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Introduction

This paper analyzes key indicators that might explain high performance and the success in education in Flemish Belgium (Flanders) and the Netherlands. It is not more than an indication because little research has been done analyzing the success factors in both countries.

The assumptions are based on my personal communication with experts in both countries and my experiences as a former dean of the “College of Education” at the “Maastricht University of Professional Education”. In my current function as director of the “Center for European Orientation Programs”, I organize orientation programs in the field of education for student teachers, teachers and other professionals in education. They come from all over the world, but predominantly from the USA. Groups visit Belgian and Dutch schools as part of their orientation in European education.

A complex of factors plays a role in the explanation of educational high performance in both countries. However, it is difficult to understand these factors in isolation. Some factors are related to the national systems of education in both countries. Other factors play a role in specific fields of education like mathematics.

I will try to compare the results in education as a whole, and mathematics in particular of both European countries with the results in the USA, as shown in the PISA-research. However, more scientific research will be needed to clarify the causes of the differences in results.

I am convinced that regression in education performance begins early in the development of children and during their school careers. That is why, although the PISA-research has been done on students in 9th grade (15 years old students), a description of the quality of primary education is important to explain these results three years later.

I will restrict this overview to elementary and secondary education. Since most of the publications about the Flemish and Dutch educational systems are written in Dutch, I will end this paper with an enumeration of the most important results. In addition, I will include English language web-sites about education in Flanders and the Netherlands. In the following pages some parts of the texts are written in italics. These parts are particularly important as possible indicators for judging the quality of education in Flanders and the Netherlands. Finally, in the summary I will collect all indicators related to the quality of education in both countries.

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1. The Dutch system of education

Compulsory education begins at age 4 through age 18.

1a Elementary Education in the Netherlands

From the age of 4 until 12 years, education is called basisschool (elementary education).

History:

Before 1985, “*kleuteronderwijs*” (kindergarten, 4 to 6 years) and “*lagere school*” (primary school, 6 to 12 years) existed as separate independent school types. Both school types also had their own buildings. A separate law for both school types existed and each school type had its own form of teacher education. Because of the different visions on education, the transition from kindergarten to primary school caused problems. Children had difficulties in changing from a kindergarten school, where freedom of choice for activities and working together in small groups was part of their daily routine, into a primary school with mainly frontal teaching and classical instruction, i.e., with little attention to the child’s individual creativity. The transition from the one to the other school caused a break in the continuing development of children. This caused problems in learning to read and calculate and a disinterest in learning in general.

In 1985, the law governing education at the elementary school level changed so that the new goal for education in “*basisschool*” (elementary school) is: the continuing progress in education for every individual child, not only in intellectual but also in physical and social development, as much as possible in a holistic approach.

The “lagere school” (primary school) changed to a school with a more flexible method of teaching, the “basisschool” (elementary school). This meant that the emphasis on things like individual work, co-operative learning and play of young children increased compared to the situation before the merger of both school types. On the other hand the “kleuterschool” (kindergarten) paid more attention to preparation processes for reading and calculation and the observation of children’s behavior in the perspective of learning processes.

In addition to regular elementary education, there was special elementary education for all kinds of students with special needs. In 1997 the government introduced a new policy, called the “going together to school” policy, in order to establish collaboration between elementary schools for special education and mainstream elementary schools. The main reason was to stop the increase of schools just for special education and to stimulate the integration of students with special needs into mainstream elementary education. Parents of students with disabilities get extra money, which enables them to choose the best solution for their child. They can choose an ordinary elementary school or they can use the money to place the student in a school for special education. Because this policy is relatively new, it is difficult to say if this policy is successful.

Structure of elementary education:

Most elementary schools are small; seldom more than 350 students and many of them educate fewer than 200 students, especially in the rural areas.

Classes are divided into age groups with a group teacher who stays one year with the same group, although there are a growing number of schools that are more flexible in the grouping of students. The elementary school is organized into eight year-groups, numbered from 1 to 8. At the age of 4, students are obliged to go to group 1, and at the age of 12 students leave for secondary education.

However, today more schools make a choice for level-groups in reading and mathematics. This means that in these subjects students of different ages, but with more or less the same level, will be taught by a teacher which can be another teacher than their age-group teacher. Schools see these level-groups as a solution to the problem of differentiation within a system of year classes.

A growing number of elementary schools are classified as alternative schools. They change more or less the traditional teacher centered structure of a year-class system to small groups of individualized teaching and learning.

Most common alternative schools are:

- a) Montessori schools: based on a child-centered, individual ways of learning
- b) Dalton schools: based on individual tasks for every student. The founder is an American teacher, named Helen Parkhurst
- c) Jena-plan schools: besides classical instruction and projects, students work in level-groups in mathematics and reading. The founder of this school type is Peter Petersen who worked as a professor in education in Jena and Berlin.
- d) Waldorf schools: Besides different conceptions of the curriculum, Waldorf schools, based on the ideas of Rudolf Steiner, see the kindergarten (4 to 6 years) separated from elementary education. In the elementary education of Waldorf schools, a class of students keeps the same teacher during the whole school period. The goal of education is a holistic approach of intellectual, emotional, social and physical education

Most elementary schools use elements of alternative schools in their teaching and grouping of students. This development has surely improved the education in elementary schools.

Curriculum of elementary education:

The aim of elementary education is to develop children's emotions, intellect and creativity and the acquisition of adequate social, cultural and physical skills.

The curriculum includes:

- a) sensory coordination and physical exercise
- b) arithmetic and mathematics
- c) Dutch language
- d) English language (in last two years)
- e) expressive activities (language, music, drawing, handicraft, play and movement)
- f) self reliance, including road safety
- g) healthy living
- h) a number of factual subjects, including geography, history, science (including biology), social structures (including political studies) and religious and ideological movements.

