# PISA: a long and winding road?

（研究会実施日:2008年1月22日）

**Ger A. J. Limpens** [Test Developer /Assessment Expert Specialist Mathematics Cito, the Netherlands]

| | |
|---|---|
| Education | Master of Science, awarded by the Faculty of Mathematics, University of Utrecht, the Netherlands (1979) |
| Experience | 1998-date, Scientific staff member – Cito - Arnhem, the Netherlands (including working as test developer for PISA and test advisor in Czechia, Aruba, Curacao, Russia, Japan).<br>1999-2007, Member of developing group Math Alympiad<br>1993-1998, Member of group mathematics test designers – Cito – Arnhem<br>1990, Writer educational mathematics texts - Hogeschool Rotterdam en Omstreken<br>1979-1998, Mathematics teacher in Secondary Education – Laren, Krommenie, Hilversum |
| Selected Publications | 1999, Praktische opdrachten, wiskunde, tweede fase havo/vwo (publication about large mathematic assignments)<br>1999, Syllabus Wiskunde, voor het schoolexamen in de tweede fase havo/vwo (publication about consequences of certain reforms of pre-university/pre high vocational level secondary education)<br>2000, Aanvulling Syllabus Wiskunde A, met voorbeeldopgaven (complementary information concerning reforms and mathematics in context at pre-university secondary education level)<br>2001, Wiskunde Alympiade 2000-2001, De Nieuwe Wiskrant (publication about Math Alympiad, cowriter)<br>2003, Wiskunde Alympiade 2002-2003, De Nieuwe Wiskrant (publication about Math Alympiad, cowriter)<br>1999-2007, Examenverslag examens wiskunde, Euclides (annual publication about results national exams secondary education mathematics, cowriter)<br>2004, Examenconstructie, een langdurig en zorgvuldig proces, Euclides (publication about the structure of construction of national exams, cowriter)<br>2004, Resultaten PISA 2003 (Dutch National Report of PISA 2003, cowriter)<br>2006, Wiskundige geletterdheid volgens PISA (second publication on Dutch results based on PISA 2003, cowriter) |

## A starting point

It is said that the famous philosopher and mathematician Bertrand Russell once wrote: “Man is the only creature that can look at a set of figures and weep” or words like these.

Of course this is true, man being the only creature being able to read and think of the meaning of figures. But the first aspect ‘read’ is not the same as the second ‘think of the meaning of figures’. Maybe Bertrand Russell would have added if PISA was around in his days already: “at least man who has mathematical literacy”…

## History of PISA

In 2000 the first round of PISA took off. At that time 32 countries (out of which 28 OECD countries) took part. Later on (2002) an extra 11 countries took part in the same survey. In 2003 41 countries were part of the new survey, including all 30 OECD countries. In 2006 there were 57 countries, including the 30 OECD countries that did the third PISA-survey. This shows that PISA is a growing success. But what is PISA?

PISA stands for Programme for International Student Assessment and is an initiative of the OECD, the Organisation for Economic Cooperation and Development. PISA wants to measure to what extend young adults (age 15) are prepared to meet the challenge of today’s knowledge societies. PISA is developed at the end of the last century because the OECD countries wanted to have their own instruments for measuring the outcomes of the education systems of the different countries. In the earlier years the results of other international explorations on the assessment of students performances were used but since 2000 the especially for OECD developed outcomes of PISA can be used for this goal. In the few years since the start of PISA, it turned already out to be a major policy tool for many other non-OECD countries as well. PISA findings are used to gauge the literacy skills of students in a specific country in comparison with those of the other participating countries. Also PISA is used to establish benchmarks for educational improvement and it gives one the possibility to understand relative strengths and weaknesses of one’s own education system

PISA contains three kinds of indicators. First there are the basic indicators that give a profile of knowledge and skills of students. Secondly we have contextual indicators that show what the relation is between these skills and important demographic, social, economical and educational parameters. And also it contains trend indicators that are generated from the data that are collected every three years

To generate these indicators several data are collected by way of a representative random sample survey in each participating country. In the Netherlands for instance 185 schools took part in the survey of 2006 and data of over 4800 student results were taken into account.
One part of the survey contains the collecting of data on three education subject domains, the three core assessment areas, being reading, mathematics and science. Every three years one of these three assessment areas is chosen as main subject. In 2000 the main subject was reading, in 2003 it was mathematics and in 2006 science took that role. In 2009 one can

predict that this is reading of course.

Apart from these three main assessment areas each PISA survey contains a survey about another, always changing, domain. In 2000 this was the idea of so-called 'Self-regulated learning' and in 2003 the domain 'Problem Solving had that role. In 2006 it was a Computer Based Test. The changing domain is however not obligatory for participating countries.

Furthermore every three years data are collected concerning background information and information about the attitude of students on the main subject, on their classes, teachers and their schools. Also questionnaires are given to be filled in to the heads of participating schools.

