Marit Kjærnsli, Svein Lie, Rolf Vegar Olsen og Astrid Roe

PISA 2006

Chapter 1 and 11 from the National PISA report "Tid for tunge løft"

PISA 2006 – main findings

This chapter has two main purposes. The first is to give a brief overview of the main goal of PISA 2006, the content and participating countries. The second is to give, a summary of the main results especially regarding the achievement levels in each subject domain. The results from the Norwegian students will be discussed both in an international and Nordic perspective. Finally, we will summarize the most important findings from each chapter.

1.1 What is PISA?

1.1.1 Content

PISA is an international comparative survey of the educational school systems in different countries. The first cycle of PISA was carried out in 2000, initiated by OECD (Organisation for Economic Co-operation and Development). PISA measures 15-year-olds' competencies in *reading*, *mathematics* and *scientific literacy*. In able to study the cumulative yield of education, the assessment takes place every three years and each time all the domains are included.

The following text box gives a brief overview of the basic elements in the PISA survey. Information about the measurements, how the survey is administrated and the quality standards are given in appendix 1.

Textbox 1.1: What is PISA?

What is OECD PISA?

- PISA (Programme for International Student Assessment) is an international comparative survey initiated by the OECD.

Content

- Measures 15-year-olds competencies in reading, mathematical and scientific literacy
- PISA takes place every three years with a different major subject domain
    - PISA 2000 – reading literacy
    - PISA 2003 – mathematics literacy
    - PISA 2006 – scientific literacy
    - Each subject domain included every time in able to study the cumulative yield
    - PISA 2003 also included problem solving

Methods

- Two hours of pencil-and paper test with tasks from the three subject domains
- Students answer a questionnaire which takes approximately 30 minutes to complete (providing information about family background, attitudes, learning strategies and learning environment in school)
- School principals are given a 20 –minute questionnaire about their schools

Organizing

- PISA was jointly developed by participating countries in OECD
- A sample of representatives from each participating country (PISA Governing Board) decides the political priorities and standards of the assessment
- The Norwegian survey is financed by the *Norwegian Directorate for Education and Training.* A research group from Institute for Teacher Education and School Development, University of Oslo is in charge of the test

PISA does not measure the school curriculum in different countries; instead it aims to measure the students' ability to understand concepts and use their knowledge and to function in various situations within each domain. Expert groups in the three domains have all developed a framework which describes in detail what is measured in each subject domain (OECD 1999, 2000, 2003 and 2006).

In the definition of the three subject domains, knowledge and skills are emphasized which are presumed to be of importance for young people to be able to participate in society in a lifelong perspective. There are less focus on specific subject skills and more on the use of knowledge in everyday tasks. In the International reports of PISA, the terms *Reading literacy*, *Mathematical literacy* and *Scientific literacy* are used on the three subject domains.

Scientific literacy includes how scientific knowledge is used in everyday situations such as interpreting information in newspapers and journals. The test demands of the students that they have scientific knowledge and that they are able to relate and reason in concrete situations which are described in the text. Scientific literacy in PISA gives priority to three scientific competencies. *Explaining phenomena scientifically* is about knowing and applying appropriate knowledge of science, such as facts, concepts and laws, especially in regards to interpreting phenomena and predicting changes in a given situation. The students have to use their knowledge of science or about science, in a given situation, or they have to explain phenomena scientifically. *Identifying science issues* requires that students show knowledge of science and what is regarded as key features of science. Students are also expected to be able to recognize what kind of issues can be investigated scientifically, and show that they are familiar with the main procedures of scientific enquiry. *Using scientific evidence*, requires students to make conclusions base upon the evidence, give reasons and produce arguments for or against a given conclusion and show that they are able to communicate their reasoning and evidence which they rely upon.

Reading literacy requires students to understand content and is capable of using written texts in order to achieve one's learning goals and develop one's knowledge. Students must be able to find relevant information, understand what the main theme of a written text is and be able to interpret or draw conclusions, reflect and evaluate the content of the text. The reading tasks are separated into three categories. In the first category, *Retrieving information* contains tasks which require the student to find information based on requirements or features specified in questions. Tasks in the second category *Interpreting texts,* requires students to form a broad understanding and develop an interpretation of the text, including drawing inferences. The third category, *Reflecting on and evaluating the content of a text,* contains tasks where students are expected to connect information from the text to their own knowledge and attitudes and opinions, and come up with their own ideas. The category also includes tasks where students are expected to evaluate the text structure such as use of graphics, genre, structure, style and language. Each of these categories contains tasks on different levels, depending upon the demands upon the students.

Mathematical literacy involves a broader perspective of knowledge and skills, than is traditionally regarded as mathematics in schools. Mathematical literacy underlines the students' ability to interpret information and reasoning based upon their knowledge in mathematics. The tasks in PISA are classified into three competency clusters. The first competency cluster being the *Reproduction cluster* covers the student's use of factual knowledge, recognition of equivalence, recollection of familiar mathematical objects and properties, performance of routine procedures, and of standard algorithms and technical skills.

In the second competency cluster, *the connections cluster,* students are expected to show that they are capable of finding connections between different areas in mathematics, and use representations of the same phenomena, find connections between definitions, evidence, examples and claims. The third competency cluster *the reflection cluster* measures the most advanced competencies. The students are expected to use critical thinking, analyze and reflect upon mathematical problems in a specific context, solve problems and discuss whether the solution may be generalized to other situations.

1.1.2 Participating countries

I PISA 2006, 57 countries participated. 30 were members of the OECD. Approximately 400 000 students participated and these are selected to represent the 32 millions of 15-year-olds which attend schools in all the participating countries. In table 1.1all the participating countries PISA 2006, are listed. Countries which are not members of the OECD, is marked with a star.

Table 1.1: Participating countries in PISA 2006

Argentina*	Ireland	Qatar*
Australia	Israel*	Romania*
Austria	Italy	Russia*
Azerbaijan*	Japan	Serbia*
Belgium	Jordan*	Slovakia
Brazil*	Korea	Slovenia*
Bulgaria*	Kyrgyzstan*	Spain
Canada	Latvia*	Great Britain
Chile*	Liechtenstein*	Switzerland
Colombia*	Lithuania*	Sweden
Croatia*	Luxembourg	Taiwan*
Denmark	Macao-China*	Thailand*
Estonia*	Mexico	Tcheck Republic
Finland	Montenegro*	Tunisia*
France	Netherlands	Tyrkey
Greece	New Zealand	Germany
Hongkong(China)*	Norway	Hungary
Indonesia*	Polen	Uruguay*
Iceland	Portugal	United States

** Countries which are not members of OECD*

All the participating countries have participated under similar conditions regarding the selection of students and procedures for how the test is carried out. When it comes to Hongkong and Macao, these are partly self-governed regions in China, but in this context, we have chosen to treat them as “countries”. All the participating countries which have satisfactory quality standards for implementation are included in the final ranking list. It is important to note though, that the international average score is taken from the OECD countries only. Most of the results in this report are from the OECD countries, or the Nordic countries. Appendix 1 gives a more accurate description of how the test is organised and administered.

1.2 Some main results

1.2.1 Main results in an international perspective

First, we would like to present some of the main results in the three different domains, science, reading and mathematics, given in average score with standard deviation in every country.

The more specific results for each category of different tasks or groups of students will be presented and discussed in the following chapters. The results will be given in figures, tables and graphics. Due to the number of participating countries, we have chosen to present the results on two figures for each subject domain, one for the OECD countries and one for the countries outside OECD. The international average score is only from the OECD countries. A brief overview of the different statistical and psychometric methods and the terminology used are given in Appendix 2.

Student performance in Science.

Figure 1.1A shows results in science for all the OECD-countries. Each country is given an average score with standard deviation in parenthesis. Confidence intervals for the average score (two standard error in each direction) is shown as the darkest part of the bars.

Countries which score higher than the OECD average will appear with the whole confidence interval (CI) to the right for the average score. The Standard deviation is given in a separate column as a measure of the variance in the achievements. The distribution is also shown at the 5., 25., 75. and 95. percentiles are given in the bars.

The Finnish students' score best of all the participating countries on the science items in PISA, but otherwise the Nordic countries do not perform particularly well. Only Sweden performs over the OECD average, but the difference is not statistically significant. Norwegian students have the lowest score among the Nordic countries, and only six OECD countries have a lower score than Norway. The average deviation from the average value (distribution) is similar to the OECD average, but after Iceland, it is the highest among the Nordic countries. The Norwegian results in science are definitely worrisome. Other details from the Norwegian results in Science will be further analyzed in this chapter and more details will be given in the Norwegian PISA report.

Figure 1.1A: Science performance in PISA 2006: OECD-countries. See text for explanation.

Country	Mean		S.D.
Finland	563	(2,0)	86
Canada	534	(2,0)	94
Japan	531	(3,4)	100
New Zealand	530	(2,7)	107
Australia	527	(2,3)	100
Netherlands	525	(2,7)	96
Korea	522	(3,4)	90
Germany	516	(3,8)	100
Great Britain	515	(2,3)	107
Czech Republic	513	(3,5)	98
Switzerland	512	(3,2)	99
Austria	511	(3,9)	98
Belgium	510	(2,5)	100
Ireland	508	(3,2)	94
Hungary	504	(2,7)	88
Sweden	503	(2,4)	94
OECD mean	500	(0,5)	95
Poland	498	(2,3)	90
Denmark	496	(3,1)	93
France	495	(3,4)	102
Iceland	491	(1,6)	97
United States	489	(4,2)	106
Slovakia	488	(2,6)	93
Spain	488	(2,6)	91
Norway	487	(3,1)	96
Luxembourg	486	(1,1)	97
Italy	475	(2,0)	96
Portugal	474	(3,0)	89
Greece	473	(3,2)	92
Turkey	424	(3,8)	83
Mexico	410	(2,7)	81