Attainment targets have been formulated indicating the basic minimum standards schools are required by law to teach their pupils in each area of the curriculum. However, schools have

considerable freedom in the choice of course books and the methods of teaching. Schools can add their own emphasis to the curriculum, dependent on environmental circumstances, the more or less multicultural population of the students, wishes of parents, and the mission of the school.

In the Netherlands, most teachers use textbooks in the various disciplines, mostly complemented with work sheets for students and a teacher book with guidelines showing how to use the textbooks in their teachings. *Most textbooks, especially in arithmetic and mathematics, are developed to use in the context of the classroom. They contain basic knowledge for every student and extra enrichment tasks for better learners.* The quality of textbooks and methods has improved over the years, by using new results of effective learning in their development. By incorporating audiovisual materials and illustrations, textbooks became more attractive for students.

Students need to receive by law a minimum of 880 hours of education per year, during the first 4 years of elementary school (totaling 3,520 hours). This is excluding the lunch break. In the last four years of elementary education, students are taught for a minimum of 1,000 hours per year, in total 4,000 hours as a minimum for the total period. The workload per day is a maximum of 5 hours, excluding lunch time.

Methods of teaching: freedom of schools

Schools in the Netherlands have freedom of education. This freedom is guaranteed by the Dutch constitution. Freedom means: groups of parents are free to found a school, to organize the teaching in school and to determinate the principles on which their school is based. It means that Dutch people have the right to found schools on the basis of their own religion, ideology or educational beliefs and to have them funded by government.

A third of the schools are run publicly ("*openbare scholen*"). These schools are open for all students regardless of religion, ideology or educational beliefs. The other two-thirds of schools are private schools ("*bijzondere scholen*"). They are typically based on a religion, most of them Roman Catholic or Protestant. However, there are also privately or publicly run schools, based on an educational philosophy (e.g. Montessori schools or Waldorf schools).

| *All schools are totally financed by the Ministry, regardless of whether they are private or publicly run.*

There are, however, some conditions to founding a private school. For instance, any school has to have 260 students attending as a minimum. Teachers need to have their license, and the school-plan has to include attainment targets approved by the school inspector (which is appointed by the government).

| *Because of the right to found a school, many communities have all kinds s of schools. Geographical proximity in the Netherlands, combined with good public transport, allows parents to freely choose a school of their preference for their child without any costs. This is one of the reasons why elementary schools are small compared to a country like the USA. This system also leads to some competition between schools and, therefore, improvement in their quality.*

Because of the freedom of teaching, schools in the Netherlands can vary much in the teaching methods. However, many schools are still more or less traditional. Teaching is done in a classroom setting together with individual and group work.

Role of the Ministry of Education, school boards, parents, students in primary education:

Ministry of Education

The role of the Ministry of Education is to create the conditions for good education. New laws are formulated which subsequently have to be confirmed by the Dutch parliament. The Ministry is also responsible for the finance of all elementary schools.

Part of the Ministry is the “Inspectorate” which has to inspect the quality of education and advise the Minister about possible improvements. The “Inspectorate” is completely independent in the advisory role to the Ministry of Education and parliament.

Yearly, every school has to send a school plan to the regional inspector. The inspector will evaluate this plan based on formal criteria set by law. These criteria include among other things: the attainment targets for the various disciplines, the number of teaching hours per year and the licenses’ of the teachers. The inspector does not have the power to comment on the method of teaching or the ideology of the school.

School boards

Every elementary school used to have its own school board but today, most school boards govern a group of elementary schools. Sometimes they also govern secondary schools. The boards are made up of a varying number of members. They are formally responsible for everything relating to the schools. The board will delegate running of the schools to an executive professional staff of typically three members. Amongst them is the “*algemeen directeur*” (comparable with the superintendent in the USA). The executive managers are professionals who decide together with the principals of the different schools what happens in the schools. In all final decisions, however, the school board negotiates with the Ministry, the delegation of parents and other parties involved with the school. *Executive managers will respect the autonomy of their schools and they do not prescribe to the schools what method of teaching they have to use.*

The school boards have a budget, based on the number of students, and school boards are free to spend the money for their best (lump sum finance). For example, the school board can use the budget for more personal, or spend the money for equipment or building. School boards divide the money on basis of number of students to their individual schools and schools have also the freedom to spend the money at the discretion of the interest of the schools.

Parents

Parents are represented in two kinds of councils:

Parent’s councils: these councils consist of parents who have their children at a particular school. They are chosen by all parents to represent the interest of parents in the education of their children.

Participation council (“medezeggenschapsraad”)

These councils have a formal role in judging the decisions of the school boards. They are based on a law on participation councils.

The councils have a voice in the matter of decisions of the board. They have the power to acknowledge or turn down a proposal of the Board. Councils exist of parents, teachers and staff, and students when they are at least 16 years old. Representatives on the councils are chosen by their corresponding groups.

Participation councils play an important role in controlling the quality of the schools.

Participation of parents in schools differs from school to school. It is very common for parents to help out in teaching reading and mathematics in groups 3 and 4 (i.e., 6 and 7 years old students). Besides parent evenings, where the teachers explain their methods of teaching, there are typically three meetings each year in which the mentor-teacher (class teacher) talks with the parents about the progress of their child.