What distinguishes PISA from earlier international comparative surveys is the following. PISA doesn't focus especially on what students are taught in the participating countries but far more on the way students are able to use learned knowledge and skills. PISA wants to measure to what extend 15 year old students will be able to apply learned knowledge and skills in real life. This means that PISA seeks to measure the ability to fulfill tasks based on reality in which the student needs an overview of certain main concepts. That is the reason the concept of 'literacy' is brought into life within the context of PISA. In the international reports of PISA the three main domains of PISA are often referred to by the terms 'reading literacy, 'mathematical literacy' and 'scientific literacy'.

Another aspect that is rather specific for PISA is the fact that PISA focuses on the moment of birth of the students that take part of the survey. That means that not complete classes of participating schools are chosen to be part of the investigation but individual, randomly chosen, students of these schools no matter which level or year group they belong to.

## PISA 2006

In PISA 2006 the three main domains were covered by several assessment items that were handed to the students.

Reading contained 8 units, containing in total 28 items. Mathematics had 48 items within 31 units and Science, being main subject in 2006, contained 140 items within 37 clusters. In my lecture I mostly of the time will talk about mathematics and also sometimes about science. Reading is, as one can imagine, not my core business so I hardly will mention this subject.

The items are, as one can imagine, divided in several types of questions. Long answer questions, to start with, which again can be divided into two sub types, the open-constructed response items (which ask for a long answer, containing an explanation of the way of thinking, with many possible answers. Partial credit can be given to partially correct answers) and the closed-constructed response items (in which a limited amount of long answers is correct). The second main type of questions consists of the short answer questions, or short-response items. For this type of question a short answer has to be given, but there is a great variation among the possible answers. The third type consists of multiple choice items, which can be divided in standard multiple choice items (in a standard multiple choice item the student has to choose one of several presented alternatives) on one hand and complex multiple choice items (being a type of question where the student has to choose several possibilities out of a range of presented alternatives) on the other hand.

Roughly half of the items for each subject, reading/mathematics/science, were open ended, which makes the rest of the items closed questions, standard or complex multiple choice.

Many of these items require professional markers to judge the quality of the given answers. These markers were trained specific for this goal and they used standardized marking guides. Furthermore randomly picked student answers were judged by four different markers and the reliability of the several markers was measured by comparing these judgments. And last but not least the several judgments of several countries were, again by sample based comparison, investigated by a specific trained group of multilingual assessors.

## Mathematical literacy

In the PISA framework (OECD 2003 and OECD 2006) mathematical literacy is defined as follows: "… an individual's capacity to identify and understand the role that mathematics plays in the world, to make well founded judgments and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen."

I suppose one can summarize this rather lengthy definition rather well as 'the ability – using mathematical knowledge –to take on and solve problems within a realistic context.'

■Mathematical areas

The concept of mathematical literacy is measured using items that belong to the following four relevant mathematical areas/concepts: Quantity, Space and shape, Change and relationships and Uncertainty.

■Situation

Also the aspect of the situation in which the item is set is taken into account when developing the test. Within PISA for mathematics the following settings are distinguished: the personal setting, the educational and/or occupational setting, the local/broader community setting and finally the scientific setting.

■Competency

When developing the items also the specific 'skills' that are needed are taken into account. For PISA three competency clusters are distinguished: the cluster of Reproduction, which containssimple mathematical operations, the Connections-cluster, in which it is all about bringing together ideas to solve straightforward problems, and the cluster of Reflection, which reaches for wider mathematical thinking.

As one might predict there is a connection with these competency aspects and the ascending degree of difficulty. On the other hand it can be observed that there are rather difficult reproduction items and also some rather easy reflection items so this connection is maybe more ambiguous as one might think.

It must be mentioned that the PISA 2006 report only give information about the overall idea of mathematical literacy without giving information on the specific mathematical areas even though each of the areas was part of the used items in 2006. In 2003 the report about mathematics was more detailed, of course because of the fact that mathematics was main subject in 2003.

■Scale

The outcome of 2003 for mathematics was

used to indicate the level of 2006. The average score of the OECD countries for PISA 2003 in mathematics was put on 500, with about two-third of the students in the OECD countries scoring between 400 and 600 points. The average OECD score for mathematics in 2006 was 498, so this might mean a slight decrease in the average. The results of the students are ordered in six proficiency levels, based on this scale of 2003 with OECD-score 500. Level 6 describes the highest level of proficiency. Further on you will find an elaborative description of the several levels.