( ) standard error in brackets

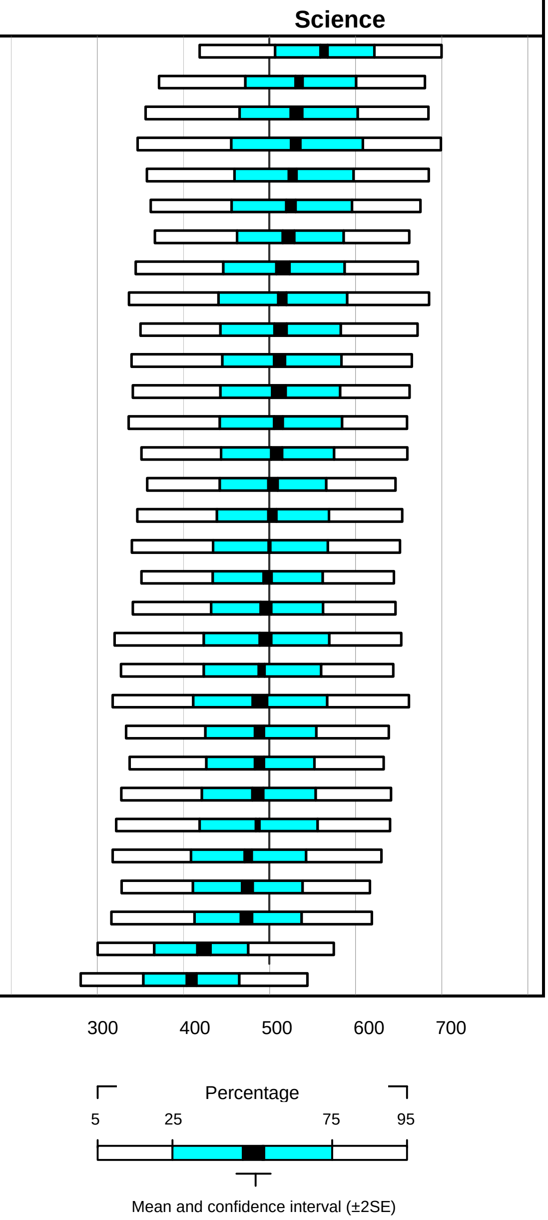
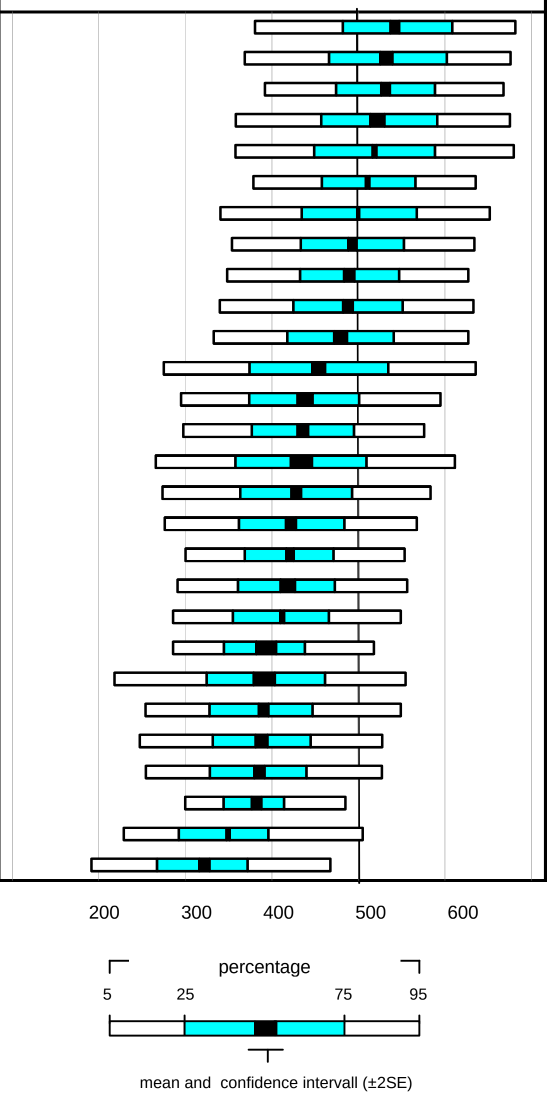


Figure 1.1B: Science Performance in PISA 2006: Countries which are not OECD members. See text in figure 1.1A for explanations. The graphic has the same scale as figure A, but the scale is closer to the left due to lower scores.

Country	Mean		S.D
Hong Kong	542	(2,5)	92
Taiwan	532	(3,6)	94
Estonia	531	(2,5)	84
Liechtenstein	522	(4,1)	97
Slovenia	519	(1,1)	98
Macao	511	(1,1)	78
OECD mean	500	(0,5)	95
Croatia	493	(2,4)	86
Latvia	490	(3,0)	84
Lithuania	488	(2,8)	90
Russia	479	(3,7)	90
Israel	454	(3,7)	111
Chile	438	(4,3)	92
Serbia	436	(3,0)	85
Bulgaria	434	(6,1)	107
Uruguay	428	(2,7)	94
Jordan	422	(2,8)	90
Thailand	421	(2,1)	77
Romania	418	(4,2)	81
Montenegro	412	(1,1)	80
Indonesia	393	(5,7)	70
Argentina	391	(6,1)	101
Brazil	390	(2,8)	89
Colombia	388	(3,4)	85
Tunisia	386	(3,0)	82
Azerbaijan	382	(2,8)	56
Qatar	349	(0,9)	84
Kyrgyzstan	322	(2,9)	84

( ) standard error in brackets

Science



Some of the results in figure 1.1A and B show that all the English-speaking countries except from USA, score below the OECD average. Also the German speaking countries such as Germany, Austria and Switzerland perform above the OECD average. It is also worth mentioning that Germany and Switzerland performed significantly weaker than the Norwegian students in PISA 2000. The countries in Latin America perform remarkably low. Lowest scores are found in Kirgizstan, Qatar and Aserbajdsjan, which have the weakest knowledge in science of all the participating countries.

Student performance in Reading

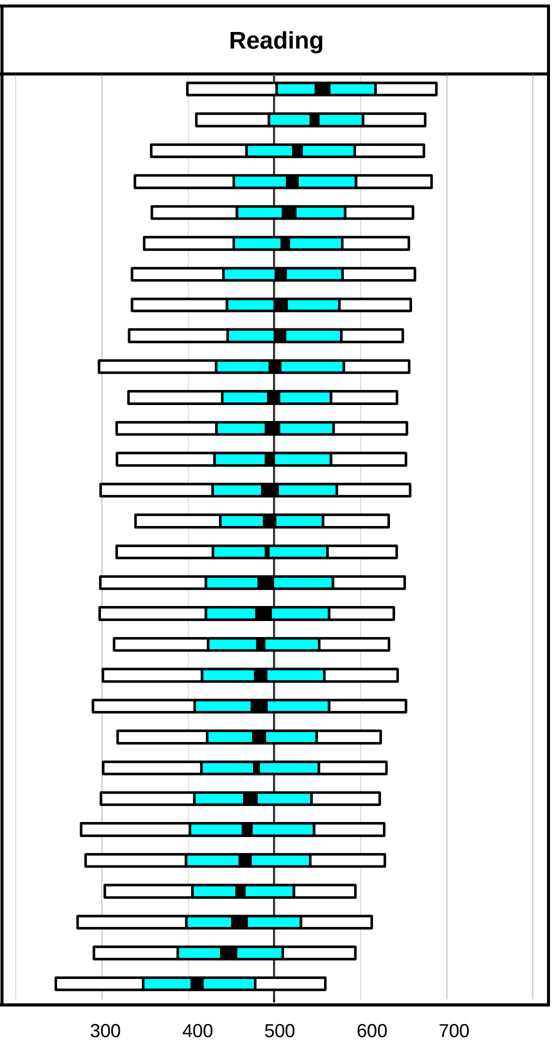
The overall results of reading are shown in figure 1.2A and B. When it comes to the OECD-countries, it is striking that all the English speaking countries score higher than the average score and all the South European countries have scores below the OECD average. Results from USA are not included, since their test booklets contained some printing mistakes which harmed the test situation, particularly regarding the reading items. With the exceptions of Poland, Estonia and Slovenia, all the countries which used to be called east European, have weak performance (have low scores). It is worth noting the particularly low scores for Montenegro, Serbia, Romania, Bulgaria and Russia. Students from the Latin countries such as Argentina, Chile, Colombia and Uruguay also appear with particularly low scores in reading comprehension. The same goes for students in Kirgizstan, Aserbajdsjan and Qatar.

The Norwegian scores are in contradiction to earlier PISA surveys, lower than the OECD average, which itself has been lowered from 500 points in 2000. Otherwise, the Finnish students perform as usual almost best of everybody, only the Korean students perform better. Of other Nordic countries, the Swedish students perform significantly higher than the OECD average, Denmark is close to the average score, and Iceland has the same result as Norway. We also notice that the distribution of results is relatively large in our country, considerably larger than in the other Nordic countries.

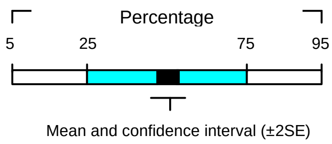
We also establish the fact that Norwegian 15-year-olds’ reading comprehension is below the OECD average, and significantly worse than in both 2000 and 2003, and students from Norway and Iceland perform lowest of the Nordic countries, but that the variance in Norway is above the average and highest of all the Nordic countries. A further description and interpretation of the results in reading, is given under 1.4 and in chapter 5 in the Norwegian PISA report.

Figure 1.2A: Reading Performance in PISA 2006: OECD-Countries. See text in figure 1.1A for explanations.

Country	Mean		S.D
Korea	556	(3,8)	88
Finland	547	(2,1)	81
Canada	527	(2,4)	96
New Zealand	521	(3,0)	105
Ireland	517	(3,5)	92
Australia	513	(2,1)	94
Poland	508	(2,8)	100
Sweden	507	(3,4)	98
Netherlands	507	(2,9)	97
Belgium	501	(3,0)	110
Switzerland	499	(3,1)	94
Japan	498	(3,6)	102
Great Britain	495	(2,3)	102
Germany	495	(4,4)	112
Denmarkl	494	(3,2)	89
OECD mean	492	(0,6)	99
Austria	490	(4,1)	108
France	488	(4,1)	104
Iceland	484	(1,9)	97
Norway	484	(3,2)	105
Czech Republic	483	(4,2)	111
Hungary	482	(3,3)	94
Luxembourg	479	(1,3)	100
Portugal	472	(3,6)	99
Italy	469	(2,4)	109
Slovakia	466	(3,1)	105
Spain	461	(2,2)	89
Greece	460	(4,0)	103
Turkey	447	(4,2)	93
Mexico	410	(3,1)	96