Students

Today students in primary education are placed more in the center of the educational process. Thus schools try to pay more attention to the individual child instead of focussing on the same curriculum for everyone. Special attention to gifted students, the inclusion of students with learning difficulties and a multicultural school population, lead to a more individual approach to students in primary education. *This process of a more individual approach is still going on. It is trying to find out the best ways of differentiation in teaching and curriculum.*

Innovation in primary education:

Improvement plans set up by the Ministry of Education (date 1998)

- **Promoting inclusion of students with disabilities in regular education.** For this goal parents of children with disabilities get extra funding. They can make a choice how to spend these funds, either in a special or a mainstream school. The main goal is that children with disabilities integrate as much as possible instead of being educated in special schools. At this moment it is too early to tell if this approach is successful.
- **Parental involvement.** *Research shows that parental involvement is very important for the school success of children.* Every school needs to have its own complaints’ committee, besides the parent councils and parent committees. From 1999 every school has to produce a school prospectus to inform parents about curriculum and results and to discuss the content of this prospectus.
- **Reducing class size.** *The most important policy is the reducing of class size. This is especially important in the lower grades. Research has shown that a more individual approach for young children is important to raise the quality of education.*
- **Quality improvement.** The underlying idea is to make more tailor-made programs for individual students. *Measures are: developing of intermediate attainment targets, introducing of pupil monitoring systems, improvement of the quality of textbooks and extending the use of information technology. The last point focus’s on ICT as integrated part of primary school arithmetic and language teaching.*

- **Autonomy of the school.** Much more than in the past, schools get the freedom to use the financial resources for personnel and materials that conform to their own needs based on choices for the best education in their particular school. This financial system is called: lump sum finance

Accountability:

Basic education finishes at the end of grade 8 (12 years old students). The students receive a certificate at this point. Although not obligated by law, most schools use the CITO-test (developed by Center for Test Development, a ministerial-founded institute). This test is not an I.Q.-test. It is rather focused on school progress related to the attainment targets in every discipline. Every student is tested externally in his last year of basic education. The school itself uses a pupil monitoring system during all years of primary education. The results of the CITO-test and the judgement of the school are used to advise parents and students about which type of secondary education is best suited for the student.

The pupil monitoring system and the external judgement of the CITO-test currently play an important role in improving the quality of primary education in the Netherlands.

1b Secondary Education in the Netherlands

History:

Secondary education in the Netherlands is very different from the USA.

Secondary schools in the Netherlands are not comprehensive schools. They are divided into streams of independent schools, with separate buildings, different teams of teachers, different examinations and different curricula.

Structure:

| At this time, there are four types of schools:

(See website the Ministry of Education: www.Minocw.nl/english/edusyst/edn100htm)

Pre-university secondary schools, called VWO schools, prepare students for examinations that give the students the possibility and right to apply for all universities in the Netherlands, i.e., without doing special admission examinations. Within these types of schools there are two streams **Gymnasium** and **Atheneum**. The programs are equal except for Gymnasium including Latin and Greek language in the curriculum. A VWO education is six years. Education finishes with an internal and external examination. The external examination, which represents half of the examination, is developed by CITO (National Center for Test development). The other half is conducted internally by the schools themselves.

HAVO schools, senior general secondary education, takes five years and prepares students for higher vocational education or universities for professional education, called HBO. *HBO schools lead to bachelor's degrees in various subjects. The final examinations are nationwide and organized similarly to VWO schools.*

After four years in VWO schools, or three years in HAVO schools, students make a choice between some sets of subject combinations. These subjects are studied in depth. The two final years are called “study house”. The goal of these two final years is to prepare students better for university study.

In reality VWO and HAVO schools form one school type often situated in the same buildings and with a common team of teachers. About 35% of all students who leave elementary school go to either a VWO or HAVO schools.

External examinations have increased the quality of schools and made control of quality and comparison between schools possible. Because of the freedom schools have to choose educational approaches, the choice for of text-books and teaching methods, and the free choice of students and parents to choose the schools of their preference, the results of the examinations play an important role in the choice for a particular school. It also helps in maintaining a high standard of secondary education.

The last school type is called VMBO, pre-vocational and secondary vocational education. It is for students from 12-16 years old. Students are prepared to continue their study in the lower and middle levels of vocational education. When students successfully finish the VMBO after four years, about 76% continue their education at a ROC (regional education center). A ROC is comparable with a community college in the United States. The other 24% enter the workforce, with the obligation to study part-time alongside their job until the age of 18 (apprenticeship).

In VMBO schools there are three streams:

- Junior general education stream leading to ROC or to continued study at the HAVO
- A theoretical-practical stream leading to ROC or work with apprenticeship
- A practical stream leading to lower levels of vocational work

All streams have national examinations like VWO and HAVO schools

Curriculum:

The curriculum of VWO and HAVO schools include all traditional subjects, with Dutch, English and mathematics mandatory during the entire period of study. Before they start the “study house”, students choose two additional foreign languages, typically French and German.

For mathematics there are two streams:

- The “A-stream” is a more applied mathematics education which students need when they go further in academic subjects, especially where they need statistics.
- The “B-stream” is comprised of theoretical mathematics which students need to continue study in science at the university.

In the curriculum of VMBO schools there is a great variety of subjects. However, Dutch, English and mathematics are mandatory during the entire period of study, with the exception of the practical stream.

Accountability:

Compared to elementary education, secondary education is much more structured.

Secondary schools have the same freedoms in their curriculum, methods of teaching, grouping and founding as elementary schools. Similar to primary education, school boards are free to found schools with full funding from the government as the public schools. Secondary schools are less diverse from each other than elementary schools in their structure and way of teaching. This is because of the role of the national final examinations at the end of secondary education and the more subject-centered teaching.

