might lead them to choose the easiest way. Using the students interests might motivate them when it comes to subjects and tasks, but it does not necessarily give the students better learning outcome in important areas. What seems fun and entertaining at the moment might not be what is of importance and interest in a longer perspective. What is known as "getting down to work" to understand something very often gives the students valuable insight. Even rehearsal might sometimes be a valuable learning strategy, when it is important to learn something by heart, which later will make it possible to use the mental energy for analytical reasoning. Perhaps we are now in an area which might explain some of the low performances in problem solving for Norwegian students.

Learning strategies and self-regulated learning

The PISA results show that we find a relatively weak correlation between the student's self-regulation and subject performances. In a school system where the teacher is passive and leaves the students much alone working as they might find the best themselves, it is easy to understand these results. The new student role demands that the students are able to self regulate their own learning, and this is even more important when it comes to their learning outcome. The students, who lack learning strategies and motivation for learning, are not able to cope with the new student role. Working with the students' learning strategies and motivation to learn, would seem to be an important goal in the Norwegian school in the years to come. We do not have data from PISA which directly shows us how this is best done, but this is clearly described by others. When it comes to the development of learning strategies, most researchers emphasize that the teacher must help the students to reflect upon their own learning process. This can be done by including an analysis of what the learning goal is for a lesson. This also includes discussing how this goal is reached, and what kind of skills is needed and what kind of quality criteria one might expect for the final product. The teacher's most important tool in such a process would be to be able to discuss the learning process with the different students alone and in the class. "Learning to learn" is only achieved by practicing different types of strategies and skills, at the same time as the teacher guide the student towards a better self-efficacy and increase the ability to monitor his or her own learning.

The road ahead

We will now make some final comments about the basic decisions the Norwegian school system is faced with. It is now a time for change, some old truths might seem to be left, and new messages seem to create a lot of fuss. PISA has pointed at some central issues, which we have been discussed and to put in a meaningful context. The PISA results speak about low performances, less than optimal pedagogical environment and a lack of useful learning strategies. In this respect we have pointed at some challenges. By implementing new methods one has to expect lower performances before they get better: In every reform, and not at least with new curricula, it takes time before it is implemented and this is why the low results might reflect that the new methods are still not quite implemented. But when the results from PISA 2003 seem to show a decrease of the performance, this interpretation might seem like wishful thinking rather then a reasonable explanation.

Our interpretation of the PISA results gives an overall picture of the situation, which is in line with research findings regarding Reform 97. In our interpretation the fundamental underlying factors behind the PISA results are the following:

- The teacher's tendencies to be unsure about their own role as leader and responsible for the students learning and learning strategegies.
- A tendency to confuse activity and learning
- A demand for student centered methods in combination with unclear expectations in the subject domains.

We do not wish to be considered as spokesmen for one or another pedagogical tradition which have conflicting ideas. Instead we would like to emphasize that all teaching strategies might be carried out with high or low quality leading to high or low learning outcome. We wish for example not to portray project work as a bad method in itself, but it is obvious that it is very demanding to use such a method and get high learning outcome. It seems like a lot is yet to be done in this respect, especially if the method is forced on teachers without any motivation or any good assumptions for using this method. Similarly, we would like to distant from the broad misunderstanding that all kind of lecturing is of no use. In the same way we would warn against the assumptions that rehearsal and working with automation of certain skills are useless. On the contrary, our data seems to show that in a lot of situations, it would actually be an important strategy.

Working with a new curricular in Norwegian school, we hope that PISA has contributed with important data and given some premises for an important discussion about which way to go from here in the Norwegian school system.

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TIMSS and PISA 2003 in Norway

The present document is a short English version of the Norwegian national reports from TIMSS (Trends in International Mathematics and Science Study) and PISA (Programme for International Student Assessment) in 2003.

TIMSS is an international study, at present covering pupils in the 4th and 8th grades in more than 50 countries. The main objective is to describe and compare the pupils' achievements in science and mathematics. One of the purposes of the national and international comparisons is to find out what factors promote learning and understanding. TIMSS is the most extensive comparative research project in educational topics ever conducted.

PISA is an international study, which in 2003 covered 15-year-olds from 41 countries. PISA assesses to what extent students near the end of compulsory education have acquired the knowledge and skills that are essential for full participation in society.

More information is given at http://www.timss.no and http://www.pisa.no

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