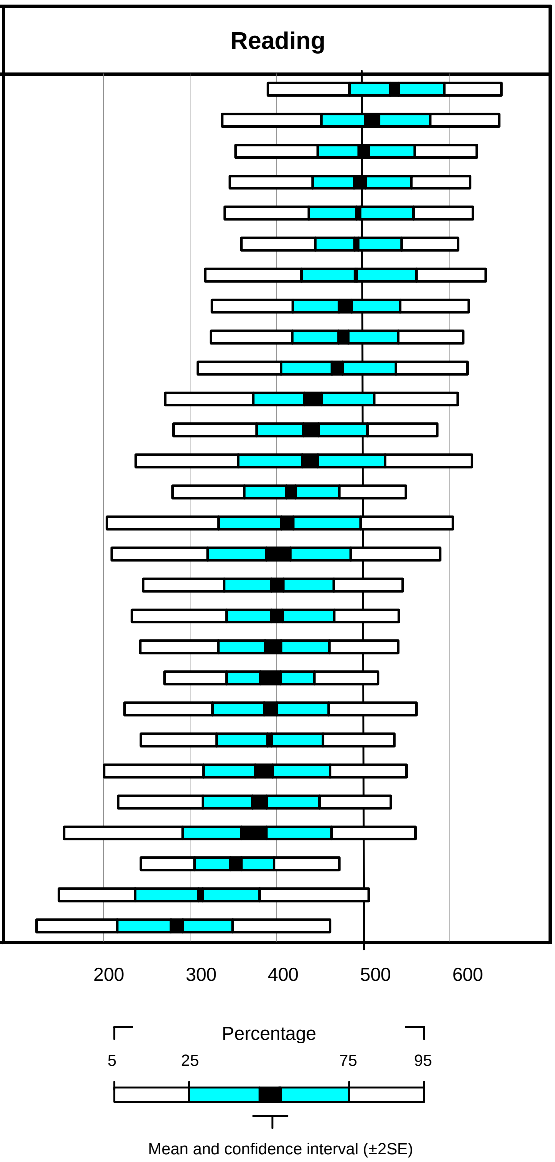


( ) standard error in brackets



Reading Performance in PISA 2006: Countries which are not OECD members. See text in figure 1.2B for explanation. The graphic has the same scale as figure A, but the scale is closer to the left due to lower scores.

Country	Mean		S.D.
Hong Kong	536	(2,4)	82
Liechtenstein	510	(3,9)	95
Estonia	501	(2,9)	85
Taiwan	496	(3,4)	84
Slovenia	494	(1,0)	88
Macao	492	(1,1)	77
OECD mean	492	(0,6)	99
Latvia	479	(3,7)	91
Croatia	477	(2,8)	89
Lithuania	470	(3,0)	96
Chile	442	(5,0)	103
Russia	440	(4,3)	93
Israel	439	(4,6)	119
Thailand	417	(2,6)	82
Uruguay	413	(3,4)	121
Bulgaria	402	(6,9)	118
Serbia	401	(3,5)	92
Jordan	401	(3,3)	94
Romania	396	(4,7)	92
Indonesia	393	(5,9)	75
Brazil	393	(3,7)	102
Montenegro	392	(1,2)	90
Colombia	385	(5,1)	108
Tunisia	380	(4,0)	97
Argentina	374	(7,2)	124
Azerbaijan	353	(3,1)	70
Qatar	312	(1,2)	109
Kyrgyzstan	285	(3,5)	102

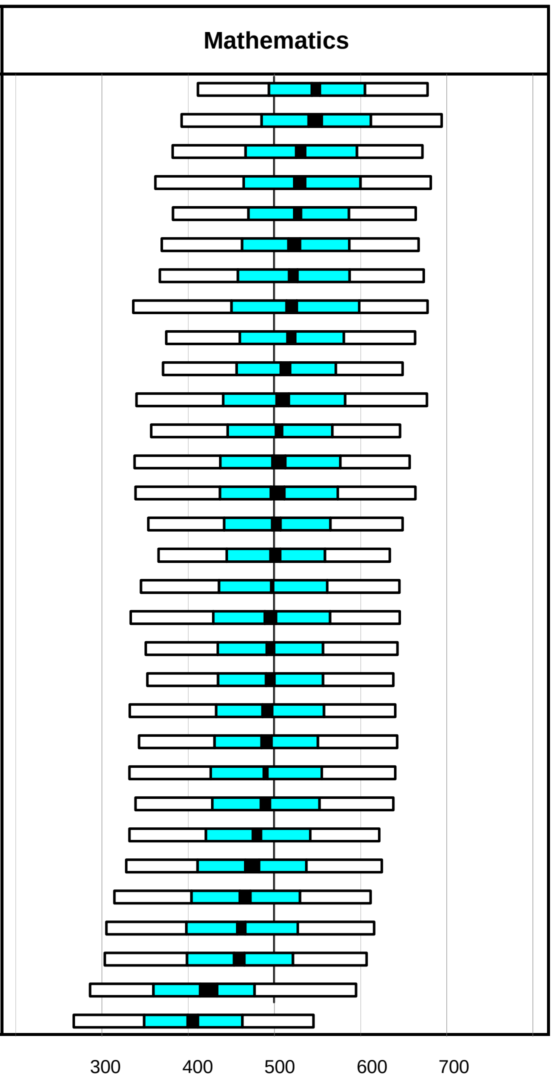


( ) standard error in brackets

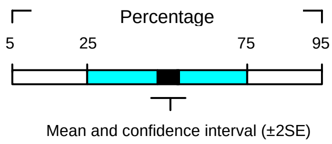
Student performance in Mathematics

Figure 1.3A: Mathematics performance in OECD-countries. See text in figure 1.1A for explanations.

Country	Mean		S.D
Finland	548	(2,3)	81
Korea	547	(3,8)	93
Netherlands	531	(2,6)	89
Switzerland	530	(3,2)	97
Canada	527	(2,0)	86
Japan	523	(3,3)	91
New Zealand	522	(2,4)	93
Belgium	520	(3,0)	106
Australia	520	(2,2)	88
Denmark	513	(2,6)	85
Czech Republic	510	(3,6)	103
Iceland	506	(1,8)	88
Austria	505	(3,7)	98
Germany	504	(3,9)	99
Sweden	502	(2,4)	90
Ireland	501	(2,8)	82
OECD mean	498	(0,5)	92
France	496	(3,2)	96
Great Britain	495	(2,1)	89
Poland	495	(2,4)	87
Slovak Republic	492	(2,8)	95
Hungary	491	(2,9)	91
Luxembourg	490	(1,1)	93
Norway	490	(2,6)	92
Spain	480	(2,3)	89
United States	474	(4,0)	90
Portugal	466	(3,1)	91
Italy	462	(2,3)	96
Greece	459	(3,0)	92
Turkey	424	(4,9)	93
Mexico	406	(2,9)	85



( ) standard error in brackets



The results in Mathematics show the same patterns as in Science and Reading. In English speaking countries, with the exception of USA, the countries have high scores. In South-Europe, and particularly in Latin-America, the student's scores are low. Countries in what was formerly known as East-Europe score some what better in mathematics than in reading.

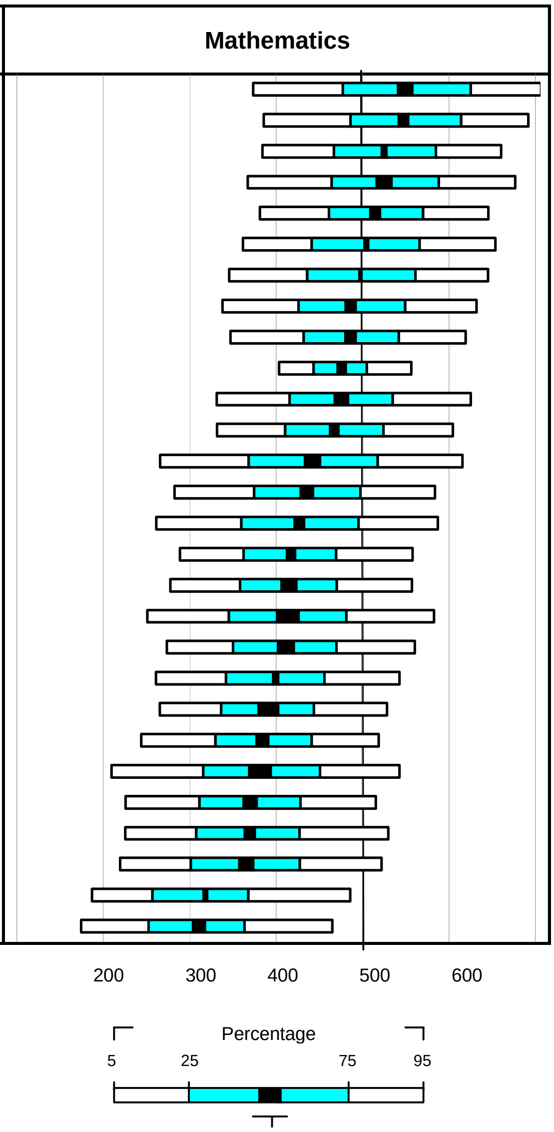
Otherwise it is worth noting that as much as five out of ten high achieving countries are East Asian. Aserbajdsjan appears with somehow surprisingly profile, since the countries results in mathematics are much better than in reading.

And again, Finland outperforms all the Nordic countries. The students from Iceland, Denmark and Sweden performed higher then the OECD average, but only the Swedish students score significantly better. The Norwegian results appear disappointing, since the Norwegian students score significantly lower than the OECD average for the first time in PISA.

When looking at the variation, it is also highest among the Nordic countries and at the same level as the OECD average when it comes to mathematics

Figur1.3B: Mathematics performance in PISA 2006: Countries which are not OECD members. See text in figure 1.1.A for explanation. The graphics has the same scale as figure A, but the scale is closer to the left due to lower scores.

Country	Mean		S.D
Taiwan	549	(4,1)	103
Hong Kong	547	(2,7)	93
Macao	525	(1,3)	84
Liechtenstein	525	(4,2)	93
Estonia	515	(2,7)	80
Slovenia	504	(1,0)	89
OECD mean	498	(0,5)	92
Lithuania	486	(2,9)	90
Latvia	486	(3,0)	83
Azerbaijan	476	(2,3)	48
Russia	476	(3,9)	90
Croatia	467	(2,4)	83
Israel	442	(4,3)	107
Serbia	435	(3,5)	92
Uruguay	427	(2,6)	99
Thailand	417	(2,3)	81
Romania	415	(4,2)	84
Bulgaria	413	(6,1)	101
Chile	411	(4,6)	87
Montenegro	399	(1,4)	85
Indonesia	391	(5,6)	80
Jordan	384	(3,3)	84
Argentina	381	(6,2)	101
Colombia	370	(3,8)	88
Brazil	370	(2,9)	92
Tunisia	365	(4,0)	92
Qatar	318	(1,0)	91
Kyrgyzstan	311	(3,4)	87



( ) standard error in brackets

1.2.2 Main findings in a Nordic perspective

Performance in all the three subject domains

Figure 1.4 shows the performance in each of the three subject domains for the Nordic countries. The results are here given as the country score over or below the OECD average. Unfortunately, Norway appears as the country with lowest scores in Scandinavia, and ignificantly below the OECD average in all the subject domains. While Finland scores far above the OECD-average in all subjects, the rest of the countries results are close to the average value. The main findings are very similar to what we saw in PISA 2003, and 2000 (Lie et al. 2001, Kjærnsli et al.2004), but the Norwegian results are even lower. We conclude that the performance is low without further comments here. The results will be discussed in detail later in this chapter.