The national examinations are based on attainment targets. Students take the national examinations more seriously and their external motivation for learning is higher than in the United States because their further education will end if they do not pass the examinations. On the other hand, students who pass the examinations have the right to go to any university or college. Universities and colleges do not have admission examinations, the secondary school diploma gives students the right to enter university or college.

Therefore it is crucially important who decides what type of secondary school a student chooses after finishing elementary school. In practice the school principal advises parents on the basis of the CITO test and the assessment of results during the student's school career. Secondary schools can refuse students. *This accounts especially for theoretically more difficult Gymnasium, Atheneum and HAVO schools.*

*As described earlier, at the end of elementary school (at the age of 12 years) every student takes a school progress test developed by CITO (Central Test Institute for Education). The test results and the opinions of the school staff lead to advice about suitable secondary education. The CITO test is not obligatory **but more than 90% of all elementary schools** participate on a voluntary basis in the CITO test. Schools are compared to each other on the test results. Hence, good test results will help attract new students.*

Because of the fact that the CITO test is mainly focused on reading, language, mathematics and science, the results in these areas improved during the last years. The question still remains how far the emphasis on reading and mathematics leads to a negligence of other more difficult assessable subjects like arts and social skills.

Innovations in secondary education as presented by the Ministry of Education:

challenges and improvements in the coming years

As society becomes more complex, more international and heterogeneous, it is a challenge to evaluate to what extent the current curriculum is still suitable in contemporary society.

However, this will only be possible when schools become an attractive learning and living environment. Students need to understand that what they learn at school is relevant for their future in society, in the labor market or for their further education.

This is why schools have to collaborate with key stakeholder such as cultural, social and welfare institutions, trade and industry, and regional training centers. Toward this goal:

- a) Schools will change from teaching centers into learning centers. This means that the focus on students will become more central. The educational career of students will be more important. This implies more continuous learning opportunities.
- b) Schools need more freedom to develop their own learning plans, because of specific situations of students and their social environments.
- c) The government should create conditions and develop general frameworks, for example the attainment targets and the exit qualifications.

- d) *Dealing with differences implies the development of tailor-made programs for students with special needs, not only related to the capacities or disabilities of students, but also to students with other cultural backgrounds or social-economical circumstances.*
- e) *Central examinations will be kept as an important instrument to ensure the quality of education. It is also of great value as a passport function and guaranteed access to post secondary education. The central examinations need improvement, especially for the VMBO schools.*
- f) *The application of ITC needs to be integrated in the innovation of education and new ways of teaching.*

2. The Flemish system of education

2a Elementary Education in Flanders

Structure:

Similar to the Netherlands there is freedom of education and the establishment of schools on religious and ideological grounds. Schools based on these grounds are called free schools (“vrije scholen”). Schools not based on these grounds are public schools. However both schools receive the same level of funding.

To be precise there are actually three types of schools:

- Schools run by the State “*gemeenschapsonderwijs*” (governmental education)
- Schools run by counties or cities “*officieel gesubsidieerd onderwijs*” (officially subsidized education).
- Schools run by foundations; in Flanders Roman Catholic schools are by far in the majority. The difference from The Netherlands is that these schools are organized and run by a network of these schools. They set the standards for the curriculum and the results that have to be achieved. Hence, Dutch schools have more freedom to fill in the curricula.

In Flanders, elementary education is obligatory from the age of 6 until 12. The schools are called “basisschool” (basic school). The government, however, pays for the cost of education from the ages of 2.5 to 18.

The first years of elementary education are called “kleuterschool” (nursery school). Children from the age of 2.5 until 6 years old attend these schools. *Nursery schools are mostly incorporated in elementary schools.* They differ in that there is different legislation for them. Nursery school is not obligatory but costs are nearly 100% covered by the Flemish government. Also children can have an extended school day so that parents are able to work. The goal of the nursery school is to prepare children for further education in basic school.

Curriculum:

For the nursery schools, the government has set attainment targets: physical education, artistic education, Dutch language, world orientation and initiation in mathematics. Typically schools do much more than just this basic program.

The basic school has the same attainment targets as the “kleuterschool” but the attainment targets have to be assessed externally by the school inspectorate.

Basic education is divided into three, two years periods or grades. In the first year of every grade the students learn new knowledge, in the second year the knowledge is consolidated and deepened. ICT is not a discipline but has to be integrated in the other subjects.

Every year nursery and elementary schools have to develop a “school work plan” that must be signed by a school inspector appointed by the Ministry of Education.

Because of the network to which most schools belong, the “school work plan” in Flanders is an official document. This is opposed to a Dutch “school work plan” which is not an official document. It is rather an extended document describing the methods of teaching.

The competition between the networks in recruiting students is even more fierce than in the Netherlands. The reason is that in Flanders there are in fact only two networks, the public schools and the catholic schools. Parents are very involved and many do volunteer work to improve the quality of teaching or to improve the buildings.

Methods of teaching:

Generally Flemish schools are more focused on the age group as a whole, while Dutch schools put more emphasis on the individual student. There is less variety and there are less alternative schools in Flanders than in the Netherlands. There are also fewer differences among curricula.

Role of ministry of education, school boards, parents and students:

The Flemish parliament finances all education and controls the schools by inspection, regardless of the networks of the schools. Parents do not have an official parent council. However, there are often parent committees and there are strong parent organizations related to the networks.

Students: In Belgium generally, the size of classes is lower than in the Netherlands. Inclusion is a topic in Flanders. For students who are unable to speak Flemish (Dutch) there are special classes. There they can stay for a maximum of a year to learn Dutch before going on to regular education. The main activity during that period is mastering the Dutch language. Gaining social skills, common values and democratic principles are part of the curriculum as well.