Figure1　Summary descriptions of the six proficiency levels in mathematics

| Level | Lower score limit | What students can typically do |
|---|---|---|
| 6 | 669.3 | At Level 6 students can conceptualise, generalise, and utilise information based on their investigations and modelling of complex problem situations. They can link different information sources and representations and flexibly translate among them. Students at this level are capable of advanced mathematical thinking and reasoning. These students can apply this insight and understandings along with a mastery of symbolic and formal mathematical operations and relationships to develop new approaches and strategies for attacking novel situations. Students at this level can formulate and precisely communicate their actions and reflections regarding their findings, interpretations, arguments, and the appropriateness of these to the original situations. |
| 5 | 607.0 | At Level 5 students can develop and work with models for complex situations, identifying constraints and specifying assumptions. They can select, compare, and evaluate appropriate problem solving strategies for dealing with complex problems related to these models. Students at this level can work strategically using broad, well-developed thinking and reasoning skills, appropriate linked representations, symbolic and formal characterisations, and insight pertaining to these situations. They can reflect on their actions and formulate and communicate their interpretations and reasoning. |
| 4 | 544.7 | At Level 4 students can work effectively with explicit models for complex concrete situations that may involve constraints or call for making assumptions. They can select and integrate different representations, including symbolic ones, linking them directly to aspects of real-world situations. Students at this level can utilise well-developed skills and reason flexibly, with some insight, in these contexts. They can construct and communicate explanations and arguments based on their interpretations, arguments, and actions. |
| 3 | 482.4 | At Level 3 students can execute clearly described procedures, including those that require sequential decisions. They can select and apply simple problem solving strategies. Students at this level can interpret and use representations based on different information sources and reason directly from them. They can develop short communications reporting their interpretations, results and reasoning. |
| 2 | 420.1 | At Level 2 students can interpret and recognise situations in contexts that require no more than direct inference. They can extract relevant information from a single source and make use of a single representational mode. Students at this level can employ basic algorithms, formulae, procedures, or conventions. They are capable of direct reasoning and making literal interpretations of the results. |
| 1 | 357.8 | At Level 1 students can answer questions involving familiar contexts where all relevant information is present and the questions are clearly defined. They are able to identify information and to carry out routine procedures according to direct instructions in explicit situations. They can perform actions that are obvious and follow immediately from the given stimuli. |

(Source:OECD PISA 2006)

## Scientific literacy

PISA 2006 defines the following four aspects of scientific literacy: to start with scientific knowledge and use of that knowledge to recognize problems, to gather new knowledge, to explain scientific phenomena and make up well-founded conclusions concerning subjects with a scientific content. The following aspect is the insight in characteristic features of science and how they are to be recognized in investigations and the development of knowledge. A third aspect is about understanding the roles that science, applied science and technology play by defining our material, intellectual and cultural environment and the fourth is the aspect of willingness to go into subjects and views with a scientific content as an intelligent citizen.

■Scientific themes
For PISA 2006 the chosen items are concentrated around five themes. These themes, which are of global interest, are health, natural sources, environment, risks and the limits of science and applied science.

■Context
The science items are also developed with the following three contexts in mind: the personal context (the individual, his relatives and friends), the society and the world

■Competency
The competencies used in PISA 2006 are chosen because they are the essence of the scientific way of working. The characteristics of these competencies are: the recognition of scientific subjects, the explanation, using scientific arguments, of specific scientific phenomena and the use of scientific ways of proof.

■Knowledge **of** science
There is an abundance of scientific knowledge out of which a choice had to be made for PISA 2006, science being the main subject. The knowledge within PISA 2006 had to meet the following requirements: it has to be relevant for daily life, it must be representative for major scientific concepts, making it usable for a longer period and has to be suited for the level of 15 year old
The knowledge is arranged within four areas, called systems. The used systems are non-living nature (subdivided in structure of matter, properties of matter, movement and power, energy and energy conversion and the correlation between energy and matter), living nature (subdivided in cells, man, populations, ecosystems and biosphere) earth and space (which has the following subdivision: the structure of earth and atmosphere, the energy in/on earth, the changes in/of the earth, the history of the earth, and the earth as part of the universe) and the last system applied science (which is divided in the role of nature, applied science and technology, the correlation between nature, applied science and technology, concepts and important fundamental ideas)

■Knowledge **about** science
PISA 2006 also assesses knowledge about science, divided in two groups, being a group around scientific investigation (think of origin, goal, experiments, data, measurements, characteristics of results) and another group, centered around scientific explanation (here one should take in mind aspects like types of explanation, the way of explanation, rules and results).

■Attitude towards science

PISA 2006 also focuses on the attitude students have towards science. In PISA 2006 this attitude is divided into the following three components, that being the interest for matters of science, the support for scientific investigation and the responsibility for natural sources and environment

■Scale

Because science being main subject in 2006 for the first time in PISA, in fact the scale is set for the first time in 2006. The average score of the OECD countries for PISA 2006 in science is, by definition, put on 500, with again about two-third of the students in the OECD countries scoring between 400 and 600 points. The results of the students are ordered in six proficiency levels, based on this scale with OECD-score 500. Level 6 describes the highest level of proficiency. Further on you will find an elaborative description of the several levels.