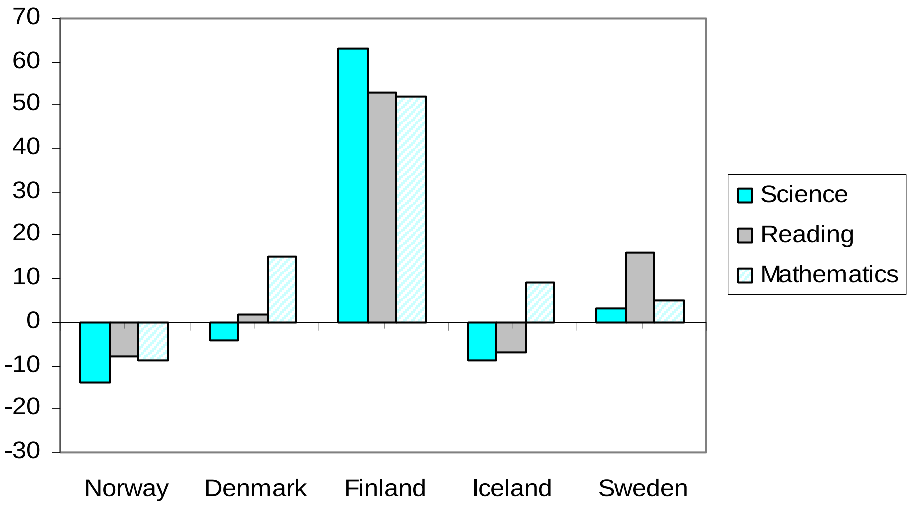


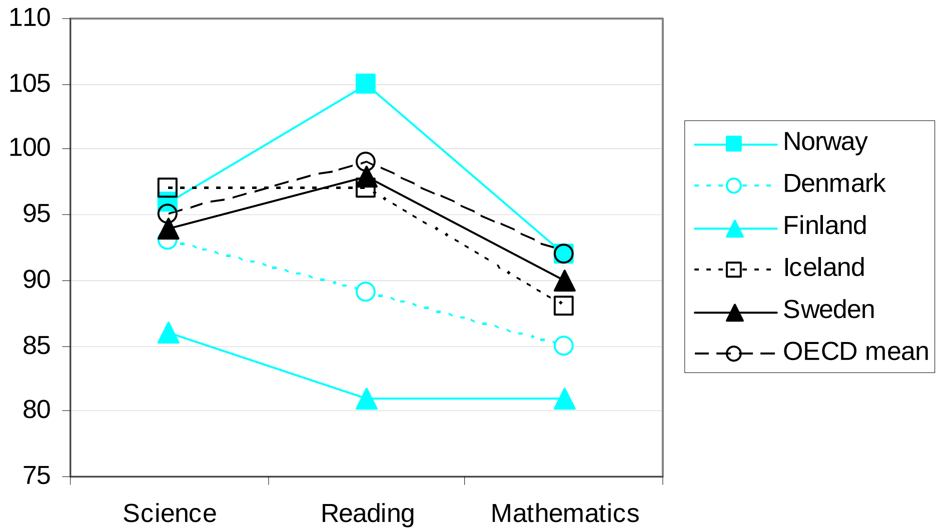
Figure 1.4: Score in Science, Reading and Mathematics for all the Nordic countries, above or below the OECD average.

Variation in the three subject domains

Also when variation is taken into account, it is interesting to compare Norway to other Nordic countries and the average score of the OECD-countries. Figure 1.5 shows the size of the standard deviation in each country has each subject domain. It appears clearly from the figure, that our country is generally the largest variation among students, and especially in reading, we notice a strikingly large variation. In regards to the stress in working for equity and equal opportunities, these results are more than problematic. According to these results, we cannot say that the Norwegian schools are able to reduce the differences between the students. Instead, in this report, we compare student groups to see what kind of factors lay behind such huge differences among the students. Important factors here are between gender differences, (see 1.4), differences between schools, and between students with different home background (see chapter 10).

Otherwise it is worth noticing the low variation in Finland. It is remarkable how Finnish students achieve high scores with low variation in all the three subject domains. In this sense, Finland can be seen as the most successful of all the countries participating in PISA.

Figure 1.5: Standard deviation (in score sum) for each subject domain in the Nordic countries and for the OECD average.



1.2.3 Development over time for the Norwegian students

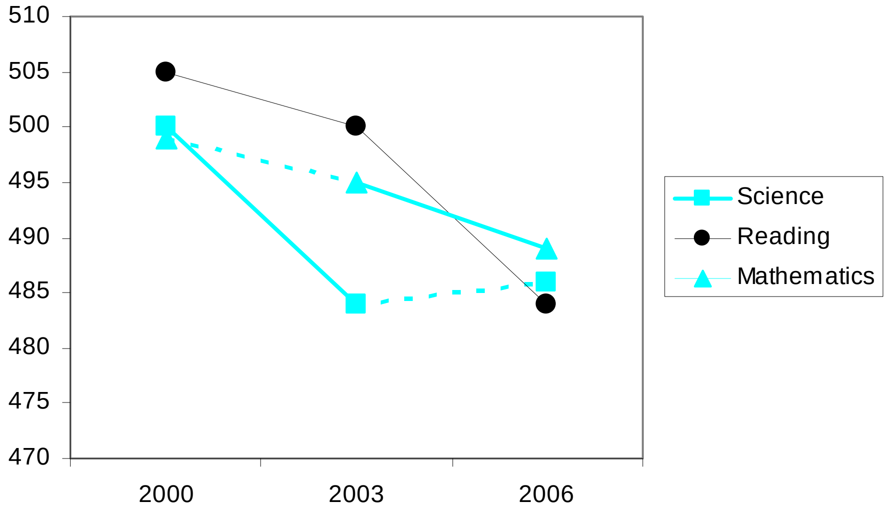
The results shown so far need to be commented on regarding changes in the Norwegian students PISA scores over time. It is important to underline though, that such comparisons are not easy, and particularly, it is more difficult in science and mathematics, than in reading.

Reading was the main domain in 2000, and several of the reading tasks used in 2000, were kept secret. This allowed us to use the Rasch-model (see Appendix 2) and make a scale for 2006 which represent exactly the same values as in 2000 and 2003. In mathematics very few items were used in 2000, which did not allow the researchers to cover the whole area of mathematics. Instead two out of four areas where chosen; *Space and Shape* and *Change and Relationship* (see chapter 7 in Kjærnsli et al. 2004). The comparison with 2000 and 2003 is therefore not quite reliable, as we did not measure the same areas in mathematics.

In a similar way, the comparison of science in 2003 and 2006 is problematic, since a new framework is made with a slightly different perspective, where among other things, the demands of reading comprehension for solving the science items, are lowered.

Despite the insecurity regarding the changes in the tests, and with certain reservations about the details, we have chosen to show the development over time in figure 1.6 for all the three subject domains. Where the comparison is particularly problematic, we have chosen to show this by using steeped lines. Even though there are some uncertainties, it appears clearly that there has been a decrease in achievements in all the three subject domains, and particularly we find a strong negative decline in reading performance. It must also be mentioned that it has been an average decline in reading comprehension in the whole OECD-area, so the OECD mean has also decreased from 500 to 492 points in the same time. This is the reason why we in figure 1.6 did not want to compare the OECD mean score when looking at changes over time period. These results will be further discussed in several of the chapters in the Norwegian PISA report.

Figure 1.6: Norwegian results in PISA from the three surveys in each subject domain. Standard errors in all the "datapunkt" is approximately 5 points. In addition, the framework in mathematics and science has changed in such a way that the scales are not exactly the same. Particularly problematic comparisons are marked with "stippled" lines.



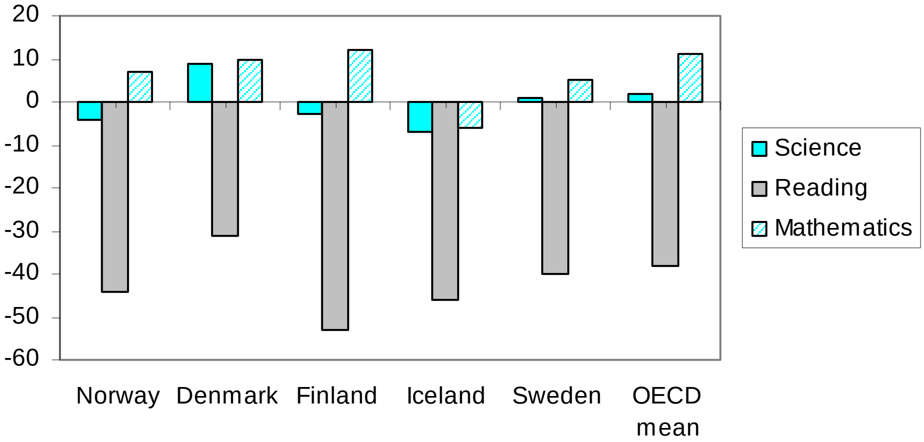
There is also a clearly decreasing pattern in all the three subject domains regarding the average achievements for Norwegian students. A comparison with earlier PISA studies shows variation among the Norwegian students is as large as earlier. There is therefore no systematic pattern in direction of larger or smaller variation over time in any of the three subject domains.

1.2.4 Gender differences.

Gender differences represent important findings in PISA. In the Norwegian report, boys and girls are compared regarding achievements, attitudes and other variables.

Some of the overall gender differences will be presented for all the three subject domains. Figure 1.7 illustrates the gender differences in the Nordic countries. It appears clearly from the figure, that girls outperform boys in reading across countries, and that there are small and variable gender differences in science and mathematics from country to country. Girls achieve slightly better than boys in science in our country, but the difference are not significant. In a later chapter in the Norwegian PISA report, the gender differences will be analyzed in detail for each subject domain.

Figure 1.7: The difference in score between boys and girls in each subject domain. Positive score values in boys' favor. The difference must be approximately 5 – 8 points to be significant.



We have compared gender differences in 2006 with the results in PISA 2003 and 2000, but it is hard to find any specific pattern through the three surveys.

For all the three surveys, the Danish students' results are in favour of the boys more than in the other Nordic countries, and this effect is particularly strong in science and reading.