Accountability:

At the end of each school year, students have to pass an assessment in order to be promoted to the next year. In Flanders, students in basic school can double a class, taking the same class again. This is not allowed in the Netherlands. At the end of elementary education, students receive a diploma. If students do not have enough credit points, they will leave elementary education without a diploma. These students continue on to secondary education where they can get the elementary school diploma after passing a different assessment usually upon completion of secondary education. Like in the Netherlands, schools have to send their school curriculum to the inspector before the start of a new school year.

2.b Secondary education in Flanders

Structure:

Secondary education, similar to the Netherlands, is divided into different school types. There are no comprehensive high schools.

There are four different types of schools:

- General Secondary Education or A.S.O. (“Algemeen Secundair Onderwijs”). It provides broad theoretical training for higher levels of a university education.
- Technical Secondary Education, or T.S.O. (Technisch Secundair Onderwijs). It is comprised of mainly technical and theoretical subjects combined with more general subjects. This school leads to higher technical education or to a professional life.
- Art Secondary Education, or K.S.O. (Kunst Secundair Onderwijs). It prepares for higher art education or a professional life.
- Vocational Secondary Education, known as B.S.O. (Beroeps Secundair Onderwijs). Students acquire specific skills and simultaneously receive general education.

It is possible for students to switch from one school type to another. For example, B.S.O. school students can complete an extra year of schooling and still go to university. However this happens rarely because of the small theoretical part of this type of secondary education.

The different school types in secondary education all have three stages. The first stage, i.e., the first two years, has a common curriculum for all school types. The other two stages are different depending on whether the student is preparing for university, higher education, or vocational education. After the third year students have to make a choice in which direction they want to receive further education or in which direction they want to take their careers. They then will get a basic program focused on that direction. There is little choice of other subjects.

Although there is freedom of education, there are more rules than in the Netherlands. (For example, the minimum number of teaching hours for every subject and the formal described attainment targets)

Methods of teaching:

The method of teaching is traditional, based on instruction for the whole class. It is a teacher-centered instruction method. Students can repeat a year, in contrast to the Netherlands where it is not allowed anymore. Teachers use more textbooks instead of creating their own teaching materials. There is less integration of subjects than in primary education.

Role of the Ministry of Education, parents and students:

The ministry of education controls the quality of the schools through inspectors. They visit each school at least once every three years. For secondary schools there are inspectors related to subjects, for instance for language or mathematics.

Parents are not directly involved in secondary education, but they have meetings with teachers and their child at least three times per year to discuss school results.

Students are less independent in the learning process compared to the Netherlands. They are more controlled in their behavior.

Because 70% of the schools in Flanders are Roman Catholic, there is a more hierarchical relationship between teachers, students and parents.

Examinations:

In Flanders there are no central external examinations like in the Netherlands. Schools organize the assessments themselves. The way they organize this is, however, under the control of the inspectorate.

3. Analysis of mathematics education in the Netherlands and Flanders based on the results of the PISA Research 2003

3a Introduction to PISA research

PISA stands for “Program for International Student Assessment”. This assessment is organized by the O.E.C.D. (Organization for Economic Co-operation and Development). A large number of countries are interested in comparing learning results of students on the basis of common standards. International experts in education developed specific assessment tests for this reason. The tests started in the year 2000 with the participation of 265,000 15-year old students in 32 countries. In 2003 the tests were repeated. 41 countries participated in the tests. In 2006 a third cycle of tests will take place, with at least 55 countries participating.

The PISA research is restricted to the subjects of reading, mathematics and science. The main goal is to test whether students at the age of 15 are capable of applying knowledge and skills in these subjects to every day life. Students fill in questionnaires regarding themselves. School principals also contribute by filling in questionnaires about the schools. This allows PISA-researchers to analyze factors that contribute positively or negatively to the test results.

In 2003 the international PISA-research was focused on mathematics education (see tables 2.11 and 2.12) in 30 O.E.C.D. countries, including The Netherlands and Belgium, and 11 partner countries, among them the United States.

3b PISA results in mathematics in the Netherlands

The Netherlands ranked third in mathematics, with a score of 538, after Finland and South Korea. (The average score being 500) The Netherlands not only had high scores in mathematics but also in reading and natural science. Only Finland had a higher general score (see figure 2.9).

It is remarkable that the scores in mathematics, reading and science are high in all three subjects. General factors in the educational system might explain high test results in all three major subjects. However, cultural backgrounds of students might also contribute to this explanation. At the same time, more or less good teaching methods used in any of the subjects are unlikely to explain higher test results in all three major subjects.

The PISA-test scores in mathematics results are divided into different skill levels. Level 5 and 6 indicates a score higher than 550 points. Level 4 is a score between 500 and 550 points. Netherlands had also a high score in the number of students with levels 5 and 6, even higher than Finland, which has a higher general score in mathematics. 25.5 % of the 15 years old students in the Netherlands had a score of level 5 or 6. In addition, the Netherlands had the lowest number of students who have result below level 1 (standard below 350 points) It seems that the new method of teaching mathematics has had a positive result, not only for fast learners but also for slow learners.

The Netherlands also had the lowest difference between boys and girls in the score in mathematics, compared to the other countries. Teachers of mathematics confirm that since the use of realistic mathematics teaching, female students are more motivated to learn mathematics. An explanation could be that female students learn more emotionally than male students, and that realistic mathematics is less rational than the traditional way of teaching mathematics.