Figure2　Summary descriptions of the six proficiency levels on the science scale

| Level | Lower score limit | Percentage of students able to perform tasks at each level or above (OECD average) | What students can typically do |
|---|---|---|---|
| 6 | 707.9 | 1.3% of students across the OECD can perform tasks at Level 6 on the science scale | At Level 6, students can consistently identify, explain and apply scientific knowledge and *knowledge about science* in a variety of complex life situations. They can link different information sources and explanations and use evidence from those sources to justify decisions. They clearly and consistently demonstrate advanced scientific thinking and reasoning, and they demonstrate willingness to use their scientific understanding in support of solutions to unfamiliar scientific and technological situations. Students at this level can use scientific knowledge and develop arguments in support of recommendations and decisions that centre on personal, social or global situations. |
| 5 | 633.3 | 9.0% of students across the OECD can perform tasks at least at Level 5 on the science scale | At Level 5, students can identify the scientific components of many complex life situations, apply both scientific concepts and *knowledge about science* to these situations, and can compare, select and evaluate appropriate scientific evidence for responding to life situations. Students at this level can use well-developed inquiry abilities, link knowledge appropriately and bring critical insights to situations. They can construct explanations based on evidence and arguments based on their critical analysis. |
| 4 | 558.7 | 29.3% of students across the OECD can perform tasks at least at Level 4 on the science scale | At Level 4, students can work effectively with situations and issues that may involve explicit phenomena requiring them to make inferences about the role of science or technology. They can select and integrate explanations from different disciplines of science or technology and link those explanations directly to aspects of life situations. Students at this level can reflect on their actions and they can communicate decisions using scientific knowledge and evidence. |
| 3 | 484.1 | 56.7% of students across the OECD can perform tasks at least at Level 3 on the science scale | At Level 3, students can identify clearly described scientific issues in a range of contexts. They can select facts and knowledge to explain phenomena and apply simple models or inquiry strategies. Students at this level can interpret and use scientific concepts from different disciplines and can apply them directly. They can develop short statements using facts and make decisions based on scientific knowledge. |
| 2 | 409.5 | 80.8% of students across the OECD can perform tasks at least at Level 2 on the science scale | At Level 2, students have adequate scientific knowledge to provide possible explanations in familiar contexts or draw conclusions based on simple investigations. They are capable of direct reasoning and making literal interpretations of the results of scientific inquiry or technological problem solving. |
| 1 | 334.9 | 94.8% of students across the OECD can perform tasks at least at Level 1 on the science scale | At Level 1, students have such a limited scientific knowledge that it can only be applied to a few, familiar situations. They can present scientific explanations that are obvious and that follow explicitly from given evidence. |

(Source:OECD PISA 2006)

## Some remarks about these statistics

First it should be noted that the ranking order in the mean scores list of course differs from the ranking order of the countries in the graph of the distribution of scores on the proficiency scale. In the mean score list every country has its position based on the mean score, which means over here in fact the score that coincides with 50%. In the graph the position of a country is based on the percentage of the students that score below level 1 as one can observe very easily.

Looking at the description lists of the several levels, both of mathematics and science, one feels the urge, at least in my view, to define an acceptable level or a level at which a knowledge society (a label that the OECD-countries give themselves, is it not?) should want to aim for. As far as I can see, this striving level is mentioned nowhere. Maybe each country should think for oneself for a start and maybe one should decide where one should want to be. In my view for both mathematics and science the striving level should be level 4: only students at this level or higher have, in my view, a level that corresponds with the label 'knowledge society'.

It is of course possible to make graphs not based on the percentage of students below level 1 but based on, let's say, the percentage of students below level 3 or below level 4. Of course the ranking order will change. But what is more relevant that one can observe from these graphs that in nearly all of the OECD-countries the group of students that scores below level 4 is rather high. Looking at for instance Japan or the Netherlands, both being countries doing rather well in the ranking lists as we all know, we can see that both countries for both subjects mathematics and science, have over 50% of the students below level 4. In my view there is a job to be done in countries like ours.