We also find strong gender polarization in the achievements in mathematics and reading in Finland. Norway is among the countries with least gender differences in science.

1.2.5 Language

16 percent of the Norwegian students who participated in PISA 2006, used *Nynorsk* as their main language. These students achieve equally well in mathematics and science as students in Norway who has *Bokmaal* as their main language. In reading we find a small difference in favour of students using *Bokmaal* as their main language, but the difference is not significant. We conclude that the difference among students using *Bokmaal* as their main language and *Nynorsk* as their main language, do not have anything to say for the results in Norway. We will therefore not comment further on the students main languages in this report.

1.3 Other main findings

In the following, we will give a brief overview of some of the other main findings. The results are extensively discussed in other chapters in the Norwegian PISA report, and in chapter 11, an attempt is made to summarise and discuss the results and what it means for the Norwegian school.

1.3.1 Student performance in Science

In chapter 3 an extensive discussion of the students' achievement on different areas in science is given. We would like to shortly summarize some of the findings. PISA 2006 has introduced six proficiency levels in science. The Norwegian student's variation is as expected when the average results are below the OECD level, and the variation larger than the OECD means score

The results are given for three different competencies, and the Norwegian students achievements are considerably lower in competence 3, *Using scientific evidence*, than the two other competence classes, *Explaining phenomena scientifically* and *Identifying science issues.* The same profile is seen in Denmark and Sweden. The Norwegian students show their strengths in Knowledge in Science, less in Knowledge of Science. They also achieve relatively better in subjects of geology and biology then subjects in physics and chemistry, even if the difference is not very large.

There are no significant gender differences in science, although we find small differences in girl's favors in our country. In each of the participating country, girls perform significantly better than boys in competence 1, (*Identifying science issues)*, while boys achieve better in competence 2 (*Explaining phenomena scientifically*). In the last competence category, the difference is smaller, but in girls favors in our country. When looking at the different areas in science, boys achieve better than girls in physics and chemistry and geology, something which is also found in the other participating countries.

1.3.2 Students' attitudes towards Science

Students' attitudes towards different aspects of science have been central in PISA 2006. They concern among other things students self-concept, their general valuation of science, their motivation to learn science and their views on important questions regarding environmental issues (see chapter 4).

Two of the constructs relate to the students self-perception of science, these are *Science self-efficacy* and *Science self-concept.* For both of these constructs, Norwegian students report results around average in OECD and among the Nordic countries. The correlations with the achievement level is approximately 0.4 both for Norwegian students and students from the other Nordic countries. A striking result is the gender differences in favor of the boys despite the fact that girls achieve better in the PISA test. Another result is the tendency that the higher students achieve in one country, the lower self-concept they report in the subject.

When students are asked about their general valuation of science, either in a personal or social since, the results are slightly below the OECD average. The gender differences are small, but the correlation with the achievement level in science is approximately 0.3.

Some of the constructs are related to students' science interest. It is also a general characteristic of Norwegian students to report less than average interest for science, just like students from the other Nordic countries. The correlations with achievement level vary from 0.2 to 0.4 depending on which aspect of the interest is measured. There are no specific gender differences.

It is worth mentioning that all the countries which are not members of OECD, report higher interest levels than the OECD average, in other words, these students show more interest for learning in general.

Several of the constructs are about the students views upon certain important environmental issues. It is about their knowledge and concerns about these issues, and also their feelings of responsibility and optimism regarding possible solutions. The results of these constructs vary a lot from issue to issue. The Norwegian students appear in an international perspective with quite average awareness to these problems, but they seem to be less worried and more optimistic about the future and the possibility to solve these problems. When interpreting these results it is important to remember that the environmental problems the students are asked about are of relatively little concern in our country.

The gender differences found in these constructs also show a striking pattern in the Nordic countries: The boys report a higher awareness and optimism than the girls regarding these problems. The girls appear with more worries and a feeling of personal responsibility to do something about the problems, compared with the boys. It is also a striking result to see how these constructs correlate with the achievement level in science: conscienscousness and feelings **of responsibility** correlate quite positively high with the achievement level, while there is no correlation between concerns for the environment and achievement level, and it is a slightly negative correlation between optimism and achievement level.

1.3.3 Teaching and learning strategies

The students were asked to make their opinion regarding several different statements about their science classes and the teaching they experience. This report gives a picture of what is going on in Norwegian classrooms compared to other Nordic classrooms and in OECD (see chapter 5). Regarding two of the constructs, *Conversation* and *Application,* Norwegian students report close to the international average score. *Practical student work* occurs more often, and *Exploration of my own ideas* less than the international average score. Especially when it comes to the last construct, we have shown a clear negative correlation between science score in most countries.

Student's use of learning strategies was not measured internationally as in the previous two surveys. Norway chose to add three constructs as national options for using learning strategies in science: elaboration strategies, control strategies and memorization strategies. In contrast to earlier PISA surveys, these items were context –specific, the students were asked to report about their use of learning strategies when preparing for a test in science. These items are therefore closer to the specific context the students experience when taking the PISA test. Even if the correlation is somehow higher then in earlier PISA surveys, the correlation is still low and gives only weak support for the theory that practicing better learning strategies will improve the students' subject learning.

1.3.4 Reading

The results show that Norwegian 15 year olds reading competence is significantly worse than three years ago (see chapter 6). Even if there has been a decline in all the OECD-area, the fall in the results is largest in our country. Students from Iceland have a corresponding decline in reading as the Norwegians. It has not happened in Sweden and Denmark, where the students achieve significantly better than the Norwegian students. The Finnish students are still on the high achievement level as in 2000 ad 2003. The gender differences in favor of the girls are generally high in all the countries, but in Norway, Finland, Iceland and Sweden they are larger than in OECD. Students in the lowest competence level have increased compared to the two previous surveys. The Norwegian students strengths and weaknesses as readers seem to be the same as in 2000, when there was a tendency of students having most problems with tasks demand accuracy and perseverance, and where the text was not particularly entertaining for young students.

The gender-difference in Norway has been large and stable from 2000 to 2006, and the decline in reading concerns therefore both girls and boys. The gender-difference varies from task to task, but the gender-specific results have the same characteristic pattern as in 2000 and 2003. In short, this means that the girls achieve much better on open tasks which demand reflection and interpretation, and which include longer texts. The boys achieve as good as girls regarding tasks about tables, maps and graphs.

When it comes to students reading habits, we can find a slight improvement from 2000, especially for boys. Norwegian boys are more positive to reading activities, and they read more books than in 2000. It must be said though, that Norwegian boys represent the least positive group of boys in PISA 2000, so they had quite a potential for improvement. Even though they are now changing in a more positive direction, we do not find any improvement regarding their reading achievements, in contrast to what one might have expected.
In fact, their achievement level has decreased. Still, it would be wrong to conclude that positive reading habits do not influence reading achievement positively. Both research and common sense tell us that it does matter. What seems to be the case is that the negative factors influence more strongly than the positive factors. Which variables that have had a negative influence on our students, we do not have any evidence about in our data. Instead we suggest that there are multifaceted and complex reasons, both related to the society and cultural issues, and also issues regarding students' background and schools and teaching. In chapter 11 we will take a closer look at some of these issues.

1.3.5 Mathematics

The Norwegian mathematic results show a weak but continuing decline in the period from 2000 – 2006. This decline is weak from one survey to the other, but all together the tendency is clear. The Norwegian results are now significantly lower than the OECD mean, something which has not been seen earlier. These results are strengthened by the results from the TIMSS survey (Grønmo et al 2004) which shows that there has been a significant decline in Mathematics, from 1995 to 2003 for younger students. These results of decrease should therefore not be ignored just because they are small from one survey to another. Compared to the other Nordic countries, the Norwegian results are significantly the weakest. The distribution in Norway is like the Norwegian results in earlier surveys, whish is close to the mean in OECD-countries, and larger than in the other Nordic countries.

The Norwegian profile of achievement in Mathematics shows the same pattern as found in 2003. Norwegian students do well on tasks regarding practical probability and statistics, while they are performing weaker in the other areas included in PISA. We are particularly concerned about the Norwegian students' weak performance regarding basic arithmetic. This characteristic pattern was even more clearly seen in TIMSS (Grønmo et al 2004, Lie et al 1997).

The gender-difference in Mathematics is in favor of the boys in all the OECD countries, with Iceland as the only exception. The difference in Norway is small, and on the same level as earlier. The underlying pattern found in the gender-differences, is found in the profiles across the framework, and seems to be the same over time. The gender-difference is furthermore related to certain tasks, something which makes it more difficult to give a clear and at the same time general, description of what these differences among boys and girls regarding competence in mathematic are actually all about. The results in Mathematics are presented in chapter 7.

1.3.6 Students' use of ITC at home and in school

Most students report that they have access to computers in their homes. 86 % of them use their computers at home everyday, while only 17 % use their computer in school every day (see chapter 8). In 2000 53% of the students reported that they used their computer at home. In 2006, the number has increased to 86%. The use of ITC in schools has also increased, but to a lesser extent.

While 5% of the students reported that they use the computer everyday in school, in 2000 there is now17% of the students who report the same. There is less gender difference in boys favor regarding use of the computer in 2006 than in 2000.

When it comes to the use of computers at home, students in all the Nordic countries are above the OECD-average. Use of ICT in schools, shows that Iceland and Finland report to use ICT less than the OECD mean, and there are few students in Finland who use ICT everyday in school.

The Norwegian students use the computer more often than six years ago, and the activity which has increased the most, is communication with others. Girls report that they communicate more often by using the computer than the boys do. In PISA 2003 31% of the girls reported to communicate with others every day, while in 2006, 78% of the girls report to do this.

The Norwegian girls report to use the internet and software relatively more often than students in the other Nordic countries and more than the OECD-average. They also report to have very high self-efficacy, both regarding basic use of the Internet and also more advanced use of ICT. There is no clear relation between ICT use and achievement.

1.3.7 Data from the school questionnaire

Norwegian principals report to a larger degree than principals in other Nordic countries that teaching in schools is impeded by lack of qualified teachers, and lack of resources such as computers and school books. These findings have to be interpreted in light of the expectations these principals meet. Compared with schools in other countries, there is reason to believe that the situation regarding materials is probably good, since Norway is among the countries with highest amount of computers. We have interpreted the situation to be that our principals face expectations from the curricula, parents, students and others regarding the material and resources.