The mere fact that the Netherlands scores better on mathematics than most other countries does not mean that results are satisfactory. This is because the PISA-research does not define what sufficient results in mathematics are. It only defines common standards in mathematics. PISA-research includes four elements of mathematics: shape and space (i.e. geometry), algebra, and uncertainty, quantity. Dutch students are predominantly good in algebra. They score less well in geometry.

In the PISA-research more then 50% of the Dutch students had a score below level 4 (i.e. below 500 points).

Level 4 includes:

- Usage of explicit models to solve more complicated calculations and working with assumptions.
- Students must be able use and integrate representation forms; use of symbolics in the context of realistic situations.
- A student must be able to give explications and he must be able to defend solutions on the basis of their interpretations.

The Dutch government has the intention to develop the Netherlands as a highly developed knowledge society. This means that most Dutch students have to reach level 4.

On the other hand, the number of students in level 1 (i.e. below 350 points) is very low compared to other countries. This means that the education in mathematics in the Netherlands is successful in teaching basic skills to students with learning difficulties.

3c.1 PISA results in Mathematics in Flanders and different scores in Walloon Provinces

Analysis of PISA results in Walloon and Flanders

The PISA research shows that Flanders had the highest score in mathematics of all countries. The difference of results for the Netherlands and Finland are small. The score for Flanders was 555. In the Netherlands the score was 538. The average score in Belgium as a whole is 529. The score in the French speaking part of Belgium (Walloon) was 490.

Educational advisors, with experience in both parts of the country, give the following reasons for the differences between Walloon and Flanders:

1) Flemish and Dutch teachings in mathematics are based more upon realistic mathematics (see point 5: Freudenthal). In contrast, the Walloon mathematics teaching is oriented towards formal mathematics.

2) Walloon and France are less focused on mathematics education in comparison to Flanders. In Flanders schools spend at least 5 hours per week on mathematics education in the first stage of secondary education.

In the other stages (i.e. stage 2 and 3) mathematics education remains important. Schools provide at least 5 hours per week of mathematics to the students in the third stage. However, students who want to study science at the university, have to take 9 hours of mathematics per week.

It needs to be said that there is a growing resistance among Flemish teachers against this very rational conception of education, with too much attention on mathematics. Many teachers complain that the social and emotional development of students has little attention in the curriculum in secondary education.

3) The difference in the initial qualifications of teachers could have an impact on the results in Walloon. It seems that the qualifications at the end of teacher education in mathematics are lower in the Walloon than in Flanders.

4) The difference in the economic situation in Flanders and Walloon might also contribute to an explanation of the differences in the test results of the PISA-research. The unemployment rate in most Walloon provinces is much higher than in Flanders. The main reason for this inequality is that many industries with relatively low-skilled employees went bankrupt or moved production to countries with low wages.

The much lower test results in all subjects in the Walloon provinces might be explained in particular by the last two factors (i.e. lower initial qualifications of teachers and a different cultural and economical background). The different teaching methods in mathematics are most likely not the only reason for the different test results in Flanders and Walloon.

Unfortunately, there is no real research available to substantiate this hypothesis.

3c.2 Influence of the Freudenthal Institute in Flanders as explanation of the high PISA-scores.

After a meeting with an inspector of mathematics in Flanders, I received the following information. Realistic mathematics has a great influence on education in mathematics in Flanders. This is reflected in mathematics textbooks that are used in Flanders. Realistic mathematics education stimulates and motivates students in learning mathematics because students see the relevance of mathematics in real life. On the other hand, students do not have enough knowledge of the formal aspects of mathematics like multiplication when they leave secondary education. Universities complain about a lack of knowledge and skills in formal mathematics operations when students begin science study at the university. This lack is the reason that the Flemish teachers want to include some '*opereatoire*' mathematics. *This is a combination of realistic mathematics and formal skills of calculation and mathematics (mechanistic mathematics). See further explanation under point 3.c.3*

3c.3 Methods of teaching mathematics in the explanation of the PISA-results

For a good understanding of the influence of realistic mathematics education, a description of methods (streams) in mathematic education in the Netherlands and Flanders can help us to understand the method and place of realistic mathematics in the development of mathematics education.

Four streams (and methods) in mathematic education have had and are still having an influence on mathematics education.

Mechanistic mathematics education

This concept is based on the behavioristic learning theory (Skinner, Gagne). Until the sixties, this concept was very common in the Netherlands and Flanders. Students learn formal rules with a lot of repetition. The teacher plays a leading role and students learn mathematic skills without placing the concepts in a context. There is little attention to problem solving. Currently there are no textbooks based on this conception of mathematics education. There are, however still some elements incorporated in textbooks. This is more true for Flemish textbooks than for Dutch textbooks. In this method, students have to take small steps to get results in more complex calculations.

Structuralistic mathematics education

In this concept, based on the ideas of Bourbaki, Resnick and Ford, mathematic structures are central. Very early on children have to learn basic structures. A lot of interaction between the teacher and the students takes place during the lessons in mathematics. There is, however, very little connection with real context.

Empirical approach of mathematics

The starting point is the interest and experience of students. The role of the teacher is not to steer the learning process, but rather to create a rich learning environment. Children learn spontaneously and they are motivated when they can decide how, what and when they want to learn. Seen from a point of motivation, this concept is right. This concept is related to the theories of Montessori and Piaget. The problem is how to bring students from spontaneous discovery to learning of more formal mathematics operations. The teacher stimulates research by students. Little help on how to solve the mathematical problem at hand is presented to the students. In the Netherlands and Flanders this approach to mathematics is common in traditional alternative schools, like Montessori schools, Waldorf schools, and Jenaplan schools. These schools form a minority of the total schools, but their influence is increasing, even in the regular schools. This approach, also called experience based education, expects every student to have enough motivation and experiences to start learning by himself. However, students with a family background in which they are little stimulated, or with a poor cultural background, need more guidance from teachers.