Table1　Some mean scores/result of PISA 2006

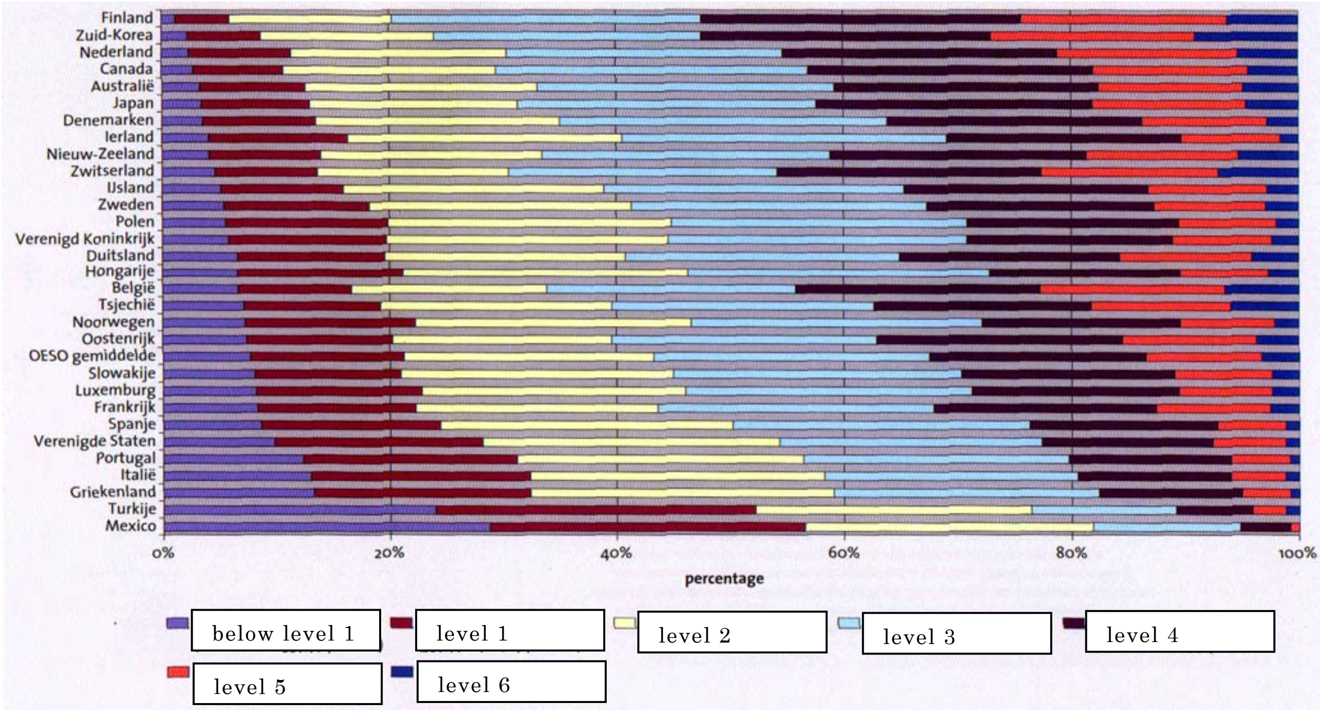
|  | Mean score |  |  | Mean score |
|---|---|---|---|---|
| Chinese Taipei | 549 |  | Norway | 490 |
| Finland | 548 |  | Lithuania | 486 |
| Hong Kong-China | 547 |  | Latvia | 486 |
| Korea | 547 |  | Spain | 480 |
| Netherlands | 531 |  | Azerbaijan | 476 |
| Switzerland | 530 |  | Russian Federation | 476 |
| Canada | 527 |  | United States | 474 |
| Macao-China | 525 |  | Croatia | 467 |
| Liechtenstein | 525 |  | Portugal | 466 |
| Japan | 523 |  | Italy | 462 |
| New Zealand | 522 |  | Greece | 459 |
| Belgium | 520 |  | Israel | 442 |
| Australia | 520 |  | Serbia | 435 |
| Estonia | 515 |  | Uruguay | 427 |
| Denmark | 513 |  | Turkey | 424 |
| Czech Republic | 510 |  | Thailand | 417 |
| Iceland | 506 |  | Romania | 415 |
| Austria | 505 |  | Bulgaria | 413 |
| Slovenia | 504 |  | Chile | 411 |
| Germany | 504 |  | Mexico | 406 |
| Sweden | 502 |  | Montenegro | 399 |
| Ireland | 501 |  | Indonesia | 391 |
| OECD-average | 498 |  | Jordan | 384 |
| France | 496 |  | Argentina | 381 |
| United Kingdom | 495 |  | Colombia | 370 |
| Poland | 495 |  | Brazil | 370 |
| Slovak Republic | 492 |  | Tunisia | 365 |
| Hungary | 491 |  | Qatar | 318 |
| Luxembourg | 490 |  | Kyrgyzstan | 311 |

|  | Mean score |  |  | Mean score |
|---|---|---|---|---|
| Finland | 563 |  | United States | 489 |
| Hong Kong-China | 542 |  | Slovak Republic | 488 |
| Canada | 534 |  | Spain | 488 |
| Chinese Taipei | 532 |  | Lithuania | 488 |
| Estonia | 531 |  | Norway | 487 |
| Japan | 531 |  | Luxembourg | 486 |
| New Zealand | 530 |  | Russian Federation | 479 |
| Australia | 527 |  | Italy | 475 |
| Netherlands | 525 |  | Portugal | 474 |
| Liechtenstein | 522 |  | Greece | 473 |
| Korea | 522 |  | Israel | 454 |
| Slovenia | 519 |  | Chile | 438 |
| Germany | 516 |  | Serbia | 436 |
| United Kingdom | 515 |  | Bulgaria | 434 |
| Czech Republic | 513 |  | Uruguay | 428 |
| Switzerland | 512 |  | Turkey | 424 |
| Macao-China | 511 |  | Jordan | 422 |
| Austria | 511 |  | Thailand | 421 |
| Belgium | 510 |  | Romania | 418 |
| Ireland | 508 |  | Montenegro | 412 |
| Hungary | 504 |  | Mexico | 410 |
| Sweden | 503 |  | Indonesia | 393 |
| OECD-average | 500 |  | Argentina | 391 |
| Poland | 498 |  | Brazil | 390 |
| Denmark | 496 |  | Colombia | 388 |
| France | 495 |  | Tunisia | 386 |
| Croatia | 493 |  | Azerbaijan | 382 |
| Iceland | 491 |  | Qatar | 349 |
| Latvia | 490 |  | Kyrgyzstan | 322 |