One central characteristic which is described here is that it is very rare to organize teaching according to student's level of competence or across grades. This can be understood historically with the implementation of the upper secondary school, where all the students went together in classes. Norwegian principals also report relatively little pressure from parents when it comes to the student's development in subject knowledge. In the Nordic countries, Finland stands out as the country where principals report little pressure from the parents, while Swedish principals report to experience large pressure from parents. Norwegian principals report that results about students subject knowledge and achievement are used to a little degree as foundation for evaluating principals or teachers. Finland and Sweden again show contrasts here, since schools in Finland to a very little degree publish their school results about subject achievements when evaluating their schools, while schools in Sweden do this to a large degree.

The results also show that Norwegian principals to a little degree perceive that they can practice autonomous, pedagogical leadership. In the other Nordic countries, principals to a larger extent see themselves as having the main responsibility for pedagogical decisions. Norwegian school leaders have to a certain degree a view upon them selves as more administrate vie leaders than the OECD average, but also for this index, Norway appear with a relatively low value among the Nordic countries. Sweden especially, appears to be a country where the principals experience that they have a strong independent responsibility regarding administrative tasks. Finland is in the opposite end with strong municipal governance of the schools. Generally, there are no relation between the reported answers from the principals and the school achievement in Norway (see chapter 10).

11 Discussion and perspectives

11.1 Premises for assessment of Norwegian schools based on PISA

11.1.1 PISA’s and our role as a part of national assessment

It is understandable that the results from PISA 2006, as earlier PISA surveys, will play an important role when discussing pedagogy and school policy. Recently a comprehensive plan for assessment of the Norwegian school system has been made (Utdanningsdirektoratet 2007a). In this plan, national tests and exams are central parts. The international studies are also important parts of this plan for national assessment. In light of this, it is also necessary to look beyond the results and try to give an interpretation in this perspective. In this chapter two particular questions will be discussed.

- How relevant are the described results in PISA as a measure of the quality in Norwegian schools?
- How can we interpret these findings in light of what actually goes on in Norwegian schools, especially regarding science and reading?

The PISA results can be said to be an evaluation of Norwegian schools on external premises. The main question in PISA is: To what degree does the Norwegian school system foster some basic competences which international consensus and agreement consider what is important for young people in a lifelong perspective?

11.1.2 PISA 2006 as an important and relevant assessment of the Norwegian school system

It will always be possible to ask the question of whether PISA gives a relevant picture of the quality of Norwegian school, since there are so many areas which are not covered and measured. In this report we have emphasized what actually *is* measured of knowledge and attitudes and we believe these are central aspects which are not vicariously selected.

Science, reading and mathematics are three subjects in school. It is also important to be aware that reading and arithmetic are described as basic knowledge in the *Knowledge Promotion*, exactly because these competencies are seen as necessary for being able to attain knowledge in all other subject domains. The literacy perspective in PISA places the survey close to what can be seen as the heart of the goals for the Norwegian school system.

We have shown that there is a reasonable relationship between the subject goals in both L97 and the *Knowledge Promotion* and what PISA measures (see chapter2, 6, and 7 for further discussions).The students in PISA 2006 only followed L97, since the new curricula where first implemented in the autumn 2006, after these students left secondary comprehensive school.

To further validate the PISA-test in the Norwegian school system, the Norwegian students where given a few additional questions as national options in the student questionnaire.

Among others, they were asked about their grades in Science, Norwegian and Mathematics the last semester. The correlation between the grades in Science, Norwegian and Mathematics on the one hand, and the PISA results on the other, is 0.48, 0.36 and 0.53 (see appendix 2 about correlation). As expected, we find the lowest correlation between reading and the subject Norwegian, since Norwegian contains far more than just knowledge of reading. These values of correlation are of such a size, as to be seen as reasonable, they are not too small, and not too big between the two measures of subject knowledge. They both measure much of the same, but exactly what is measured and how it is measured, is so different that the correlation between them cannot be expected to be higher. We conclude that there are also empirical arguments for a reasonably high validity for the PISA test as a relevant measure of the competence in the Norwegian school system.

We further claim that the knowledge, skills and attitudes emphasized in PISA, represent what is seen as the central and overall goals in L97, and also for the Knowledge Promotion. This is also obvious when noticing the slogan in PISA: “Learning for life”, which reflects the knowledge which is important in real life, not only in school and further education. The slogan also reflects other aspects than the purely cognitive ones. Motivation, positive self-esteem and good learning strategies are not only important for good learning in school, but also for further learning in a life long perspective.

It is our conviction that the PISA test measures competencies which are also valuable in a Bildung perspective. The Literacy tradition PISA builds upon, does represent something which is of importance in general. It is something which is important for personal growth and critical insight which will give valuable knowledge for future education and work. The PISA test represents as we see it the Bildung tradition as good as other tests and exams in our country.

11.1.3 Do Norwegian students show low test motivation for the PISA test?

In the previous PISA report, we mentioned the possibility that students with low test motivation could influence the test scores (Kjærnsli et al 2004, p. 252). Why should they bother to struggle on the test, if they did not get anything back, not even their personal result as a test score? We have established that in some schools, some boys who seem to ignore the test, and not participate in it, that they do not bother with spending more than a short time on the test. However, it is hard to say whether these are boys who in other circumstances would have achieved better on the test.

We can to a certain degree measure the students test motivation in PISA. The task booklet contains an “effort-thermometer” where the students are supposed to report their relative contribution on a scale from 1 to 10 that is the effort they used when taking the PISA test, where 10 represents the effort they would have used if their contribution they showed on the test would have influenced their semester grade in school. The average level for Effort in Norway was somewhat low compared with other countries, but the differences between the countries were small (OECD 2007b). On the student level, these variables correlate approximately 0.2 with achievement in the Nordic countries, and it explains close to 4 % of the variance between the students. But even more important is the fact that the student’s achievements and *the relative effort* did not show any correlation at all in Norway. The effort variable cannot explain anything of the variations in achievement between countries. We have also corresponding data from the effort thermometer in PISA 2000, and it shows that the average level for *relative effort* was on the same level as in 2006. We cannot show any significant change through this period, what so ever. Less effort from students on the PISA test can therefore not be a significant factor behind the decline in the achievement level.

In her PhD thesis, Hanna Eklöf (2006) carried out a survey of the Swedish students test motivation for TIMSS 2003. She gave a student sample an additional questionnaire just before and after the test and also carried out interviews of the students. Her conclusions were that the sample of students looked at the test as important, and they were motivated for doing their very best, and carried out the test in line with this. We do not have any reason to believe that the situation is different in our country than in Sweden when it comes to test motivation on a "low-stake" international test, which have no consequences for the students. This message is also in line with findings in Therese Hopfenbeck PhD work, (unpublished). She has interviewed 22 Norwegian students which have participated in the PISA test, and they give an impression of having been doing their best.

What is mentioned here, does not mean that we believe that all Norwegian students have worked as hard as possible on the PISA-test, but we believe that their effort on this test correspond with their achievement in school in general. In this way, we might say that the results are realistic, unless more effort is seen in schools in ordinary school work. We will come back to this question.

11.2 Science

11.2.1 A Strategy for Science

The governments' strategy for A Joint Promotion of Mathematics, Science and Technology (KD 2006a, 2007) shows that science and mathematics are prioritized areas. The most important functions these documents have, is to coordinate the different initiative and through reviews give feedback to these initiatives. The strategy plan also identifies what kind of mandate the different partners have. The strategy plan has also been evaluated, and several reports from the evaluation have been published (Norwegian Directorate for Education and Training2005, 2006a, 2006b, 2006c). The evaluation claims that there seems to be a problem with communication or leadership with the consequence that the strategies do not reach the schools well enough. One important result of the strategy plan was the establishment of the Norwegian Centre for Science Education at the University of Oslo. This centre has been one of many initiatives established for supporting science in all grades in the Norwegian Primary and Lower Secondary Education, and it has played an important part in coordinating the different initiatives which are identified in the strategy plan.

Despite this, it must be reasonable to ask whether the investment in science has actually made an impact on science in schools. First and foremost there have been changes regarding mathematics, where large initiatives have taken place: There has been an increase in the number of hours in mathematics in school both in Primary, Lower and Upper Secondary Education. In addition, some teachers have received funding for relevant education in mathematics. Science has not been strengthened with more school hours in Primary and Lower Secondary Education, and even if there is some funding for further education in science, (20 millions), these can hardly be characterized as a heavy investment in science.

It is also reasonable to ask whether the initiatives are adequate in relation to the goals which are part of the strategy plan. These goals have been less specific in the latest versions of the plan, but still we question whether there has been a strong enough emphasis on the science teachers. Nor are we convinced that campaigns are sufficient to motivate students to choose science education classes. Teachers above the age of 60 are soon retiring; and unfortunately, they have more science education than the new teachers who are now recruited into schools. However, a large number of the new teachers have some science in their teacher education. There are reasons to believe that there is a need for extensive initiatives to increase the teachers' competence in science and to stimulate for new science activities in school.

11.2.2 Recruitment

In the end, the consequence of the crises in the science subjects is that our industry and business will lack people with engineering background and other science competencies.
A message has been sent about how hard it is to recruit people with special competence in several engineering fields. We would like to look at our data and suggest what might happen. Data from the student questionnaire includes four different indications whether students can see themselves as working with science in the future, and these are shown in 11.1 for all the Nordic countries.

The students were asked to take position to statements such as
"*I would like to study science after secondary school* and *I would like to work in a career involving science"* (see chapter 4.4.4). In table 11.1 the columns to the right show the percentage of students who agree to these statements. Students were also asked about which profession they see themselves in, when they are 30-years-old. These professions have been categorized in what is known as ISCO-system (see 10.2). These profession-categorizations have been coded in a way which makes it possible to identify professions which are related to science. It must be added that the ISCO-system is not precise regarding these categorizations, since the system is based on categories of professions. The profession "teacher" or "professor" will for instance in this categorization not be identified as a science career, even if it is science teachers and professors in science. Engineers, though, of different kinds, including different professions related to medicine, will be identified as careers in science. We have also developed a variable based upon a combination of student's results in the subject domain and their interests. It is natural to presume that a combination of different factors will in the end be of decisive importance for the students future choice, but our indicators are only based upon a hypothesis that both good subject achievements and high interest for the subject is necessary condition for a 15 year old choosing a future career in science. Since we are primarily interested in the situation in Norway, we have chosen to define a criterion which identifies students who score in the top half for both interest and achievements. These percentages are given in the column to the left in table 11.1.

	High interest and high achievement	Science related careers when they are 30 years old	Would like to have a profession related to science	Would like to study science further
Norway	29	24	30	22
Denmark	28	22	29	21
Finland	33	18	26	23
Iceland	30	32	38	35
Sweden	27	22	30	26

Table11.1 Percentage of students who may be regarded as potentially interested in a science education. See text for further explanations.