“Realistic mathematics” as developed by Freudenthal Institute

(The following text is based on an interview with Dr. Truus Dekker, staff member of Freudenthal Institute.)

The Freudenthal Institute has developed a new way of teaching mathematics. Professor Hans Freudenthal (1905-1990) founded it in 1971 as a part of the faculty of mathematics and science at the University of Utrecht. The main goal is to teach mathematics on a realistic basis. It means that mathematics should play a role in the real life of children and adults. It is opposed to the formal way of teaching mathematics at the universities. Students have to recognize that reality has a quantitative aspect. A student can investigate this aspect of reality by using mathematics and arithmetic.

Learning mathematics and arithmetic is a creative process. It is more than just passively learning formula and equations. It starts in early childhood. The relation between sensorimotoric learning, discovery learning and the manipulating of quantities, form the basis of mathematics learning. Memorizing of formulas comes much later. First students learn mathematics in a context of real problems.

One of the problems in traditional mathematics education is motivation. This is because students see math as remote from real life. The Freudenthal Institute developed a theory of realistic mathematics education (RME), as a result of research of teaching mathematics in the classroom. It is a process of continuing collaboration between theory and practice, of doing research in schools, testing materials and observing the learning process in mathematics. RME as developed by Freudenthal Institute has become a large international network. Many co-operative projects with other institutes and schools, national and international conferences and summer courses take place. Freudenthal has its own journal and staff members publish in educational journals, newsletters and websites.

3d Influence of realistic mathematics in schools in the Netherlands and Flanders.

The change from formal to realistic arithmetic and mathematics started at the end of the seventies and early eighties, beginning with elementary education in Dutch schools. In the elementary schools it is called: WISCOBAS (“wiskunde voor de basisschool”). In realistic mathematics there is no separation between arithmetic and geometry. In the eighties new textbooks appeared, based on realistic mathematics which the majority of schools started using. At the same time, teacher educators in mathematics and arithmetic did an in-service course in realistic mathematics. Subsequently they started to teach these methods to student teachers. An extended program started in the training of student teachers at the teacher colleges for primary and secondary education. This came together with schools organizing meetings to inform parents about the changes in mathematics education. This enabled parents to help their children with their homework.

The Freudenthal Institute has stimulated [a great deal of](#) innovation in mathematics education. It is a successful example of an innovative project in the Netherlands and later in Flanders.

4. Explanation of the results of the PISA score in mathematics in USA

This explanation is based on an interview I had with Dr. Truus Dekker, staff member of Freudenthal Institute. She is also connected with the Freudenthal Institute in the USA.

The mathematics score of the USA in the PISA-research of 2003 was 483. The country ranks 31st out of 42 countries. In the other researched areas the results for USA are as follows:

- reading: average of 495, (20th place)
- problem solving: 477 (31st place)
- science: 491 (24th place)

What are the reasons that the results in the United States on PISA are not very high compared to most European and Asian countries?

I believe that the following factors play a role in the explanation of lower results:

1. *The United States is too focused on test scores and formal education in mathematics*
Research in England suggests that results improve on a short-term basis but that these results are not sustained over a longer period of time. The curriculum becomes narrowed and teachers are too focused on test results rather than on the learning process.
2. *In many schools in [the United States](#) there is a lack of continuity in the curriculum for mathematics. Many teachers develop their own teaching materials and lesson plans. Because of this, there are gaps in student knowledge and students drop out when they can no longer follow the lessons.*
3. *In the Netherlands schools can make use of good textbooks, because publishers collaborate with the Freudenthal Institute. These textbooks contain lessons for the different grades and they give a description of the content of lessons by week. The lessons in the textbooks contain basic content for all students, enrichment tasks for fast learners, remedial tasks and rehearsal tasks.*
On average, half of the time, students work by themselves or in small groups. The other half is direct teaching by a teacher in front of a class. Students have access to specialized computer programs and worksheets that enable them solve mathematical problems. Students can check their answers with the computer program.
4. *It requires a high level of education when teachers choose to work without proper textbooks. And when they opt to work without textbooks, teachers must be prepared to invest a considerable amount of time in preparation.*
Many teachers are not sufficiently educated in many states in the United States. There is also a lack of quality teachers as a result of the fact that the social status of teachers has degraded over time.
Moreover, many students who are studying mathematics leave education because of financially more attractive jobs. These reasons make good textbooks even more urgent. Currently the Freudenthal Institute has an office in the United States. In Philadelphia realistic mathematics is being introduced in all schools. I do not know if the results have improved since the introduction of realistic mathematics in Philadelphia.
5. *The typical class-size plays a less important role. In the Netherlands, the average class size is around 26 students per class. In the United States, the average class size is lower. In many classes there are also extra class-assistants and remedial teachers.*
6. The total cost per student in elementary and secondary education is lower in the Netherlands and Belgium than in the United States. The same is true for teacher salaries. Only in the upper levels of secondary education are salaries of

teachers higher in The Netherlands. This however cannot play an important role in the explanation of higher scores in mathematics of the 15 years old student, as shown in the PISA-research.

7. Centrally organized examinations by the Dutch Ministry of Education might explain good test results in mathematics. Without a diploma based on these central examinations, students cannot continue academic or vocational study.