| |
|---|
| Statistically significantly above the OECD average |
| Not statistically significantly different from the OECD average |
| Statistically significantly below the OECD average |

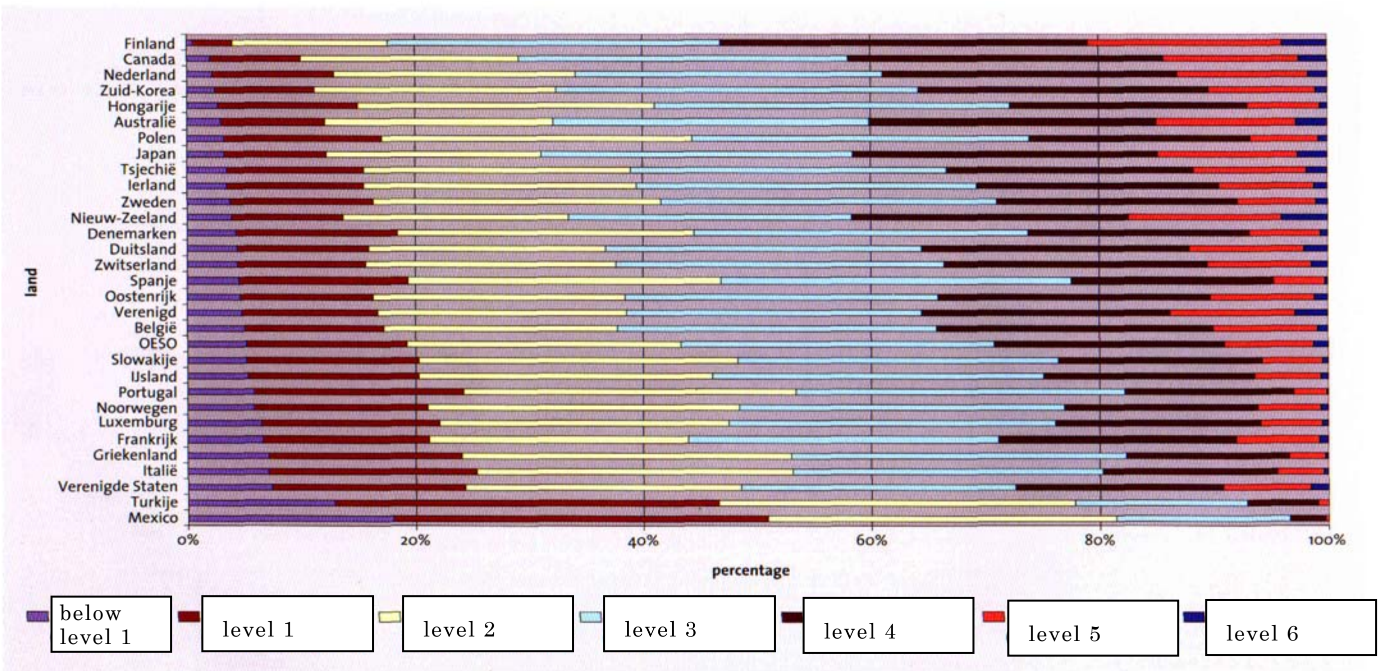
(Source:OECD PISA 2006 database.)

Figure3　Distribution of scores on the proficiency scale for mathematics in the OECD-countries based on ‘below level 1’




(source: ‘Resultaten PISA-2006’, Dutch PISA-2006 report)

Figure4　Distribution of scores on the proficiency scale for science in the OECD-countries based on ‘below level 1’




(source: ‘Resultaten PISA-2006’, Dutch PISA-2006 report)

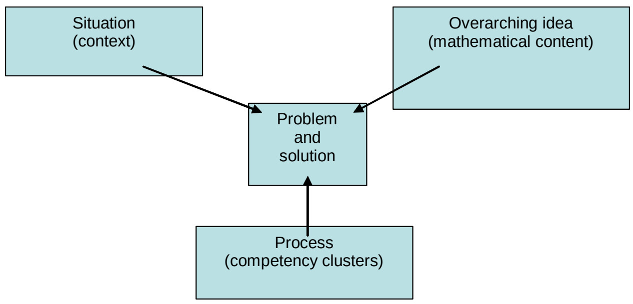
## Mathematical literacy revisited

Let's go back to mathematics and spent some time on the aspect of competencies. Often it is asked what is the difference between competency and skills. Indeed, that is a difficult question. An answer might be found in the Framework 2003 of PISA. In this framework one can find the following.
In math several competencies are recognized. Think of competencies like thinking and reasoning, argumentation, communication, modeling, problem posing and solving, representation and the use of symbolic, formal and technical language and operations