Compared to the achievements in science and interest in science, there are, in a Nordic perspective, many Norwegian students who see themselves as future students of science and/or with a career related to science. No matter what kind of indications we choose to trust, there seems to be as many students in Norway who have future perspectives of a science career as in any other country, and this percentage is about one fourth of the students. One would perhaps expect Finland to have relatively more students because of their high achievement and strong interests, as it is defined here. However, it is worth noticing that the proportion of Finnish students, who see them selves having a science career when they are 30-years-old, is not very large in a Nordic perspective.

It is important to specify that in most Nordic countries more than half of the students' who have the combination of strong interest and good achievements, do not see them selves with a future science career. It is also worth noticing, that among the students who would like to have a profession related to science when they are 30 years old, there are approximately as many girls as boys. When it comes to questions about whether they would like to study science in a University College or University, however, it is a slightly majority of boys who say they strongly agree or agree (25% of the boys and 20 % of the girls).

It is not easy to conclude from these data how many students who will actually choose a science career in the future. The situation in Norway does however seem to be as good as or even better than the situation in the other Nordic countries. In addition we know that there has been a remarkable increase in number of students attending science programs in upper secondary school (Norwegian Directorate for Education and Training 2007b). As of autumn 2007, 44% of the students chose science programs in their second year of Upper Secondary School in Norway. This is less than 15 percentage of the total number of students who applied for a program in Upper Secondary School the second year, and slightly less than 20% of all the students attending the second year of Upper Secondary School. This means that the number of students which is reported in table 11.1 is not as far from the number of students who actually chose science subjects as a basic for their year in Upper Secondary Education this fall. An optimistic interpretation of the numbers in table 11.1 may therefore be that the high number of students applying for science programs in Upper Secondary School might not just be a temporary flash in the pan.

11.3 Making space for reading?

11.3.1 Good strategy plans are not enough

Despite the fact that reading is not the main domain in PISA 2006, the decline among Norwegian students, and reading skills from 2000 to 2006 is of such a size, that it must be given some attention, which is why we include this section. Even if we can see a slight decline in the whole OECD area, the decline in Norway is much larger. The PIRLS study (Progress in Reading Literacy Study), has measured reading skills among fourth graders in an international perspective from 2001 to 2006. In 2001 the Norwegian results were close to the international average (Solheim and Tønnesen 2003). This mean is based upon all the participating countries, and they contain more poor countries than member countries in OECD, as the mean score in PISA is based upon. The results from PIRLS were not as good as one could expect. The results from 2006 show the same pattern as in 2001, and there has not been any improvement during these years (Van Daal et al 2007). In the perspective of the major effort made by the Norwegian Ministry of Education and Research to improve reading skills and students pleasure and interest of reading put forward in campaigns in 2003 such as "Make space for reading!" (MSFR) (Ministry of Education and Research 2005), both the results from PISA and PIRLS might be seen as a paradox. Although the boys read more books in PISA 2006 and have slightly more positive feelings towards reading in their spare time than was the case in 2000, why have the results in reading literacy not improved in these two studies?

The evaluation of MSFR which was published in the middle of our work, may give some more information regarding the paradox that positive efforts seems not to work, or influence negatively.

The short report shows among other things that MSFR has been both welcomed in schools and is implemented a large[1] number of smaller and larger projects over the country in the period of 2005 and 2006 (Buland et al. 2007). Some schools report that their students also have improved on their local tests, but even more report about subjective observations claiming that both reading skills and the amount of reading has improved. The short report does not say which grades are involved, or how the students reading skills have been measured, but it is stressed that it is yet too early to say whether it has improved the reading skills at a national level. Both PISA and the PIRLS show that there has not been any improvement from 2001 to 2006, neither among fourth graders or the tenth graders in Norway regarding reading skills. Despite the decline in PISA and lack of improvement in PIRLS, there is no reason to claim that *Making space for reading* has failed. The plan has made reading one of the top priorities in school and have also made Norwegian teachers more concerned about how important reading is through out the school. One important cause for not seeing any positive effect of learning results in PIRLS and PISA may be that the plan was not implemented until the school year 2003 – 2004, in several places. It might be too short for causing any effect on the students who participated in the reading test in PISA in 2006.

Even though Norwegian boys in PISA report to have changed their reading interest and attitude to reading in a slightly positive direction, these changes may occur more quickly. Reading competence though, takes more time to improve. The short report shows that despite of the main goal in Make space for reading has reading skills as main goal, only 20% of the projects in 2005 and 2006 have reading skills as their main focus. Almost as many projects

[1] 1643 projects in 2005, and 1706 projects in 2006

has actually been about motivating boys for reading, especially books, and in the report it is concluded that this has been one of the strategy-plans most important contribution.

One conclusion might be that the decline in reading skills among Norwegian students in PISA is caused by other negative factors which have a stronger influence than the positive initiatives which MSFR has come up with. If we are going to be able to say anything about this, we have to look carefully at other areas in the school. Since books and newspapers are less used and digital media are changing the reading patterns, this is one of the most obvious changes during the last 20 years regarding reading. Digital media contains a large amount of texts which has to be read, but texts on the screen/internet demands another approach to reading than ordinary text on paper. We have not enough research about digital reading yet, neither about what and how much young people actually read when they are using internet, or to which degree gender differences in girls favour is less than earlier years when it comes to digital texts. PISA 2009 might give important results here, since parts of the reading test will be electronic. Another and perhaps more important aspect regarding the students reading habit, is the fact that computer-games seem to exclude reading of books as a spare time activity, especially among boys.

11.3.2 Reading instruction: What is that?

It seems to be quite clear that students, who do not receive any reading instruction, do not become as good readers as they could have been if they had been given reading instruction. Research has been done lately which shows that there seems to be little reading instruction in Norway after the "first reading instruction" (Rasmussen 2003, Mortensen-Buna 2004). Hopefully this is now changing, but students who participated in PISA 2006, have probably not experienced this while they were in Lower secondary school.

In the final report from PISA+[2] (Lie et al. 2007) it is also claimed that there is little reading instruction in lower secondary school. One common issue found for teachers in the subject Norwegian who were observed and interviewed, is that they do not give much reading instruction, they do not work much on reading comprehension, reading strategies and reading motivation, and they claim that they lack knowledge of how to teach reading strategies. The research further shows that students read much in school, but that reading skills has little attention in the classroom compared to writing. The research also documented the writing process, and what characterizes good writing, but similar dialogues about reading were not found at all.

The texts which students read in their Norwegian classes are often used as a starting point for teaching students about different genres, and how different authors use different techniques. The goal for this work is that students should be able to use this knowledge to improve their own writing. Good reading competence is dependent on good text comprehension, and therefore text knowledge has a positive effect on reading comprehension, but it would have given even a better effect if the teachers had made this relation clear for the students. The students know what good writing instructions is, but when asked about what kind of reading instruction they receive after they have started early in primary school, they simply answer: Reading instruction? What is that? The students are continuously given feedback from their teachers about the quality of their texts both as feedback when they are working on texts, and as final grades in the end. They know what writing instruction is. Several research studies show that reading instruction should continue through out schools, and that reading

[2] Pluss: Prosjekt om Lærings- og Undervisnings-Strategier i Skolen

instructions must be clear and explicit. These kind of reading instruction where seldom observed in the research project PISA+.

It is a general view that students will improve their reading by reading. Different kinds of reading competitions are a widespread activity in a lot of schools. The goal is often to read as many books or pages as possible in a very short time. Of course this can help some students, and sometimes it might even lead to some students becoming more interested in reading. But it is obviously not enough to let students read texts, as long as the teachers do not know what happens when the student read the text, what happens when the text and the reader meet. Sometimes a lot happens, sometimes it does not? One student answered the following in an interview: I might read, and then I am thinking of something else, then I have not understood. (….) Then I close my book and think that I have read (Roe 2007). This student is not a unique example, and the problematic aspect of this, is that it is possible to read like this without teachers knowing about it. When the students say they have read something, it doesn't necessarily mean they know what they have been reading about. This "unconsciousness" reading however is seldom seen when students are really interested in what they are reading. Good reading comprehension is dependent of interest and motivation. The teachers must give the students good answers on the question often asked by students: Why do we have to read this text? In addition students themselves must believe that they are able to understand the text. The PISA+ study concluded among others that there is little information given to the students about what they are supposed to learn from reading the text, why these texts are important and what they can do with the knowledge these text contain. The feedback students are given, is often short, positive and general, and very seldom about specific elements and why.

Learning how to read is a democratic right in a country where good economy and high level of education may be seen both in a functional perspective and in a Bildung perspective. In a functional perspective, it is about having the reading competence necessary for living in a text based society. In a Bildung perspective reading competence might be seen as being able to understand the world as it is revealed through several different text genres, something which will be of great importance for people both now and in the future, socially, in work situations, in the spare time in a career and in the public life. The world is continuously changing, and the technology developing has made huge impact on the society in a very short time the last couple of decennials. Which changes will happen and how fast, we do not now. Reading will no matter what be an important tool for both participating in the society and being able to think critically and creatively. Through reading we may discover the relation between other experiences and our own, we may study issues systematically and in depth and get access to information and arguments which we can use to analyze and critically assess the content of what we are reading. Reading competence might be the key to success in school and later in life, to be able to participate in work in the society and in social life.

11.4 Why a decline in the knowledge level?

11.4.1 PISA 2000 – 2006: current situation and a trend

PISA 2006 is the third PISA survey, and the first cycle of PISA is now ended. The three first studies have had reading, mathematics and science as main domains, and in PISA 2009, the cycle will start all over again. In many ways PISA 2006 represents not only a picture of the current situation, but the survey also invites for an analyzes of the trends from 2000 to 2006. To get reliable and comparable data as a basis for trend analyzing is difficult, and in this book we have repeatedly stated that such comparisons must be done with caution. Yet, when the tendency seems to be clear, the situation is easy to interpret.

We will now summarize some of the main findings in PISA 2006 and for the entire period:

- Weak results and a declining tendency in the period 2000-2006 in all the three subject domains.
- Large decrease in reading from 2003 and a still large gender difference, despite increased effort in reading activities especially focusing on boys.
- Despite the initiative in science subjects, there are still weak performances in science and mathematics.
- Larger distribution than expected when it comes to knowledge in all the three subject domains.
- A significant relation between achievement and home background, but this relation is not striking in ad international perspective. There are reasons to believe that this tendency is now stronger than before the implementation of L97 (our former Curriculum plan).