5. SUMMARY OF INDICATORS

5.1 Indicators which could explain good results in education in general in The Netherlands and Belgium

- The merger of kindergarten and elementary school in The Netherlands has a positive influence on the continuity of the learning process of children. It also allows for a more flexible and child centered learning process in the newly created “basis-school” for students from 4-12 years. (see page 1)
- The combination of early childhood, kindergarten and elementary school in one building (pupils from 2,5 years until to 12 years). Education fully paid by government has a positive effect on the continuity of education.
- The possibility of parents of students with special needs to spend the money as they think appropriate for their child, may be a good development in raising the quality of education for these children. (see page 5)
- The relatively small elementary schools in The Netherlands and Flanders (in most cases not more then 350 students) seem to improve the quality of education. This is giving parents a wider choice of schools for their children.
- The development of level groups in elementary education in some subjects like reading and mathematics solve the problem of differentiation between age groups. (see page 2)
- The good elements of the alternative schools, namely the child-centered education could be enrichment for more traditional class centered education. (page 2)
- The formulation of attainment targets and the freedom of schools in their teaching methods and philosophies seem to lead to good results. (see page 3)
- The use of good textbooks in most disciplines is surely one of the main reasons that the education in The Netherlands and Flanders results in high scores in most disciplines. (page 3)
- The freedom of education gives parents the right to found schools based on their religious background or educational ideas. It causes a lot of variety between schools and the freedom to choose between these schools. It also stimulates competition between schools. (see page 3/4)

- The control of quality of schools by an independent and external inspectorate is a good instrument to get an independent view on the results of schools. This control makes it possible to compare schools with each other on their results. (page 4)
- The role of the executive managers in relation to the school principals and the school boards guarantees a more professional management style. This is done without undermining the independence and responsibility of every individual school. (see page 4)
- Lump-sum finance is a good strategy to give responsibilities to schools. Schools and school boards can make their own choices and set their own priorities. This is contrary to a centralized financing model. In that way the Belgian system of finance is more centralized. There the networks and the Flemish government have more control over finances. (page 4)
- Participation councils on a legal basis can play an important role in controlling the quality of schools. When they have a right of agreement in important questions, they can force the board to make well-considered choices. (page 5)
- The pupil monitoring system and the external judgement of the CITO-test at the end of elementary education play important roles in improvement of elementary education. (page 6)
- Integration of ICT in primary and secondary education is important (especially in arithmetic and mathematics). It makes it possible to design differentiated tasks, thereby enabling remedial teaching. (page 6). Publishers design new methods including software.
- External examinations in secondary education organized by the government may be the most important reason [that these countries can maintain](#) high standards. It makes comparison between schools possible by which parents can choose [a](#) school for their children. (page 7/8)
- The national examinations in secondary education in the Netherlands are important for increasing the standard of education and improving the results in nearly all subjects. Certificates allow students to continue their study at university or vocational education.
- Selection of students, by means of the CITO-test, at the end of elementary education has improved the results in the three main subjects (reading, mathematics and science). However, the results in other not assessed subjects have decreased.
- In Flanders the beginning of the nursery school for children at 2.5 years improves the development of children, in particularly children with a poor cultural background.
- The competition between the school networks in Flanders raises the standard of education. These networks play an important role in the quality of education. The control on the schools works in the same way as the external examinations in the Netherlands.

- In Flanders the control over the curriculum of schools is stronger. The method of teaching is more class-focused in comparison to the Dutch student-centered teaching method. It is unclear how much external control influences the quality of education.

5.2 Indicators for mathematics education in The Netherlands and Flanders.

- [Analysis of the PISA results \(2003\) suggest that](#) in the Netherlands and Flanders the method of teaching plays an important role in the explanation of the strong results in mathematics.
- But also general indicators of the Dutch and Flemish educational system are important influence on results. The results are not only good in mathematics but also in other areas such as reading and science. (page 13)
- Despite the good results, the Dutch government is not satisfied. The Dutch government strives to a level 4 in the PISA-score, as a minimum for most students, to be competitive in the knowledge society.
- It is unclear if the difference in PISA- scores between the Walloon and Flemish provinces is caused by a more realistic way of teaching mathematics in Flanders, or by cultural and economical differences between both states. (page 14/15)
- The influence of realistic mathematics, as developed by Freudenthal Institute of the University of Utrecht, has a great impact on the innovation in mathematics education. This influence is visible in the textbooks of mathematics in both countries. It also has improved the motivation to learn mathematics because of the more direct relation of mathematics with real life.(page 16/17)
- Realistic mathematics could only be successful because of its embedding in a total innovation project, including in teacher education, textbook development, and information to parents.

6. Websites and literature

<http://www.minocw.nl/english/index.html>

This web site gives information by the Dutch Ministry of Education in English.

http://www1.oecd.org/scripts/cde/members/EDU_UOEAuthenticate.asp

This web site informs about the outcomes of the OECD research in education in countries in the European Union, publicised in “Education at a Glance”. Ministry of Education, Culture and Science: Education at a Glance 2003: OECD indicators.

Web site: http://taalunieversum.org/onderwijs/termen/vlaanderen/primair_onderwijs/

This site is dedicated to the Flemish education system. The site is in the Dutch language.

<http://www.pisa.org>

Outcomes international: education overall.

<http://www.ond.vlaanderen.be/English/>

Description of the educational system in Flanders.

<http://www.fi.uu.nl/>

Publications of the Freudenthal Institute, University of Utrecht.

http://www.isec2000.org.uk/abstracts/papers_t/tanciq_1.htm

A publication of Tansig at the ISER conference. Research about early education in mathematics.

Treffers, A.: Three dimensions. A model of goal and theory description in mathematics.

Tomic, W and Span, P: Onderwijspsychologie, Open University, Heerlen (not in English available), page 310-328: conceptions about mathematics education.