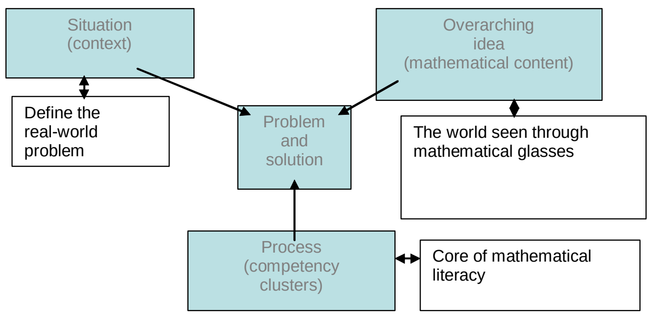
For PISA these competencies were clustered, as we saw earlier, in three competency clusters, being the reproduction cluster, the connections cluster and the reflection cluster.

About items within the **reproduction** cluster it can be mentioned that they are relatively familiar, that they require essentially the reproduction of practiced knowledge, that they are often about knowledge of facts and that they contain common problem representations. They are about the recognition of equivalents, about the recollection of familiar mathematical objects/properties, they contain the performance of routine operations and/or the application of standard algorithms/technical skills. And also it can be mentioned that items of this cluster are about the carrying out of straightforward computations when they ask for the manipulation of expressions containing symbols or formulae (and if so these symbols or familiar are presented in a familiar or even standard form).
Items within the **connections** cluster on the other hand are not simply routine and they involve somewhat familiar settings or extend and develop beyond the familiar to a relatively minor degree. They involve greater interpretation demands and require making links between different representations of the situation, or linking different aspects of the problem situation in order to develop a solution.
Items within the **reflection** cluster demand some insight and reflection on the part of the student and also demand creativity in identifying relevant mathematical concepts or in linking relevant knowledge to create solutions. Items of this cluster involve more elements than in the other clusters and have a demand for students to generalize and explain/justify their results.

These competency clusters fit, in the view of the Framework, in with the rest of the relevant aspects when it comes to solve a mathematical problem where mathematical literacy is observed.




Mathematical literacy can be put at its place in this scheme. This turns into the following scheme:



Of course, one still can ask where is the difference with 'mathematical skills'. In my view one finds this difference in the aspect of the real world, of the situation. In a 'classical' mathematical situation one only needs mathematical skills to bring the problem to an end. In a context-based situation one needs the competencies to make the problem into math and, after solving it, bring it back to the real-world situation. Of course, the two aspects are very much related and most of the times one cannot separate both very well. But there is, in my view, a difference. And that difference is relevant for most of us, I think.

## An example

Let us look at an example. The next item stems from PISA 2003. Of course, this problem is part of the released material. It can be found in 'Learning for Tomorrow's World, First Results from PISA 2003' and it is a very nice example what PISA is about. It is the item 'Robberies'.

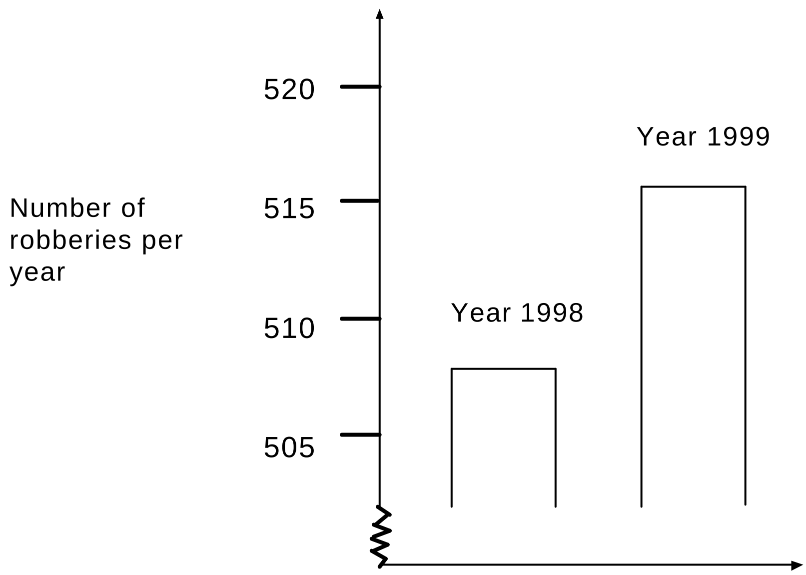
In the next example you will see the students' text and also the information that was given to the markers. While looking at the item I will explain certain aspects of it.