The big challenge is to point at possible explanations regarding the problematic picture of the knowledge level in the Norwegian school. When we are approaching this, it is obvious that our role as researchers is ambiguous.
Our role demands of us that we try to interpret the data and point at some consequences, dilemmas and relations, and also point at possible causalities. On the other hand, it is a big step from these data to clear interpretations of them, and even further to give any recommendation of concrete activities. When we in this final chapter come up with some interpretations and relations, we stress the obvious that it is our interpretations, and we also hope we may contribute in such a way that other researchers, politicians and people working in schools take the challenge to discuss or critizes our interpretations and present their own opinions. We do not keep the truth about the reality behind these data, but PISA gives us a unique opportunity as a premise for a serious and informed discussion about the reality.
A discussion of such important questions about Norwegian schools, demands reasons, evidence, a literature review of relevant research and discussion these research. There is no room for such a discussion in this report, but we would like to present a short version.

In the report from PISA 2003 (Kjærnsli et al 2004) we reflected upon empirical results under the heading”Right in track or going nowhere”. The following areas where said to be problematic: weak and declining results compared to PISA 2000, larger variation then expected, big gender-differences in girls favor in reading, little reported use of learning strategies, problematic relations between students and teachers and too much noise and disturbance. The further analysis pointed at challenges regarding changing student- and teacher roles, especially related to student centered learning and unclear learning goals. In this relation we asked for teachers with more subject knowledge and leader of the learning activity. It was warned against claiming that one method was better than another, instead we wished to focus on the quality of the learning processes which were carried out. It was also claimed that new learning activities demands much more of the teacher when it comes to subject knowledge and subject didactics reflection. As far as we can understand, all these issues are still important challenges.

The TIMSS survey with data from 1995 (Lie et al 1997) and 2003 (Grønmo et al. 2004) is also an important to understand our interpretations. The data goes further back in time, the students are younger, and it is only mathematics and science which is measured. The conclusion of TIMSS 2003 is remarkably similar to our findings in PISA; we can see a strong decline in the achievement level from 1995 in both mathematics and science. In addition, it is pointed out that our curriculum L97 strongly emphasized how mathematics could be used in everyday life situations.

L97 says that the use of mathematics should be the overall them in an attempt to give the"subject a social and cultural support (?) by especially focus on the use of mathematics (KUF 1996 p. 156). This should in the one hand make Norwegian students especially prepared for tasks found in PISA, which is made to be relevant in real life situations, but it does not seem to be the case. When application goes at expense of basic knowledge in mathematics, can indeed the way to practical use of mathematics be a hard one. The weak Norwegian results in TIMSS were commented as following: "We dare say that it must be something fundamentally wrong when the results in TIMSS are as catastrophic as they appear" (Grønmo et al 2004, p. 215) and "fundamentally wrong" is interpreted as a lack of basic knowledge and skills in mathematics.

It is important to point out that the two studies complement each other on important areas. This means that weak achievements to a very little degree can be said to have context specific explanations through concrete sample of tasks regarding subject issues, contexts or task format. The obvious decline competence level in Norwegian schools is therefore further confirmed for science and mathematics, subjects, and PISA 2006 also when it comes to reading. The big question is: What can be the cause of this?

In the following, we will look at some of the organizational changes which have appeared regarding teaching the last years, which might have been a cause for the decline in subject knowledge in PISA and TIMSS.

11.4.2 Organizing students and teaching

Not many years ago, teaching was basically given by one teacher teaching one class in one classroom and with one timetable. The word "class" is not any longer so relevant. Now students may be organized in small groups and these groups might be quite flexible, both regarding hours used on a task, and also regarding how the teachers organize students across different grades. There has been a lot of attention given to flexibility in organization, at the same time as we have noticed a certain longing after the simple and easy structures, see for instance "Utdanning" issue 17, 2007. There are schools which seem to succeed in creating a safe learning environment, by dividing the class into smaller groups where everybody might be seen as the primary pedagogical unity. The changes have been hard and difficult, both regarding schools and other institutions. Being able to use new methods demands insight from both teachers and school leaders, and the changes from what we can call a traditional classroom to a more flexible one, will certainly demand a conscientious and goal oriented effort over a long period of time. There is not much research in Norway on working environment and classes as a social unity. There is an increasing worry for students, and especially the weakest ones, and how they might suffer when the class as a social unit no longer exists (Bergem 2007, Ogden interviewed in the magazine Bedre skole nr. 3 2007, Bergem, Telhaug og Haug interviewed in the magazine Utdanning nr. 17 2007). We believe these worries should be taken seriously.

Work plans have been used for a while in Norwegian schools, among others as a tool for enabling teachers to help each student better. Work plans vary when it comes to how they are designed, what they contain and for how many weeks they are made, including the students possibility for choosing achievement level (Carlgren et al. 2006, Klette 2007a, b, Bergem 2007). A main concern and challenge is that the work plan in itself cannot help the students to learn how to take care of their own learning. It demands of the students that they are more or less self-regulated.

More problematic findings regarding work plans are described in the PISA+ project (Lie et al 2007). For some subjects, such as mathematics, some types of work plans might lead towards their intentions, when learning is taken into account. This is especially noticeable when a school is organizes part of their teaching as “working hours” or “guidinghours”, where each student may choose which kind of subject and what kind of tasks he or she would like to work on. One of the observed findings in some of the working hours, was that students worked with different tasks in different subjects with only one teacher present. This teacher was not always the teacher in the particular subject these students were working on. In the observed mathematic hours, it was typical to see students decide how to regulate their use of time and these included that some students did not see any point in working with mathematics, since they hade either done the tasks or they wanted to postpone the work on mathematics. Despite the fact that students were sitting two or two together or in a larger group, the work plans did seldom invite students to cooperate, basically because students did not work on the same task at the same time. In addition, it was difficult for a teacher to gather all the students around one subject task, since most students were not working on the same task (Bergem 2007).

Work plans demand high expectations of the students, regarding their ability to plan and organize their own learning. Some students are able to do this, while other students do not have the abilities to judge how their time or the effort needed in the specific situation. Further we know that some students easily are tempted to choose to be less active in a school hour. Elstad (2002) and Dale and Wærness (2006) have concluded that there seem to be a contradiction between the ambitious goals in subject domains, and low goal expectations which lead to indulgence as a meaningful strategy for both students and teachers, in an attempt to avoid conflicts. The work plans can be seen as reinforcing differences rather than leveling them out. Klette (2007a) says: ” *…one might claim that use of work plans contribute to a situation where some groups of students more or less administrate their own accident. In such a case, the individualized working methods strengthen the established differences between students. In opposition to their intentions, working plans strengthen differences instead of leveling them out” (p.351).*

The increased use if individualization of teaching such as work plans seem to promote, has been questioned. Klette (2007a) claims that the extended use of work plans weaken the class and the student collective, in such a way that the students becomes less motivated for participating in collective dialogues and discussions. The meaning of learning in a social community is strongly emphasised in modern learning theory, especially the youngest students need to test their understanding and get feedback on their content knowledge through subject dialogues with teachers and peer students, especially in science and mathematics.

We do not think work plans are a bad tool. It might be positive in much sense. Among the positive effects is the possibility for the teacher to teach more thinking of each student, and have the possibility for talking to them all. We fear that the work plans and its challenges might be one of the reasons for the low result in PISA. So far, there has been little discussion on work plans and how they influence schools and teaching. We believe it is about time we do so.

11.4.3 Efficient teaching time?

A question raised is to what degree the time for teaching is actually spent on teaching in the Norwegian school system. The answer of course, depends upon how one defines “teaching”. Recent research can tell us something. In the PISA+ project more than 136 Norwegian-, science,- and mathematics hours were videotaped and analyzed more or less down to seconds, depending upon different criteria (Lie et al 2007). One of the criteria for the analyses was whether what was going on had a subject focus or if was more about administration, organisation and other non-subject related activities. One of the conclusions was that there are relatively many things going on which do not have anything to do with the subject.
In another study, research from 27 classrooms are described, grade 1 to 4th, where six researchers have observed what goes on in the classroom. It was found that approximately 30 % of the time in schools is used on “not subject related activities”, such as administration, telling what will happen, and discipline, giving messages and so on (Peder Haug, interviewed in Aftenposten 17th of January 2007).

Both these research projects find that too much time is wasted on other activities than teaching, for instance before teaching actually starts, something which seems to be the case also in PISA 2000 and 2003. It is natural with some time for administration, but it is time for a discussion about why so much of the time is used on administration.

11.4.4 Cross curricular dilemmas in science and mathematics.

The Norwegian school has focused on cross curricular issues for a long time. Through L97 cross curricular project work was implemented with a demand of 20 % of the time should be used for this. Cross-curricular work leads to a movement away from the subjects to themes of the projects. The school subjects have in more or less a natural logic and hieratic structure, and science and mathematics are perhaps more like this than other subjects. When using cross- curricular work, this logic of structure is challenged.

One positive aspect with cross-curricular school work, is that it is experienced as meaningful and useful, and the cross-curricular projects have absolutely strong sides, and may also contribute to another and equal important type of knowledge such as the teaching of pure subject knowledge. At the same time, it is important to know that the specific subject may be ignored or not emphasised enough when working on a project. Valdermo (2007) claims that there is a danger for multisubjects, theme based teaching that knowledge, such as mathematics and science, can be left out, simply because students divide their subjects among themselves, instead of working together with all the subjects. He also asks several questions whether such a project may lead to superficial knowledge and claims that it can be hard to promote science competence in cross-curricular projects, and that science and mathematics seems to loose in such circumstances. We do believe that it is important to be aware of these problems, so the subjects content knowledge, the scientific methods and working methods, included the didactics of the subject, do not disappear. It is very important that the teachers are able to keep the specific subjects uniqueness and logic even while doing cross-curricula projects.

11.5 Concluding remarks

In this chapter we have looked at some characteristics of the Norwegian school system which we believe may be one explanation of the weak and declining results by the Norwegian students. We have described a picture which is characterized by more freedom for students and a more passive teacher role. This is also in line with the descriptions from PISA 2003. This time we have included some descriptions from classroom studies which to a large degree confirm this picture. We are sure that the weak pedagogical leading in classrooms are one main concern for interpreting the decline in the subject achievement level. We will not argue against student active learning processes, but we observe that from the classrooms, these methods may demand a stronger didactic leader who helps the students to guide towards their learning goals and also hold high expectations and check their work and learning outcome.

The *Knowledge Promotion* must be said to be an ambitious curriculum with clear learning goals. These plans stress the basic knowledge which is central in PISA. In PISA 2009 we will again measure students, and this time it will be students who have followed the *Knowledge Promotion* for some years. It will therefore be exciting to see whether some of the weaknesses which we have pointed at will be corrected through more concrete learning objectives in this curriculum.