ROBBERIES

**Question 1: ROBBERIES** *M179Q01- 01 02 03 04 11 12 21 22 23 99*

A TV reporter showed this graph and said:

"The graph shows that there is a huge increase in the number of robberies from 1998 to 1999."




Do you consider the reporter's statement to be a reasonable interpretation of the graph? Give an explanation to support your answer.

**ROBBERIES SCORING 1**

**[Note: The use of NO in these codes includes all statements indicating that the interpretation of the graph is NOT reasonable. YES includes all statements indicating that the interpretation is reasonable. Please assess whether the student's response indicates that the interpretation of the graph is reasonable or not reasonable, and do not simply take the words "YES" or "NO" as criteria for codes.]**

***Full Credit***

Code 21: No, not reasonable. Focuses on the fact that only a **small part** of the graph is shown.

- Not reasonable. The entire graph should be displayed.
- I don't think it is a reasonable interpretation of the graph because if they were to show the whole graph you would see that there is only a slight increase in robberies.
- No, because he has used the top bit of the graph and if you looked at the whole graph from 0 – 520, it wouldn't have risen so much.
- No, because the graph makes it look like there's been a big increase but you look at the numbers and there's not much of an increase.

Code 22: No, not reasonable. Contains correct arguments in terms of ratio or percentage increase.

- No, not reasonable. 10 is not a huge increase compared to a total of 500.
- No, not reasonable. According to the percentage, the increase is only about 2%.
- No. 8 more robberies is 1.5% increase. Not much in my opinion!
- No, only 8 or 9 more for this year. Compared to 507, it is not a large number.

Code 23: Trend data is required before a judgement can be made.

- We can't tell whether the increase is huge or not. If in 1997, the number of robberies is the same as in 1998, then we could say there is a huge increase in 1999.
- There is no way of knowing what "huge" is because you need at least two changes to think one huge and one small.

***Partial Credit***

Code 11: No, not reasonable, but explanation lacks detail.

- Focuses ONLY on an increase given by the exact number of robberies, but does not compare with the total.
- Not reasonable. It increased by about 10 robberies. The word "huge" does not explain the reality of the increased number of robberies. The increase was only about 10 and I wouldn't call that "huge".
- From 508 to 515 is not a large increase.
- No, because 8 or 9 is not a large amount.
- Sort of. From 507 to 515 is an increase, but not huge.

**[Note that as the scale on the graph is not that clear, accept between 5 and 15 for the increase of the exact number of robberies.]**

Code 12: No, not reasonable, with correct method but with minor computational errors.

- Correct method and conclusion but the percentage calculated is 0.03%.

***No Credit***

Code 01: No, with no, insufficient or incorrect explanation.

- No, I don't agree.
- The reporter should not have used the word "huge".
- No, it's not reasonable.　Reporters always like to exaggerate.

Code 02: Yes, focuses on the appearance of the graph and mentions that the number of robberies doubled.

- Yes, the graph doubles its height.
- Yes, the number of robberies has almost doubled.

Code 03: Yes, with no explanation, or explanations other than Code 02.

Code 04: Other responses.

Code 99: Missing.

## Aspects worth mentioning

Each item, as we can see in this example, contains a code in the beginning of the item which tells us about the number of the unit and the number of the question. Also some information of the scoring structure is already shown in this code. Typical is also the fact that, in this unit, being a unit with only one question, it might be suggested that there are more questions to follow, mentioning question 1 in the title of the item.

In the marking guide we discover the aspect of partial credit coding (the coding goes down starting with full credit, following by partial credit to 'no credit'. Also one can see in this example a sample of double digit coding, a technique by which distinction can be made in the analysis between different answers that are not different in 'quality'. Furthermore we can see that several correct or partial correct answers contain lots of non-mathematical language and also that, in this question, there exists the necessity of having an explanation. Last but not least one should take notice of the aspect lenience when it comes to acceptance of the given answers: look for an example of this fact in the note that is preceding the actual marking guide.

## Rounding off

PISA is an international three-year survey for education systems, originally for the OECD-countries. PISA distinguishes itself from other international surveys because of the aspect of literacy. This literacy component tries to cope with the aspect of the knowledge society in which one wants to strive for a citizen who is well aware of several scientific aspects and who is also able to use basic concepts to get his way around in his society. PISA started in 2000 and will be conducted the next time in 2009. Of course it is an instrument that can and will be used as a certain competition between several countries. There's nothing against that, in my view, but the far more important aspect for PISA in my view is that it shows that even in the OECD-countries very many students don't have the level that one should have in a knowledge society. For me it means that the lesson of PISA should be that a country should focus more on the groups with the lesser abilities. The basic level of education should rise in several countries. One can reach for that goal, not focusing on the 15-year old students that probably will visit university or higher vocational education, but on the other hand focusing on the student that probably will finish at a maximum the middle or lower vocational/prevocational levels of education. In many countries this goal probably would mean a different way of teaching and probably also a change in the content of several secondary education subjects. All in all indeed probably a long and winding road, I suppose.